



TECHNICAL  
SPECIFICATIONS  
ISSUED FOR BID

**Greenland Water Treatment Plant  
Phase 2 - WTP, Wellhead Mechanical,  
and Raw Water Main**

JEA Project No. 8004372

JEA  
Jacksonville, FL

December 2019





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SECTION 01010  
SUMMARY OF WORK

PART 1 GENERAL

1.01 LOCATION OF WORK

- A. The work of this Contract is located at the Greenland Water Treatment Plant (WTP) at 6850 Energy Center Drive, Jacksonville, Florida 32256.
- B. It shall be noted that the Greenland WTP site is located in a secured Owner site with restricted access, referred to as the Greenland Energy Park. The Contractor will be responsible for complying with Owner security measures applied at this site.

1.02 SCOPE OF WORK

- A. Owner is implementing an expansion to their existing Greenland WTP to serve the south-central and southeastern portions of Owner's potable water distribution service area. The Phase 2 (the work) expansion will result in a finished water capacity of 9.0 million gallons per day (mgd) on a maximum day demand (MDD) basis of production. The work shall include the following;

The addition of a new backup 2,000 gallons per minute (gpm) Backup well (Well No. 3) with a variable frequency driven (VFD) vertical turbine well pump, in conjunction with the two existing 2,500-gpm production wells, and will allow the finished water capacity to be met on a "firm" basis. Raw water will be conveyed from Backup Well No. 3 to an existing stub-out at existing Production Well No. 2 via approximately 2,800 linear feet (LF) of 16 inch DR25 PVC raw water main. The Backup Well No. 3 facility will include associated electrical, instrumentation and control equipment, including a motor control center (MCC) and VFD. The Backup Well No. 3 site work will include an access driveway, site fencing, lighting, facility access gate, and associated landscaping. The addition of a new 1.1-million-gallon (MG) ground storage tank (GST) will increase the finished water on-site storage to 2.1 MG total. One new 2,000-gpm high service pump (HSP) will operate in parallel with four existing HSPs (two 2,000-gpm and two 1,000-gpm), and will provide a firm high service pumping capacity of 8.64 mgd. The existing sodium hypochlorite feed and storage system will include modifications to make the system less vulnerable to environmental conditions. A new 750 kW emergency power generator and a 5,000-gallon above ground fuel tank will provide emergency WTP operations at the current firm capacity. The ozone injection system will also be evaluated for redundancy and possibly adding a third ozone injector assembly.

- B. Contractor shall provide Owner the ability to operate the existing WTP to its full capacity, including, but not limited to, well pumping, disinfection, emergency generator and high service pump capabilities during construction until Owner acceptance of the new WTP facilities.
- C. Contractor shall comply with the JEA (i.e., Owner) Manual of Water and Wastewater Standards and Specifications, issued January 2019 or latest version, during construction for standard construction details and specific requirements, unless shown otherwise on the Contract Drawings and specifications.
- D. Contractor shall coordinate their Work with the Work by Owner and/or Others to avoid construction and schedule conflicts.

- E. As specified herein, Owner will coordinate with Contractor for removal of temporary facilities and temporary pumping equipment with subsequent off-site transport of said equipment by Owner so as to not hinder the Work of the Contractor. Such removal of equipment shall include the removal and transfer of a temporary security fence around the immediate well site to the Owner. Contractor is also advised that a portion of the Greenland WTP site, not impacted by the Work specified herein, may be designated as a parking area for non-Owner entity vehicles. Contractor shall make reasonable accommodation for any work by Others for the construction of the said parking areas.
- F. The scope of work for this contract shall include but is not necessarily limited to, the following, all in accordance with the Contract Documents:
1. Mobilization/Demobilization, General Requirements, Bonds and Insurance, Permitting, Project Controls, Testing, As-Built Drawings.
  2. Demolition: Prior to demolition of equipment or facilities, the Contractor shall coordinate with Owner on any Owner-designated equipment identified to be salvaged. Contractor shall only be required to move the identified equipment and/or materials to an on-site storage area with temporary covering or protection from the elements for subsequent removal by the Owner. Included in the demolition is the following areas; additional demolition is as shown on the drawings or specified herein.
    - a. The existing 500 kw Generator and Fuel Tank shall be removed and relocated to an offsite JEA facility. The following is included in this demolition and removal.
      1. Fuel to be removed and properly disposed of by the contractor.
      2. Tank to be cleaned for closure with notification to the proper state agency.
      3. Removal and transport of the abandoned generator to a new JEA facility (2740 County Road 210W)
      4. Unloading of the relocation of the existing generator and fuel tank, at the new facility and unloading and placement on the site on a new concrete slab..
  3. Site Work
    - a. Erosion Control;
    - b. Site Restoration including Seeding, Sodding, Paving and other Restoration;
    - c. Miscellaneous Paving, Grading and Drainage;
    - d. Fencing
    - e. Yard Electrical and Instrumentation improvements;
    - f. Yard Piping; and
    - g. Demolition
  4. Construction of Backup Well No. 3 to include the mechanical outfitting, electrical and instrumentation/control as specified herein, including, but not limited to:
    - a. Well Pump, Motor, VFD and Accessories
    - b. Well Header Piping, Valves, Fittings and Appurtenances
    - c. Concrete Pad
    - d. Site Work Access Road, Site Swing Gate and Fencing, and Final Grading
    - e. The drilling and testing of Backup Well No. 3 will be by Others. Contractor shall, if requested by Owner, remove any temporary pumps, piping or hoses, and other miscellaneous equipment used for temporary pumping of raw water. This equipment shall be moved to an identified portion of the well-site for subsequent removal by Owner.

- f. Raw water piping from well site no. 3 to a connection to the existing raw water supply pipe adjacent to well site no. 2.
5. Construction of a new 1.1-MG prestressed concrete storage tank with piping, drainage and accessories as specified herein.
6. Furnish and install a new horizontal split case high service pump and additions and modifications to the process piping and all associated valves and appurtenances, as shown on the drawings and described herein.
7. Furnish and install new sodium hypochlorite feed and injection system modifications as shown on the drawings and specified herein.
8. A new 750 kw Emergency Generator and new 5,000-gallon Fuel Tank, as shown on the drawings and specified herein. Provide at least 75% of the rated storage capacity of the fuel tank for startup purposes, or approximately 3,750 gallons.
9. Modifications to the ozone system.
10. Operational and maintenance manuals for all equipment
11. Equipment and services for acceptance testing
12. Review of equipment installation
13. Warranties and bonds
14. All testing required during construction and startup
15. All instrumentation and electrical components including conduit, wire, electric motors, control panels, and field instruments
16. All permits necessary, including, but not limited to, the FDEP Specific Permit to Construct PWS Components, SJRWMD/FDEP Environmental Resource Permit (ERP) Minor Modification Letter Permit, FDEP Generic Permit of Produced Ground Water, COJ 10-Set Review, and COJ Site Clearing Permit.
17. All other work in these contract documents not covered by the items listed above.

#### 1.03 WORK SEQUENCE

- A. Perform Work in sequence listed below to ensure completion of the Work in the Contract Time. Completion dates of the various stages shall be in accordance with the approved construction schedule submitted by the Contractor. The Greenland WTP is an existing operating WTP plant and is required to maintain the current plants rated permitted capacity (approximately 6.0 mgd), except for outages (less than a 6 hour time increment) as approved by the Owner.
- B. A general construction sequence is provided in Specification Section 01014. It is highly critical for the existing plant to remain in service while the proposed improvements are being implemented with the exception of pre-arranged, scheduled, temporary shutdown periods for interties and connections.

- C. The Sequence described in Section 01014, requires completion of the mechanical outfitting of the raw water production well and the raw water pipeline to the connection point at well site no. 2, within 10 months of the Contractors Notice to Proceed (NTP) date. The overall construction schedule, as identified in the Agreement, is required to be substantially complete within 15 months (or 450 days) of the NTP date, with a final completion date of 16 months (or 480 days) from the NTP date.
- D. The Contractor shall submit a construction schedule including ancillary functions including shop drawing preparation and submittal, off-site and on-site testing, commissioning activities, and performance testing to the Engineer for approval prior to commencing work. Completion dates of the various stages shall be in accordance with the approved construction schedule submitted by the Contractor.

#### 1.04 CONTRACTOR'S USE OF PREMISES

- A. Contractor shall have use of the premises for the performance of the Work at the Greenland WTP site only. Contractor shall coordinate activities with Others who may be performing work in the same general area.
- B. Contractor shall limit the use of the premises for their Work and for storage to allow for:
  - 1. Work by Other.
  - 2. Owner occupancy
  - 3. Designated parking area for non-Owner entities
- C. Coordinate use of premises with other Contractors and Owner.
- D. Contractor shall assume full responsibility for security of all their subcontractors' materials and equipment stored on the site.
- E. If directed by the Owner or Engineer, move any stored items which interfere with operations of Others.
- F. Obtain and pay for use of additional storage or work areas if needed to perform the Work.

#### 1.05 CONTRACTOR'S STAGING, STORAGE AND STOCKPILE AREA

- A. A staging, storage and stockpile area will be made available by the Owner at the project site. The Contractor is not allowed to store any equipment outside these limits.

#### 1.06 OWNER OCCUPANCY

- A. Owner will occupy premises during performance of the work to conduct normal operations of the Greenland WTP. Coordinate all construction operations with Owner or Engineer to minimize conflict and to facilitate Owner usage.
- B. Contractor's Responsibilities
  - 1. Coordinate delivery date and unloading equipment requirements, inspections, and storage for each pre-purchased item with Owner.

2. Review shop drawings, product data and samples. Notify Owner and Engineer of any discrepancies or problems anticipated with use of pre-purchased item.
3. Receive and unload items at site including Equipment provided by Others, specifically the high service pump and motor.
4. Inspect items jointly with Owner and record any shortages, damaged or defective items including Equipment provided by Others, specifically the high service pump and motor.
5. Assume responsibility for items, including insurance, upon acceptance of items at site including Equipment provided by Others, specifically the high service pump and motor.
6. Handle items at site, including uncrating and storage as well as handling Equipment provided by Others, specifically the high service pump and motor. Protect items from exposure to elements and damage.
7. Install and test high service pump and associated motor.
8. Assemble, install, connect and finish products and provide warranty for Contractor furnished materials and workmanship as specified.
9. Repair or replace items damaged as a result of Contractor's work.

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SECTION 01014  
CONSTRUCTION SEQUENCE

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. This Project consists of work on property owned by JEA (Owner). The Greenland WTP must remain in continuous operation during construction of this project. Portions of the system can be taken out of service for short durations (maximum of 6 hours) with prior approval from the Owner. All required interruptions with Greenland WTP operations including piping, electrical, and instrumentation connections shall be coordinated with the Owner and Engineer. Contractor shall notify the Owner and Engineer, in writing, of any required interruptions of Greenland WTP operations a minimum of 15 calendar days prior to the necessary operations interruptions. If an interruption to Greenland WTP operations arises in an unplanned manner, Contractor shall immediately coordinate with the Owner in writing and verbally as to the timing of the unplanned interruption to Greenland WTP operations. All such interruptions will be at the sole discretion of the Owner except as necessary to prevent harm to personnel and the Work.
- B. The Work shall be performed in such a manner as to minimize the disruption to the operation and staff of the existing Greenland WTP. Modifications that affect or may affect the operation of the facility shall not be made without written permission from the Owner.
- C. Modifications to the existing Hypochlorite feed and injection system are required under this project. The contractor shall be responsible to provide temporary hypochlorite feed and injection systems, including temporary storage tanks, metering pumps, piping and injection quills, if needed, to perform this work. A more detailed description of the work is as shown on sheets M-11 and M-12 and paragraph 1.06.D, herein.
- D. Modifications to the existing Ozone injection system are required under this project. The contractor shall be responsible to provide coordinate with JEA staff for the removal of the Ozone system from service and the use of the natural draft cascade tray aerators for intermittent removal of H<sub>2</sub>S from the raw water supply, while the ozone system is being modified. A more detailed description of the work is as shown on sheets M-13 and M-14 and paragraph 1.06.E, herein.
- E. The construction progress schedule required under Section 01310 shall reflect the conditions presented in this section.
- F. See Sections 01465 for Equipment Testing and Startup and 01730 for Operation and Maintenance Data requirements and Divisions 11 through 16, inclusive, on specific equipment startup and testing requirements.
- G. Special precautions are necessary to ensure that no damage occurs to these facilities including piping, utilities, roads, interiors of structures and structures in general that are to remain in operation and are not to be modified or replaced. Any temporary facilities, materials, equipment and labor required to ensure that no damage occurs shall be provided by the Contractor as part of the Work and at no additional cost to the Owner.
- H. The Owner reserves the right to postpone shutdowns due to operational and/or weather related concerns.

- I. As described herein, and as required by the Agreement, the completion of the mechanical outfitting of the raw water production well no. 3 and the raw water pipeline to the connection point at well site no. 2, is required to be substantially complete, within 10 months of the Contractors Notice to Proceed (NTP) date. The overall contract time, as identified in the Agreement, is required to be substantially complete within 15 months (or 450 days) from the NTP date, with a final completion date of 16 months (or 480 days) from the NTP date.

#### 1.02 DEFINITIONS AND TERMS

- A. Construction Scheduling Constraints: Constraints for performance of the Work, required because of special sequencing with other parts of the Work, calendar time constraints and special testing, commissioning and procedures are identified in this Section. These constraints are in addition to the standard procedural constructions such as show and working drawings, testing, commissioning, training, etc. These constraints shall be included in the Contractor's progress schedule.
- B. Special Conditions: Certain special conditions related to performance of the Work are identified in this Section and shall be included in the Contractor's progress schedule.

#### 1.03 NOTIFICATION REQUIREMENTS

- A. The Contractor shall give a minimum of 15 calendar days advance written notice to the Engineer and Owner of each component proposed for shutdown, tie-in, or disruption, all of which shall be subject to Owner's approval and limitations. Shutdowns, tie-ins or disruptions specifically mentioned in this Section must conform to this requirement and any others requested by the Engineer or Owner.
- B. In general, no work which affects or could affect the plant operations or plant performance shall be performed without a specific plan written by the Contractor approved in advance by the Engineer and the Owner.

#### 1.04 SUBMITTAL REQUIREMENTS

- A. Contractor shall submit shop drawings and working drawings in accordance with Section 01300 to show details of all temporary services, bypasses, shutdowns, tie-ins, and connections to existing systems.
- B. Contractor shall submit a sequence of construction to perform the project work as shown on the contract drawings and as described herein to be approved by Engineer and Owner.

#### 1.05 SITE CONDITIONS

- A. Several areas of construction under this Contract shall be coordinated with the Plant Operating Personnel and accomplished in a logical order to maintain the process flow through the plant and to allow construction to be completed within the time allowed by Contract Documents. Coordinate the activities with the other contractors, if any, to allow orderly and timely completion of all the work.
- B. When access through construction areas must be disrupted, provide alternate acceptable access for the plant operators or other contractors.

- C. Coordinate the activities in the interface or common areas with these other contractors and the plant operators. Submit to the Engineer and Owner a description and schedule as to how the common areas will be utilized, recognizing the required coordination with other contractors and the plant operators.
- D. Various interconnections within the plant will depend on the closure of various valves and gates. Many of these valves and gates may not seal properly. Coordinate with the Plant Operation Personnel prior to attempting any such closure and provide any corrective measure of temporary facilities necessary to attain the shut-off needed to perform the work at no additional cost to the Owner and without interrupting the plant operation.
- E. Various interconnections within the plant may require temporary partial power shutdown. Make every effort necessary to minimize the shutdown time and coordinate with the Plant Operating Personnel and/or utility authorities prior to attempting any such power shutdown. Furthermore, provide any corrective measure or temporary facilities necessary to perform the work at no additional cost to the Owner and without interrupting the plant operation.
- F. When the work requires an existing facility to be taken out of operation, temporarily or permanently, notify the Engineer, Owner and plant operators 15 calendar days in advance.
- G. Where water is required in large quantity for preoperational testing or other use, Contractor shall purchase said water from the Owner. A meter will be installed at the existing fire hydrant located on the southside of the site by the Owner. Contractor shall pay all fees and water usage charges. Plant water in relatively small quantities, if requested promptly by Contractor, may be available for limited use at the Plant Operators' discretion.
- H. During Start-Up Testing, make available the manpower, equipment and manufacturer's representatives required to make any necessary adjustments and training.

#### 1.06 CONSTRUCTION CONSTRAINTS

- A. The following is a list of constraints to consider in developing the overall plan of construction. This list is not intended to release the Contractor from the responsibility to coordinate the work in any manner which will ensure project completion within the time allowed. The following areas are not necessarily listed in their required sequence of construction. A suggested sequence within each area, where necessary, is included.
- B. Production Well Number 3 and the 16 inch Raw Water Main
  - 1. The completion of the mechanical outfitting of the raw water production well and the raw water pipeline to the connection point at well site no. 2, is required to be substantially complete, within 10 months of the Contractors Notice to Proceed (NTP) date.
- C. Sitework
  - 1. Erosion control and temporary fencing of all construction areas shall be performed within 30 calendar days after the Notice to Proceed. All erosion control devices and storm drainage piping and inlets shown on the Drawings shall be installed prior to any clearing and grubbing in this area.

2. All underground pipes, conduits, cables, duct banks, and structures shall be located by electronic locator equipment and test pits in each area of excavation and flagged and mapped before any excavation is performed for structures, pipes, cables, conduits, duct banks, or removals. Working drawings of existing and proposed new work shall be prepared to scale and submitted to the Engineer in advance of excavation. The Contractor shall be fully responsible for any process outages caused by disruption of underground facilities including responsibility for regulatory fines and the Owner's costs of dealing with regulatory agencies.
3. The Contractor's field office shall be set up and fully equipped and all utilities connected within 30 calendar days from the Notice to Proceed. The office shall be removed not earlier than the date of substantial completion and not later than the date of final payment.
4. All underground pipes, conduits, cables, duct banks, and structures installation work shall be organized and scheduled to accomplish the following:
  - a. The Owner access to operating facilities shall be maintained at all times.
  - b. All underground work in each area shall be performed concurrently to avoid subsequent trenching through the same areas.
  - c. Yard electrical work and piping work shall be shown on the same working drawings and fully coordinated horizontally and vertically.
  - d. Existing systems shall remain fully operational except for pre-planned, scheduled, and organized temporary outages.
5. New pavement (if applicable) shall not be installed until all piping, cables, conduits, and duct banks under the paved area have been installed. Roads shall be stabilized with crushed stone until that time. The Contractor shall maintain at least one lane of the roadways clear at all times to facilitate operation of the Greenland WTP. If the entire width of road is to be temporarily out of service, the Contractor shall coordinate details of outage with the Engineer and Owner and provide signage for detouring traffic within the site. The surface pavement course and cap on existing roads shall not be installed until all other construction work is finished. Any unstable areas in base course or existing pavement shall be removed and replaced prior to the final surface course installation.
6. Locations and numbers of sedimentation control facilities shall be adjusted as the work progresses so that all site runoff flows through sedimentation control facilities at all times. Facilities shown are minimums only. At no time shall un-desilted water be allowed to leave the site. Maintenance and upgrading of facilities shall be scheduled weekly and after all rain events.
7. The Contractor shall submit a Notice of Intent to Use Noticed General Permit for Short Term Construction Dewatering to the St. Johns River Water Management District prior to starting any dewatering activity at the project site.
8. All connections to existing facilities shall be scheduled through the Engineer and the Owner to minimize the impact on plant operations and construction progress.
9. All existing trees on the site around and/or adjacent to the construction area shall be protected and remain undamaged at all times. If the Contractor anticipates damage to a tree due to construction activities the Contractor shall contact the Engineer immediately and prior to commencing work in that area.

D. Existing Water Treatment Plant Facilities

1. Contractor shall not impact existing water treatment plant facilities, including the existing high service pumps, the existing injection of sodium hypochlorite downstream of the ground storage tank, ozonation and aeration of raw water to existing Ground Storage Tank No. 1.

E. Modifications to Hypochlorite Feed and Injection System

1. Contractor shall coordinate with Owner so there is no interruption to the existing disinfection process (i.e. sodium hypochlorite injection system) during chemical feed system replacement and modifications.
2. Modifications to sodium hypochlorite facility include the containment system, the covered canopy, replacing the metering pumps (to be furnished by Owner) and chemical piping, the existing injection quills and civil improvements.
3. Modifications to existing sodium hypochlorite injection quills includes, the addition of a new concrete vault, to house the new sodium hypochlorite injection quills. Contractor to provide a connection from the existing disinfection chemical piping to the existing GST No. 1 or install a temporary tap on the discharge header of the high service pump between pump no. 2 and pump no. 1 to provide alternative disinfection point of injection during the modifications to the existing injection quills. Contractor to ensure an eyewash station remains online or a supplementary eyewash station is provided during the chemical equipment modifications.
4. Contractor to coordinate a construction sequence that allows at least one chemical tank to remain in service during chemical piping replacement. Contractor to ensure an eyewash station remains online or a supplementary eyewash station is provided during the chemical facility modifications.

F. Modifications to Ozone System

1. Installation of new ozone injector and off gas air release valve will require temporary shut-down of the ozone system. The ozone system shall not be shut-down in increments greater than 6-hours.

G. Electrical Facilities

1. Preoperational Testing.
  - a. Upon construction completion of the new electrical facilities, conduct preoperational testing as required by the Contract Documents.
2. Start-Up Testing.
  - a. Upon satisfactory preoperational testing of the electrical facilities and availability of adequate load to test these facilities, test facilities under normal operating conditions.
3. Contractor shall provide temporary portable generator power and fuel storage systems, while modification and removal is made to the existing 500KW generator system and until the new 750 KW generator and fuel system has been tested, started up and approved by the manufacturer, the Engineer and Owner and any regulatory agencies governing the

installation of this system. Any temporary power and fuel storage provided shall be adequate to provide a minimum of 500 KW equivalent load capability. The new Generator system shall be tested, accepted, and operationally complete with its auto-transfer capability, before the temporary portable emergency generator is removed from service.

4. The partial start-up and operation of certain parts of the plant may require some, but not all, MCCs to be placed in operation. OWNER may occupy or operate these facilities before the entire work is ready for acceptance. Such action by the OWNER (or plant personnel) shall not constitute acceptance of the entire area.

#### H. Testing

1. All facilities and systems shall be tested as a condition precedent to substantial completion. See Section 01465 and equipment specifications for additional requirements. Start-up plans for each facility and equipment shall be submitted, reviewed and approved by the ENGINEER.
2. All new facilities and systems shall continue to operate for a two (2) week period prior to initiating the demolition work of the existing facilities.

#### 1.07 PERMITS

- A. The CONTRACTOR shall arrange for all required inspections and shall close out the permits at the end of the Contract.

#### PART 2 PRODUCTS (NOT USED)

#### PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01026  
APPLICATION FOR PAYMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Submit Applications for Payment to the Owner in accordance with the schedule established by Conditions of the Contract and Agreement between Owner and Contractor.
- B. The accepted Schedule of Values, Section 01370, shall be used as the basis for the Contractor's Application for Payment.

1.02 RELATED WORK

- A. Agreement between Owner and Contractor is included in the Front End Documents provided by the Owner.
- B. Standard General Conditions of the Construction Contract are included in the Front End Documents provided by the Owner.
- C. Schedule of Values are included in Section 01370.
- D. Audio Video Taping and Construction Photographs are included in Section 01380.
- E. Contract Closeout is included in Section 01700.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, applications typed on forms provided by the Owner, Application for Payment, with itemized data typed on 8-1/2-in by 11-in or 8-1/2-in by 14-in white paper continuation sheets.
- B. Provide itemized data on continuation sheet.
  - 1. Format, schedules, line items and values: Those of the Schedule of Values accepted by the Engineer.
- C. Provide construction photographs in accordance with Section 01380.

1.04 PREPARATION OF APPLICATION FOR EACH PROGRESS PAYMENT

- A. Application Form
  - 1. Fill in required information, including that for Change Orders executed prior to date of submittal of application.
  - 2. Fill in summary of dollar values to agree with respective totals indicated on continuation sheets.
  - 3. Execute certification with signature of a responsible officer of Contract firm.

4. Owner shall provide a template example Application for Payment.

B. Continuation Sheets

1. Fill in total list of all scheduled component items of Work, with item number and scheduled dollar value for each item.
2. Fill in dollar value in each column for each scheduled line item when work has been performed or products stored.
  - a. Round off values to nearest dollar, or as specified for Schedule of Values.
3. List each Change Order executed prior to date of submission, at the end of the continuation sheets.
  - a. List by Change Order Number and description, as for an original component item of work.
4. To receive approval for payment on component material stored on site, submit copies of the original paid invoices with the application for payment.

1.05 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

- A. When the Owner requires substantiating data, submit suitable information, with a cover letter identifying.
  1. Project.
  2. Application number and date.
  3. Detailed list of enclosures.
  4. For stored products:
    - a. Item number and identification as shown on application.
    - b. Description of specific material.
- B. Submit one copy of data and cover letter for each copy of application.
- C. Maintain an updated set of red-line drawings to be used as as-build drawings in accordance with Section 01720. As a prerequisite for monthly progress payments, exhibit the updated record drawings for review by the Owner and the Engineer.
- D. As a prerequisite for payment, Contractor shall submit the followings:
  1. Updated cash flow.
  2. Updated schedule.
  3. Man hours.
  4. JSEB participation.
  5. Updated record drawings (red-lines).

1.06 PREPARATION OF APPLICATION FOR FINAL PAYMENT

- A. Fill in Application form as specified for progress payments.
- B. Use continuation sheet for presenting the final statement of accounting as specified in Section 01700.
- C. Submit all Project Record Documents in accordance with Section 01050 and 01700.

1.07 SUBMITTAL PROCEDURE

- A. Submit Draft Application for Payment with required documentation to the Owner at the time stipulated in the Agreement via e-mail. When approved, submit hardcopies to JEA Accounts Payable.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01045  
CUTTING, CORING, AND PATCHING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section covers the cutting, coring, rough and finished patching of holes and openings. Holes and opening maybe in existing construction, or in parts of new construction. Procedures for cutting and patching will be the same for either condition.
- B. All cutting, coring, and rough patching shall be performed by the Contractor. Finish patching shall be the responsibility of the Contractor and shall be performed by the trade associated with the application of the particular finish.
- C. Provide all cutting, fitting and patching, including attendant excavation and backfill, required to complete the work or to:
  - 1. Make its several parts fit together properly.
  - 2. Uncover portions of the work to provide for installation of ill-timed or improperly scheduled work.
  - 3. Remove and replace defective work.
  - 4. Remove and replace work not conforming to requirements of Contract Documents.
  - 5. Remove samples of installed work as specified for testing.
  - 6. Provide penetrations of structural surfaces and materials for installation of piping, ductwork, equipment and electrical conduit.
  - 7. Provide penetrations of non-structural surfaces and materials for installation of piping, ductwork, equipment and electrical conduit. The determination of what is a nonstructural surface or material shall be made by the Engineer.
  - 8. Remove, install, or relocate materials or equipment.

1.02 RELATED WORK

- A. Summary of Work is included in Section 01010.
- B. Site work is included in Division 02.
- C. Concrete is included in Division 03.
- D. Pipe penetrations and assemblies are included in Section 01180.
- E. Conduit sealing methods is included in Division 16.
- F. Duct penetration assemblies are included in Division 15.

### 1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, a written request prior to executing any cutting or alteration which is not shown or detailed on the contract documents which affects or requires:
  - 1. Cutting structural members.
  - 2. Holes drilled in beams or other structural members.
  - 3. Work of the Owner or any separate contractor.
  - 4. Structural value or integrity of any element of the project.
  - 5. Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
  - 6. Efficiency, operational life, maintenance or safety of operational elements.
  - 7. Visual qualities of sight-exposed elements.
- B. Request shall include:
  - 1. Identification of the project.
  - 2. Description of affected work.
  - 3. The reason for cutting, alteration or excavation.
  - 4. Effect on work of Owner or any separate contractor, or on structural or weatherproof integrity of project.
  - 5. Description of proposed work:
    - a. Method and extent of cutting, patching, alteration, or excavation.
    - b. Trades who will execute the work.
    - c. Products proposed to be used.
    - d. Extent of refinishing to be done.
  - 6. Alternatives to cutting and patching.
  - 7. If the work is considered out of scope, provide a cost proposal.
  - 8. Confirmation of coordination with any separate contractor whose work will be affected.
  - 9. Related shutdown requests if required to do the work.
  - 10. Request for hot work permit if required to do the work.
- C. Submit written notice to the Engineer designating the date and the time the work will be uncovered.
- D. When a written request is required, do not proceed with the work until a written notice to proceed is received from the Engineer.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Comply with specifications and standards for each specific product involved. Where there is no equivalent specification, the Contractor shall notify the Engineer who will provide a specification for the materials to be used.
- B. Concrete and grout for rough patching shall be as specified in Divisions 3.
- C. Materials for finish patching shall be equal to those of adjacent construction. Where existing materials are no longer available, use materials with equivalent properties and that will provide the same appearance. The materials are to be approved by the Engineer prior to their use.

## PART 3 EXECUTION

### 3.01 INSPECTION

- A. Inspect existing conditions of project, including elements subject to damage or to movement during cutting and patching.
- B. After uncovering work, inspect conditions affecting installation of products, or performance of work.
- C. Report unsatisfactory or questionable conditions to the Engineer in writing; do not proceed with work until the Engineer has provided further instructions.

### 3.02 PREPARATION

- A. Provide adequate temporary support as necessary to assure structural value or integrity of affected portion of work.
- B. Protect surrounding materials and equipment prior to starting work.
- C. Contain and control cooling liquids and slurry produced by the cutting and coring operations.
- D. When the cutting or coring will result in the structure or equipment being exposed to provide adequate weather protection.
- E. Provide dewatering for excavation work in accordance with Division 2.

### 3.03 PERFORMANCE

- A. Execute cutting and demolition by methods which will prevent damage to other work and will provide proper surfaces to receive installation of repairs.
- B. Execute excavating and backfilling by methods which will prevent settlement or damage to other work. When excavating in close proximity to piping, duct banks or other items subject to damage, use hand excavation.
- C. All equipment and workplace safety shall conform to OSHA standards and specifications pertaining to plugs, noise and fume pollution, wiring and maintenance.

- D. Where possible, employ original installer or fabricator to perform cutting and patching for:
  - 1. Weather-exposed or moisture-resistant elements.
  - 2. Sight-exposed finished surfaces.
- E. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes.
- F. Restore work which has been cut or removed; install new products to provide completed work in accordance with requirements of Contract Documents.
- G. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes:
  - 1. For continuous surfaces, refinish to nearest intersection.
  - 2. For an assembly, refinish entire unit.
- H. Remove rubble and excess patching materials from the premises.

#### 3.04 CORING

- A. All coring shall be performed in such a manner as to limit the extent of patching. Locate the rebar before coring to minimize cut throughs.
- B. Coring shall be performed with an approved non-impact rotary tool with diamond core drills.
- C. Size of holes shall be suitable for pipe, conduit, sleeves, equipment or mechanical seals to be installed.
- D. Fit work to minimize space to pipes, sleeves, ducts, conduit and other penetrations through surfaces.
- E. Fit to pipes and other penetrations in tanks to be water tight using seals or other methods defined in the specifications.
- F. All holes cut through concrete and masonry walls, slabs or arches shall be core drilled unless otherwise approved. All work shall be performed by mechanics skilled in this type of work.
- G. If holes are cored through floor slabs they shall be drilled from below where possible. If holes are drilled from above, provide protection and containment below the area being drilled to catch the plug and contain liquid and slurry.

#### 3.05 CUTTING

- A. All cutting shall be performed in such a manner as to limit the extent of patching.
- B. Fit work to minimize space to pipes, sleeves, ducts, conduit and other penetrations through surfaces.
- C. Cutting shall be performed with a concrete saw and diamond saw blades of proper size.

- D. Provide for control of slurry generated by sawing operation on both sides of wall and from below if cutting a floor.
- E. When cutting a reinforced concrete wall or floor, the cutting shall be done so as not to damage the bond between the concrete and reinforcing steel left in structure. Cut shall be made so that steel neither protrudes nor is recessed from face of the cut.
- F. Adequate bracing of area to be cut shall be installed prior to start of cutting. Check area during sawing operations for partial cracking and provide additional bracing as required to prevent a partial release of cut area during sawing operations.
- G. Provide equipment of adequate size to remove cut panel.
- H. Saw cut concrete and masonry prior to breaking out sections.
- I. Install work at such time as to require the minimum amount of cutting and patching.
- J. All cutting of structural members shall be done in a manner directed by the Engineer.
- K. Cut opening only large enough to allow easy installation of the equipment, ducting, piping or conduit.
- L. When existing conduits or pipe sleeves are cut off at the floor line or wall line, they shall be filled with grout or suitable patching material.

### 3.06 PROTECTION

- A. Provide devices and methods to protect other portions of project from damage.
- B. Provide protection from elements for that portion of the project which may be exposed by cutting and patching work.
- C. Maintain excavations free from water.

### 3.07 PATCHING

- A. Rough patching shall be such as to bring the cut or cored area flush with existing construction unless otherwise shown.
- B. Finish patching shall match existing surfaces as approved.
- C. Patching shall be of the same kind and quality of material as was removed.
- D. The completed patching work shall restore the surface to its original appearance or better.
- E. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed to include the joint between the existing material and the patch.
- F. Equipment damaged during cutting and patching shall be replaced or repaired by the equipment manufacturer, at the Engineer's sole discretion and at the expense of the Contractor doing the work.

- G. Repaint any damage to factory applied paint finishes using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted in accordance with the field painting requirements specified in Section 09902 at the expense of the Contractor doing the work.
- H. Slurry or tailings resulting from coring or cutting operations shall be contained and vacuumed or otherwise removed from the area following drilling or cut.
- I. Equipment shall be protected against mechanical and water damage during cutting and patching. Provide protective covers or use other means such as temporary relocation to protect equipment that is at risk of damage from the cutting and patching
- J. Provide protection for existing equipment, utilities and critical areas against water or other damage caused by drilling operation.

END OF SECTION

SECTION 01046  
CONTROL OF WORK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor must meet all general requirements of JEA Water and Wastewater Standards (January 2019 or latest edition) and the following general construction requirements outlined in this Section hereinafter.

1.02 PRIVATE LAND

- A. The Contractor shall not enter or occupy private land outside of easements, except by permission of the land owner.

1.03 PIPE LOCATIONS

- A. The Contractor shall locate pipelines substantially as indicated on the Drawings. The Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings are noted on the Drawings, such notation is for the Contractor's convenience and does not relieve him from laying and jointing different or additional items where required.

1.04 OPEN EXCAVATIONS

- A. The Contractor shall adequately safeguard all open excavations by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons and damage to property. The Contractor shall provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. The Contractor shall remove bridges provided for access during construction when no longer required. The length or size of excavation shall be controlled by the particular surrounding conditions, but shall always be confined to the limits prescribed by the Engineer. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of the open trench, prohibiting stacking excavated material in the street and requiring that the trench shall not remain open overnight.
- B. The Contractor shall take precautions to prevent injury to the public due to open trenches. The Contractor shall provide adequate light at all trenches, excavated material, equipment, or other obstacles which could be dangerous to the public at night.

1.05 CARE AND PROTECTION OF PROPERTY

- A. The Contractor shall be responsible for the preservation of all public and private property and use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, the Contractor shall restore such property to a condition similar or equal to that existing before the damage was done, or make good the damage in other manner acceptable to the Engineer.

## 1.06 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

- A. The Contractor shall assume full responsibility for the protection of all buildings, structures, and utilities, public or private, including poles, signs, services to buildings, utilities in the street, gas pipes, water pipes, hydrants, sewers, drains and electric and telephone cables, whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from injury of any kind. Immediately repair any damage resulting from the construction operations.
- B. Assistance will be given the Contractor in determining the location of existing services. The Contractor, however, shall bear full responsibility for obtaining all locations of underground structures and utilities (including existing water services, drain lines and sewers). Maintain services to buildings and pay costs or charges resulting from damage thereto.
- C. The Contractor shall notify all utility companies in writing at least 72 hours (excluding Saturdays, Sundays and Legal holidays) before excavating in any public way.
- D. Along the proposed pipe lines as indicated on the plans, the Contractor shall remove the surface materials only to such widths as will permit a trench to be excavated which will afford sufficient room for proper efficiency and proper construction. All applicable regulations shall be followed. Where sidewalks, driveways, pavements, and curb and gutter are encountered, care shall be taken to protect against fracture or disturbance beyond reasonable working limits. All fractured, broken, or disturbed surfaces shall be restored to their original condition prior to completion of the work.
- E. Restoration of all surfaces including road subbase, soil cement, limerock base, asphaltic concrete surface, portland cement concrete pavement and driveways, sidewalks, and concrete curbs shall be in strict accordance with Drawings. Sites shall be restored to existing conditions including grassing. Any modifications from existing conditions shall require prior approval from owner of existing structure, property, or utility.
- F. Lawn areas shall be left in as good or better condition as before starting the work. Where sod is to be removed, it shall be carefully restored with new sod of the same type. Solid sodding shall be placed on all slopes greater than 4:1, within 10 feet of all proposed structures and where existing sod is removed or disturbed by the work. In addition, Contractor shall restore all storm drains, culverts, inlets, and storm manholes to equal or better condition.
- G. Any fence, or part thereof, that is damaged or removed during the course of the Work shall be replaced or repaired by the Contractor and shall be left in as good a condition as before the starting of the work. The manner in which the fence is repaired and replaced and the materials used shall be subject to the approval of the Engineer.
- H. All trees and shrubs not shown to be removed on the plans shall be protected by the Contractor at his expense. No excavated materials shall be placed so as to injure such trees and shrubs. Trees or shrubs destroyed by negligence of the Contractor or his employees shall be replaced by the Contractor with new stock of similar size and age at the sole expense of the Contractor.

## 1.07 WATER FOR CONSTRUCTION PURPOSES

- A. Where water is required in large quantity for preoperational testing or other use, purchase it from the Owner. A meter will be installed on one of the existing fire hydrant located on the site

by the Owner. Pay all fees and water usage charges. The plant water, if requested promptly by Contractor, may be available for limited use at the Plant Operators' discretion. All water usage shall be metered.

- B. The express approval of the Owner shall be obtained before water is used. Waste of water shall be sufficient cause for withdrawing the privilege of unrestricted use. Hydrants shall only be operated under the supervision of the Owner's personnel.

#### 1.08 MAINTENANCE OF FLOW

- A. The Contractor shall provide for the flow of sewers, drains and water courses interrupted during the progress of the work, and immediately cart away and remove all offensive matter. Discuss the entire procedure of maintaining existing flow with the Engineer at least seven (7) days prior to the interruption of any flow.
- B. The Contractor shall provide for the flow of sewers, drains and water courses interrupted during the progress of the work, and immediately cart away and remove all offensive matter. The Contractor shall discuss the entire procedure of maintaining existing flow with the Engineer well in advance of the interruption of any flow.

#### 1.09 PROTECTION OF CONSTRUCTION AND EQUIPMENT

- A. All newly constructed work shall be carefully protected from damage in any way. No wheeling or walking or placing of heavy loads on it shall be allowed and all portions damaged shall be reconstructed by the Contractor at his own expense.
- B. All structures shall be protected in a suitable manner. Should any of the floors or other parts of any structures become heaved, cracked or otherwise damaged, all such damaged portions of the work shall be completely repaired and made good by the Contractor at his own expense and to the satisfaction of the Owner. If, in the final inspection of the work, any defects, faults or omissions are found, the Contractor shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation for the materials and labor required. Further, the Contractor shall be fully responsible for the satisfactory maintenance and repair of the construction and other work undertaken herein, for at least the guarantee period described in the Contract.

#### 1.10 COOPERATION WITHIN THIS CONTRACT

- A. All firms or persons authorized to perform any work under this Contract shall cooperate with Contractor and subcontractors or trades and assist in incorporating the work of other trades where necessary or required.
- B. Cutting and patching, drilling and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

#### 1.11 CLEANUP AND DISPOSAL OF EXCESS MATERIAL

- A. During the course of the work, the Contractor shall keep the site of operations as clean and neat as possible. The Contractor shall dispose of all residue resulting from the construction work and, at the conclusion of the work, remove and haul away any surplus excavation, broken

pavement, lumber, equipment, temporary structures and any other refuse remaining from the construction operations and leave the entire site of the work in a neat and orderly condition.

- B. In order to prevent environmental pollution arising from the construction activities related to the performance of this Contract, the Contractor shall comply with all applicable Federal, State and local laws and regulations concerning waste material disposal, as well as the specific requirements stated in this Section and in other related sections.
- C. Disposal of excess excavated material in wetlands, stream corridors and plains is strictly prohibited even if the permission of the property owner is obtained. Any violation of this restriction by the Contractor or any person employed by him will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. The Contractor will be required to remove the fill and restore the area impacted at no increase in the Contract Price.

#### 1.12 GRADES, SURVEY LINES, AND PROTECTION OF MONUMENTS

- A. All work shall be constructed in accordance with the lines and grades shown on the drawings. The full responsibility for keeping alignment and grade shall rest upon the Contractor.
- B. Bench marks and base line controlling points shall be established prior to beginning work. Reference marks for lines and grades as the work progresses will be located to cause as little inconvenience to the prosecution of the work as possible. The Contractor shall so place excavation and other materials as to cause no inconvenience in the use of the reference marks provided. Contractor shall remove any obstructions placed contrary to this provision.
- C. The Contractor shall furnish and maintain, at his own expense, stakes and other such materials and give such assistance, including qualified helpers, for setting reference marks to the satisfaction of the Engineer. The Contractor shall check reference marks by such means, as he may deem necessary. The Contractor shall, at his own expense, establish all working or construction lines and grades as required from the reference marks and shall be solely responsible for the accuracy thereof.
- D. Property corners and survey monuments shall be preserved using care not to disturb or destroy them. If a property corner or survey monument is disturbed or destroyed during construction, whether by accident, careless work, or required to be disturbed or destroyed by construction work, said property corner or survey monument shall be restored by a land surveyor registered in the state of Florida. All costs for this work shall be paid for by the Contractor.

END OF SECTION

SECTION 01050  
PROJECT CONTROLS (SURVEYING)

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall provide and pay for field engineering services required for project; including but not limited to:
  - 1. Survey work required for project controls and layout.
  - 2. Certified as-built surveys specified herein.
- B. The Contractor shall retain the services of a registered land surveyor licensed in the state of Florida to:
  - 1. The Contractor shall identify existing control points and property line corners indicated on the Drawings.
  - 2. The Contractor shall verify and record all existing structure locations in the vicinity of, or adjacent to, the proposed Work; and, the locations of all pro-posed structures and facilities.
  - 3. The Contractor shall maintain an accurate record of locations of all new buried piping and existing buried piping and other buried existing facilities (piping, conduits, and structures) encountered and/or relocated during construction of the new Work.
  - 4. The Contractor shall maintain accurate locations of all new structures, including corner locations, tank locations and equipment locations within the project site.

1.02 RELATED WORK

- A. Summary of Work is included in Section 01010.
- B. Contract Closeout is included in Section 01700.
- C. Record Drawings are included in Section 01720.
- D. JEA's Water and Wastewater Standards Manual, Section 501.

1.03 SUBMITTALS

- A. The Contractor shall submit, to the Engineer, in accordance with Section 01300, the name, address and state registration and license number of proposed registered land surveyor.
- B. On request of the Engineer, the Contractor shall submit documentation to verify accuracy of field engineering work.
- C. At the end of the project, and prior to final payment, the Contractor submit certified drawing(s) (with the Surveyor's title block) of the items listed below. All surveys shall be tied to the applicable Grid System and shall indicate all pre-existing and new project benchmarks. Vertical Control shall conform to the project elevation datum designated on the plans.

1. Certified site survey at 1-in = 50-ft scale or larger, but not greater than 1-in = 20-ft scale, on 24-in by 36-in sheet(s), indicating the building corners, sidewalks, paved areas and location of all above ground structures within the project site or limits of construction.
2. Certified survey, drawn to the same scale as the Engineer's yard piping drawings, showing the locations, lines and grades in plan and profile views of all below-grade lines (piping and concrete-encased electrical ducts) exterior to buildings and other buried facilities (e.g., valves, tanks, etc.). This requirement includes all utilities installed as a part of the scope of this project, as well as existing lines encountered during the installation of the new Work.
3. Certified survey showing the locations, lines and grades of all pipes 4-inch diameter and larger above ground, buried and exterior to buildings and other buried facilities (e.g. valves, tanks, vaults, etc.) installed as a result of the work. This shall be at the same scale as the Engineer's yard piping drawing.
4. Topographical surveys shall be scaled 1-in = 50-ft scale or larger, but not greater than 1-in = 20-ft scale, on 24-in by 36-in sheet(s), with 2-foot contour intervals for 1 inch:50 feet scale drawings and 1-foot contour intervals for 1 inch:20 feet scale drawings.
5. Certified survey showing elevations of all flow control points, such as weirs, elevations of all new structures, pipe inverts, rim elevations on manholes, and elevations of equipment.

#### 1.04 QUALIFICATIONS OF SURVEYOR

- A. Registered land surveyor licensed in the state of the project location.

#### 1.05 SURVEY REFERENCE POINTS

- A. Existing basic horizontal and vertical control points for the project are those designated on Drawings.
- B. The Contractor shall locate and protect control points prior to starting site work and preserve all permanent reference points during construction.
  1. The Contractor shall make no changes or relocations without prior written notice to and approval by the Engineer.
  2. The Contractor shall report to the Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.
  3. The Contractor shall require the surveyor to correctly replace project control points which may be lost or destroyed. Establish replacements based on original survey control.

#### 1.06 PROJECT SURVEY REQUIREMENTS

- A. The Contractor shall establish a minimum of two permanent bench marks on site, referenced to data established by survey control points.
  1. Record locations, with horizontal and vertical data, on the as-built Survey.
  2. Permanent benchmarks shall be installed and spaced for convenient reference and use at locations along the pipeline route and/or on the plant site.

3. Benchmarks shall be installed to National Geodetic Survey standards and shall include horizontal and vertical data, as well as the installation date.
- B. The Contractor shall establish lines and levels; locate and lay out:
1. Site improvements.
    - a. Stakes for grading, fill and topsoil placement.
    - b. Utility slopes and invert elevations.
    - c. Sidewalks, pavement, fencing, storm drainage facilities, and other finish surface work.
    - d. Locations, sizes and depths of manholes, valves and fittings.
  2. Batter boards for structures.
  3. Building foundation, column locations and floor levels.
  4. Controlling lines and levels required for mechanical and electrical trades.
- C. If lines, levels or layouts are lost or destroyed, or if required by the Owner or Engineer, the Contractor shall verify layouts by same methods.
- D. The Surveyor shall provide all elevation in North American Vertical Datum of 1988 (NAVD 88).
- E. The Contractor shall establish all lines and grades prior to construction of line work for all force mains, transmission mains, storm drainage piping, gravity sewers and other new utility lines at 100-ft increments, at defined breaks in grade, and at manholes.
- F. The following dimensional references must be depicted on the As-Built drawings.
1. Depths of various elements of foundation in relation to finish first floor datum.
  2. All underground piping with elevations and dimensions. Changes to piping location. Horizontal and vertical locations of all underground utilities and appurtenances, referenced to permanent surface improvements. Actual installed pipe material, class, etc. All pipes and valves shall be labeled using the method as per the contract drawings.
  3. Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.
  4. Field changes of dimension and detail.
  5. Changes made by Field Order or by Change Order.
  6. Details not on original contract drawings.
  7. Equipment and piping relocations.
  8. All underground duct banks with elevations and dimensions, horizontal and vertical locations of underground duct banks, and manholes along duct banks.
  9. All underground cable elevations and horizontal locations of underground cables.

10. All existing and new structures clearly indicated.

11. All elevations of new structures clearly indicated.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 RECORDS

- A. The Contractor shall maintain a complete, accurate log of all control and survey work as it progresses.
- B. The Contractor shall update the project as-built survey on a monthly basis, based on the work performed during the month. The Contractor shall submit one copy of up to date as-built documentation with Contractor's monthly applications for payment.
- C. The Contractor shall maintain an accurate record of new and existing piping, conduit and structure changes, revisions, relocations, and modifications.
- D. At the end of the project, the Contractor shall submit the following:
  - 1. Four signed and sealed prints of all required as-built survey information.
  - 2. Copy of all AutoCAD files of documents specified in Article 1.03.C, above on a CD or DVD or flash drive, if approved by the OWNER.

END OF SECTION

SECTION 01110  
ENVIRONMENTAL PROTECTION PROCEDURES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials and equipment and perform all work required for the prevention of environmental pollution in conformance with applicable laws and regulations, during and as the result of construction operations under this Contract. For the purpose of this Section, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and/or recreational purposes.
- B. The control of environmental pollution requires consideration of air, water and land, and involves management of noise and solid waste, as well as other pollutants.
- C. The Contractor shall schedule and conduct all work in a manner that will minimize the erosion of soils in the area of the work. The Contractor shall provide erosion control measures such as diversion channels, sedimentation or filtration systems, berms, seeding, mulching or other special surface treatments as are required to prevent silting and muddying of streams, rivers, impoundments, lakes, etc. All erosion control measures shall be in place in an area prior to construction activity in that area. Specific requirements for erosion and sedimentation controls are specified in Division 2.
- D. This Section is intended to ensure that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. These are general guidelines. It is the Contractor's responsibility to determine the specific construction techniques to meet these guidelines.
- E. All phases of sedimentation and erosion control shall comply with and be subject to the approval of Duval County. The Contractor shall prepare sedimentation and erosion control drawings meeting the requirements for approval by that agency. Upon approval, the Contractor shall furnish two copies of the approved Drawing to the Engineer.

1.02 APPLICABLE REGULATIONS

- A. The Contractor shall comply with all applicable Federal, State and local laws and regulations concerning environmental pollution control and abatement.

1.03 NOTIFICATIONS

- A. The Engineer will notify the Contractor in writing of any non-compliance with the foregoing provisions or of any environmentally objectionable acts and corrective action to be taken. State or local agencies responsible for verification of certain aspects of the environmental protection requirements shall notify the Contractor in writing, through the Engineer, of any non-compliance with State or local requirements. After receipt of such notice from the Engineer or from the regulatory agency through the Engineer, immediately take corrective action. Such notice, when delivered to the Contractor or his authorized representative at the site of the work, shall be deemed sufficient for the purpose. If the Contractor fails or refuses to comply promptly, the Owner may issue an order stopping all or part of the work until satisfactory corrective action has

been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor unless it is later determined that the Contractor was in compliance.

#### 1.04 IMPLEMENTATION

- A. Prior to commencement of the work, the Contractor shall meet with the Engineer and the Owner to develop mutual understandings relative to compliance with these provisions and administration of the environmental pollution control program.
- B. The Contractor shall remove temporary environmental control features, when approved by the Engineer and incorporate permanent control features into the project at the earliest practicable time.

#### PART 2 PRODUCTS (NOT USED)

#### PART 3 EXECUTION

##### 3.01 EROSION CONTROL

- A. The Contractor shall provide positive means of erosion control such as shallow ditches around construction to carry off surface water. Erosion control measures, such as siltation basins, hay check dams, mulching, jute netting and other equivalent techniques, shall be used as appropriate. Offsite surface water shall be diverted around the site, to a downstream channel ahead of siltation barriers. Flow of surface water into excavated areas shall be prevented. Ditches around construction area shall also be used to carry away water resulting from dewatering of excavated areas. At the completion of the work, ditches shall be backfilled and the ground surface restored to original condition.

##### 3.02 PROTECTION OF STREAMS AND SURFACE WATERS

- A. The Contractor shall take all precautions to prevent, or reduce to a minimum, any damage to any stream or surface water from pollution by debris, sediment or other material, or from the manipulation of equipment and/or materials in or near such streams. Water that has been used for washing or processing, that contains oils or sediments that will reduce the quality of the water in the stream, shall not be directly returned to the stream. Divert such waters through a settling basin or filter before being directed into streams or surface waters.
- B. The Contractor shall not discharge water from dewatering operations directly into any live or intermittent stream, channel, wetlands, surface water or any storm sewer. Water from dewatering operations shall be treated by filtration, settling basins, or other approved method to reduce the amount of sediment contained in the water to allowable levels.
- C. The Contractor shall take all preventative measures to avoid spillage of petroleum products and other pollutants. In the event of any spillage, prompt remedial action shall be taken in accordance with a contingency action plan approved by the Florida Department of Environmental Protection. The Contractor shall submit two copies of approved contingency plans to the Engineer.
- D. Water being flushed from structures or pipelines after disinfection, with a  $\text{Cl}_2$  residue of 2 mg/l or greater shall be treated with a dechlorination solution, in a method approved by the Engineer, prior to discharge.

### 3.03 PROTECTION OF LAND RESOURCES

- A. The Contractor shall restore land resources within the project boundaries and outside the limits of permanent work to a condition, after completion of construction that will appear to be natural and not detract from the appearance of the project. The Contractor shall confine all construction activities to areas shown on the Drawings.
- B. Outside of areas requiring earthwork for the construction of the new facilities, the Contractor shall not deface, injure, or destroy trees or shrubs, nor remove or cut them without prior approval. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorage unless specifically authorized by the Engineer. Where such special emergency use is permitted, first wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable, or wire is placed. The Contractor shall in any event be responsible for any damage resulting from such use.
- C. Before beginning operations near them, the Contractor shall protect trees that may possibly be defaced, bruised, injured, or otherwise damaged by the construction equipment, dumping or other operations, by placing boards, planks, or poles around them. Monuments and markers shall be protected similarly.
- D. Any trees or other landscape features scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to their original condition. The Engineer will decide the method of restoration to be used and whether damaged trees shall be treated and healed or removed and disposed of.
  - 1. All scars made on trees by equipment, construction operations, or by the removal of limbs larger than 1-in in diameter shall be coated as soon as possible with an approved tree wound dressing. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes will not be permitted.
  - 2. Climbing ropes shall be used where necessary for safety. Trees that are to remain, either within or outside established clearing limits, that are subsequently damaged by the Contractor and are beyond saving in the opinion of the Engineer, shall be immediately removed or replaced.
- E. The locations of the Contractor's storage and other construction buildings required temporarily in the performance of the work, shall be cleared portions of the job site or areas to be cleared as shown on the Drawings and approved by the Engineer and shall not be within wetlands or floodplains. The preservation of the landscape shall be an imperative consideration in the selection of all sites and in the construction of buildings. Drawings showing storage facilities shall be submitted for approval of the Engineer.
- F. If the Contractor proposes to construct temporary roads or embankments and excavations for plant and/or work areas, he shall submit the following for approval at least ten days prior to scheduled start of such temporary work.
  - 1. A layout of all temporary roads, excavations, embankments and drainage to be constructed within the work area.
  - 2. Details of temporary road construction.

3. Drawings and cross sections of proposed embankments and their foundations, including a description of proposed materials.
  4. A landscaping drawing showing the proposed restoration of the area. Indicate the proposed removal of any trees and shrubs outside the limits of existing clearing area. Indicate locations of guard posts or barriers required to control vehicular traffic and protect trees and shrubs to be maintained undamaged. The Drawing shall provide for the obliteration of construction scars as such and shall provide for a natural appearing final condition of the area. Modification of the Contractor's approved drawings shall be made only with the written approval of the Engineer. No unauthorized road construction, excavation or embankment construction including disposal areas will be permitted.
- G. The Contractor shall remove all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess of waste materials, or any other vestiges of construction as directed by the Engineer. It is anticipated that excavation, filling and plowing of roadways will be required to restore the area to near natural conditions which will permit the growth of vegetation thereon. The disturbed areas shall be prepared and sodded as described in Section 02932, or as approved by the Engineer.
- H. All debris and excess material will be disposed of outside wetland or floodplain areas in an environmentally sound manner.

#### 3.04 PROTECTION OF AIR QUALITY

- A. Burning - The use of burning at the project site for the disposal of refuse and debris will not be permitted.
- B. Dust Control - Maintain all excavations, embankment, stockpiles, access roads, plant sites, waste areas, borrow areas and all other work areas within or without the project boundaries free from dust which could cause the standards for air pollution to be exceeded and which would cause a hazard or nuisance to others.
- C. An approved method of stabilization consisting of sprinkling or other similar methods will be permitted to control dust. The use of petroleum products is prohibited. The use of chlorides may be permitted with approval from the Engineer.
- D. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor shall have sufficient competent equipment on the job to accomplish this. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs, as determined by the Engineer.

#### 3.05 MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

- A. The Contractor shall maintain all facilities constructed for pollution control as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created.

END OF SECTION

SECTION 01170  
SPECIAL PROVISIONS

PART 1 GENERAL

- A. Any modifications to the design or design intent shall require the prior written approval of the Design Engineer of Record. Request for Information relating to the design intent shall be submitted to the Engineer for forwarding to the Design Engineer of record for his/her response. Shop Drawings and Submittals shall be submitted to the Engineer for forwarding to the Design Engineer of Record for review and approval in accordance with Section 01300. All testing required under this Agreement shall be performed in the presence of the Design Engineer of Record as applicable unless such observations of the testing are waived by the Design Engineer of Record.
- B. Contractor shall strictly follow JEA's Water and Sewer Standards Manual, January 2019 or latest edition during the construction of the improvements at the Greenland Water Treatment Plant as well as these contract documents. Contractor shall issue a Request for Information in the event of a discrepancy between the contract documents and the JEA's Manual for Engineer and Owner to clarify.

1.02 INSTALLATION OF EQUIPMENT

- A. Special care shall be taken to ensure proper alignment of all equipment with particular reference to the pumps and electric drives. The units shall be carefully aligned on their foundations by qualified millwrights after their sole plates have been shimmed to true alignment at the anchor bolts. The anchor bolts shall be set in place and the nuts tightened against the shims. After the foundation alignments have been approved by the Engineer, the bedplates or wing feet of the equipment shall be securely bolted in place. The alignment of equipment shall be further checked after securing to the foundations, and after conformation of all alignments, the sole plates shall be finally grouted in place. The Contractor shall be responsible for the exact alignment of equipment with associated piping and under no circumstances, will "pipe springing" be allowed.
- B. All wedges, shims, filling pieces, keys, packing, grout, or other materials necessary to properly align, level and secure apparatus in place shall be furnished by the Contractor. All parts intended to be plumb or level must be proven exactly so. Perform all grinding necessary to bring parts to proper bearing after erection.

1.03 SLEEVES AND OPENINGS

- A. The Contractor shall provide all openings, channels, chases, etc. in new construction and furnish and install anchor bolts and other items to be embedded in concrete, as required to complete the work under this Contract. Perform all cutting, coring and rough and finish patching required in existing construction for the work of all trades.
- B. The Contractor shall furnish all sleeves, inserts, hangers, anchor bolts, etc. required for the execution of their work. It shall be their responsibility before the work of the Contractor is begun to furnish him with the above items and with templates, drawings or written information covering chases, openings, etc. which they require and to follow up the work of the Contractor as it progresses, making sure that their drawings and written instructions are carried out. Failing to do this, they shall be responsible for the cost of any corrective measures which may be

required to provide necessary openings, etc. If the Contractor fails to carry out the directions given him, covering details and locations of openings, etc., Contractor shall be responsible for any cutting and refinishing required to make the necessary corrections. In no case shall beams, lintels, or other structural members be cut without the approval of the Engineer.

#### 1.04 SUBMITTALS

- A. Submit to the Engineer in accordance with Section 01300, a valve schedule as specified in Paragraph 1.10.

#### 1.05 GREASE, OIL AND FUEL

- A. All grease, oil and fuel required for testing of equipment shall be furnished with the respective equipment. The Owner shall be furnished with a year's supply of required lubricants including grease and oil of the type recommended by the manufacturer with each item of equipment supplied under Divisions 11, 15, and 16.

#### 1.06 TOOLS

- A. Any special tools (including grease guns or other lubricating devices) which may be necessary for the adjustment, operation and maintenance of any equipment shall be furnished with the respective equipment.
- B. Tools shall be furnished in heavy steel tool boxes complete with lock and duplicate keys.

#### 1.07 POWER SUPPLY

- A. Unless otherwise specified, all motors 1/2 Hp and larger shall be designed for a power supply of 460 Volts, 3 Phase, 60 Hz, and all motors 1/3 Hp and smaller shall be designed for a power supply of 120 Volts, single phase, 60 Hz.

#### 1.08 POWER FACTOR CORRECTION CAPACITORS

- A. All single and multi-speed three phase induction motors 5 Hp and larger shall be furnished with factory provided power factor correction capacitors.
- B. Capacitors shall be sized by the manufacturers such that over voltage due to self-excitation will be prevented and transient torques limited to normal values. Full load power factor shall be corrected to not less than 0.95 where such correction will not violate the provisions of NEC Article 460.
- C. Capacitor enclosures shall be compatible with those specified for their respective motors, i.e., dust-tight for indoor installation in non-hazardous areas and weatherproof for outdoor installations.
- D. Capacitors shall be dry or oil insulated with integral fuse protection and discharge resistor. The insulating medium shall be non-flammable and meet U.S. Environmental Protection Agency Standards.
- E. Capacitors shall be installed under Division 16.

1.09 ARCHITECTURAL COATINGS

- A. Maintain coordination among all Sections (windows, window walls, louvers, doors and frames, etc) requiring PVF or PVC coatings. All coatings shall match to the satisfaction of the Engineer with regard to color and texture. Items rejected by the Engineer shall promptly be removed from the job site.

1.10 PIPE MARKING

- A. Pipe marking is included in Division 9 under Painting, but it shall be the Contractor's responsibility to assist, as required by the Engineer, in identifying pipe contents, direction of flow and all else required for proper marking of pipe.

1.11 VALVE IDENTIFICATION

- A. The Contractor shall prepare a valve schedule for all valves required for his work showing a number, the location, type, function, and normal operating position, for each valve. The schedule shall be submitted to the Engineer for approval not less than 120 days prior to start-up.
- B. The Contractor shall furnish tags for all valves required for the work. Valve tags shall be 2-in diameter, 19 gauge, stainless steel, with stainless steel hooks suitable for attaching the tag to the valve operator. Tags shall be stamped or etched with the valve number and the information on the valve schedule coded in a system provided by the Owner. Submit two samples of the type of tag proposed and the manufacturer's standard color chart and letter styles to the Engineer for approval.
- C. The Contractor shall install valve tags on all valves required for his work.

1.12 SIGNIFICANTLY IMPORTANT ARCHAEOLOGICAL AREAS

- A. Certain areas at the site, located on the Drawings, have been determined to be archaeological significant. Exercise the utmost care to ensure that these areas remain undisturbed, and prevent construction or private vehicles from crossing over these areas. In addition, when directed by the Engineer, cover these areas with 1-ft common fill to the limits directed by the Engineer. All costs for this work shall be included in the total Contract Price.

1.13 NOISE LIMITATIONS

- A. All equipment to be furnished under this Contract, unless specified otherwise in the technical specifications, shall be designed to ensure that the sound pressure level does not exceed 85 decibels over a frequency range of 37.8 to 9600 cycles per second at a distance of 3-ft from any portion of the equipment, under any load condition, when tested using standard equipment and methods. Noise levels shall include the noise from the motor. Mufflers or external baffles shall not be acceptable for the purpose of reducing noise. Data on noise levels shall be included with the shop drawing submittal.

1.14 SPARE PARTS

- A. Where spare parts are specified in the technical sections, furnish all spare parts recommended by the manufacturer or system supplier for one year of service. In addition, furnish all spare parts itemized in each Section.

- B. Collect and store all spare parts in an area to be designated by the Owner. Furnish the Owner with an inventory listing all spare parts, the equipment they are associated with, the name and address of the supplier and the delivered cost of each item. Copies of actual invoices for each item shall be furnished with the inventory to substantiate the delivery cost.
- C. Spare parts shall be packed in cartons, properly labeled with indelible markings with complete descriptive information including manufacturer, part number, part name and equipment for which the part is to be used and shall be properly treated for one year of storage.

#### 1.15 RIGHT TO KNOW LAW

- A. The Contractor shall submit to the Florida Department of Environmental Protection the Material Safety Data Sheets for all substances or mixture of substances used on the Project by him or his Subcontractors prior to commencing any work.

#### 1.16 HURRICANE PREPAREDNESS PLAN

- A. Within 30 days of the date Notice to Proceed, submit a Hurricane Preparedness Plan to the Engineer and the Owner for approval. The Plan shall describe in detail the necessary measures which the Contractor will perform, at no additional costs to the Owner, in case of a hurricane warning. Revise Plan as required by the Engineer and Owner.

#### 1.17 WEATHER PROTECTION

- A. In the event of inclement weather, the Contractor shall protect the Work and materials from damage or injury from the weather. If, in the opinion of the Engineer, any portion of the Work or materials has been damaged by reason of failure on the part of the Contractor or subcontractors to so protect the Work, such Work and materials shall be removed and replaced with new materials and Work to the satisfaction of the Engineer.

#### 1.18 SERVICES OF MANUFACTURERS' FIELD SERVICE TECHNICIAN

- A. Bid prices for equipment furnished by the Contractor under Divisions 11, 13, 15 and 16 shall include the cost of a competent field service technician of the manufacturers of all equipment to supervise the installation, adjustment and testing of the equipment and to instruct the Owner's operating personnel on operation and maintenance. The approved Manufacturer's operation and maintenance data as specified in Section 01730 shall be delivered to the Engineer prior to instructing the Owner's personnel. This supervision may be divided into two or more time periods as required by the installation program or as directed by the Engineer.
- B. After installation of the equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the Manufacturer's field service technician shall inspect, operate, test and adjust the equipment. The inspection shall include at least the following points where applicable.
  - 1. Soundness (without cracked or otherwise damaged parts).
  - 2. Completeness in all details, as specified and required.
  - 3. Correctness of setting, alignment and relative arrangement of various parts.

- C. Upon completion of this work, the Manufacturer's field service technician shall submit, in triplicate, to the Engineer a complete, signed report of the results of his/her inspection, operation, adjustments and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified and suggestions for precautions to be taken to ensure proper maintenance.
- D. A certificate from the Manufacturer stating that the installation of the equipment is satisfactory, that the unit has been satisfactorily tested, is ready for operation and that the operating personnel have been suitably instructed in the operation, lubrication and care of the unit shall be submitted prior to the startup and performance demonstration hereinafter specified. The certificate shall indicate date and time instruction was given and names of operating personnel in attendance. This certification shall be submitted on the certification sheet, a sample of which is at the end of this Section.
- E. See the detailed Specifications for additional requirements for furnishing the services of the manufacturer's field service technician.

END OF SECTION

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## SECTION 01180 PIPE PENETRATIONS

### PART 1 GENERAL

#### 1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install pipe penetration assemblies at all floor and wall penetrations as shown on the Drawings. This Section covers materials for the various pipe penetration configurations. Generally, penetration details are called out on the Drawings and referenced on the detail sheets. Where penetrations are required and not called out, it shall be assumed the most conservative penetration detail shown on the detail sheets shall be utilized as appropriate for the piping type, the wall or floor construction and the rating of the wall or floor penetrated.

#### 1.02 SUBMITTALS

- A. Submit manufacturers' literature, installation instructions, and where applicable, fire rating and certified test results of the various components on all items to be furnished in accordance with Section 01300.

### PART 2 PRODUCTS

#### 2.01 PIPE SLEEVES

- A. Unless otherwise shown all pipe sleeves shall be Schedule 40 galvanized steel pipe conforming to ASTM A53 or PVC for sodium hypochlorite applications. Where indicated, provide a 2-in minimum circumferential water stop welded to exterior of sleeve at its midpoint. Ends of sleeves shall be cut and ground smooth and shall be flush with the wall or ceiling and extend 2-in above finished floors. Sleeves to be sealed with mechanical seals shall be sized in accordance with the seal manufacturer's recommendations. Sleeves to be sealed by caulking and sleeves for insulated piping shall be sized as required.

#### 2.02 SEALING MATERIALS

- A. Mechanical seals shall consist of rubber links shaped to continuously fill the annular space between the pipe and the wall opening or sleeve. Link pressure plates shall be molded of glass reinforced nylon. All Hardware shall be Type 316 stainless steel. Links shall be colored throughout elastomer for positive material identification. Each link shall have permanent identification of the size and manufacturer's name molded into the pressure plate and sealing element. Completed sealing system shall be duty pressure rated for 20 psig differential pressure. Link material shall be EPDM for all services except fire rated assemblies, fire rated seals shall use silicone link material. Mechanical seals shall be PSI-Thunderline/ Link-Seal as manufactured by Pipeline Seal & Insulator, Inc., Houston, TX, or pre-approved equal.
- B. Sealant shall be a two-part foamed silicone elastomer by Dow Corning Co., Product No. 3-6548 silicone R.T.V.; 3M brand fire barrier products caulk C.P. 25 and 3M brand moldable putty MP+; or Flame-Safe fire stop systems FS-900 by Rectorseal. Sealant bead configuration, depth and width shall be in accordance with manufacturer's recommendations.

2.03 MISCELLANEOUS MATERIALS

- A. Bonding compound shall be Sikadur Hi-Mod epoxy by Sika Corp.; Euco 452 by Euclid Chemical Corp.; Master Builders Company or equal.
- B. Non-shrink grout shall be Masterflow 713 by Master Builders Co.; Euco NS by Euclid Chemical Co.; Five Star Grout by U.S. Grout Corp. or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Assemble and install components of pipe penetration assemblies as detailed on the Drawings.

END OF SECTION

SECTION 01200  
PROJECT MEETINGS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. The Owner shall schedule and administer pre-construction meeting, periodic progress meetings and specially called meetings throughout progress of the work.
  - 1. Prepare agenda for meetings.
  - 2. Make physical arrangements for meetings.
- B. The Engineer shall:
  - 1. Preside at meetings.
  - 2. Record the minutes; include significant proceedings and decisions.
  - 3. Reproduce and distribute copies of minutes within 10 working days after each meeting.
    - a. To participants in the meeting.
    - b. To parties affected by decisions made at the meeting.
- C. Representatives of the Contractor, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.
- D. Attend meetings to ascertain that work is expedited consistent with Contract Documents and construction schedules.

1.02 RELATED REQUIREMENTS

- A. Construction Schedules are included in Section 01310.
- B. Shop Drawings, Working Drawings and Samples are included in Section 01300.
- C. Project Record Documents are included in Section 01720.
- D. Operating and Maintenance Data is included in Section 01730.

1.03 PRE-CONSTRUCTION MEETING

- A. Schedule a preconstruction meeting no later than 10 days after date of Notice to Proceed.
- B. Location: A central site, convenient for all parties, designated by the Owner.
- C. Attendance
  - 1. Owner's Representative.
  - 2. Engineer and their professional consultants.

3. Resident Project Representative.
4. Contractor's Superintendent.
5. Major Subcontractors.
6. Major suppliers.
7. Utilities.
8. Others as appropriate.

D. Suggested Agenda

1. Distribution and discussion of:
  - a. List of major subcontractors and suppliers.
  - b. Projected Construction Schedules.
2. Critical work sequencing.
3. Major equipment deliveries and priorities.
4. Project Coordination.
  - a. Designation of responsible personnel.
5. Procedures and processing of:
  - a. Field decisions.
  - b. Proposal requests.
  - c. Submittals.
  - d. Change Orders.
  - e. Applications for Payment.
6. Adequacy of distribution of Contract Documents.
7. Procedures for maintaining Record Documents.
8. Use of premises:
  - a. Office, work and storage areas.
  - b. Owner's requirements.
9. Construction facilities, controls and construction aids.
10. Temporary utilities.
11. Housekeeping procedures.

1.04 PROGRESS MEETINGS

- A. Schedule regular periodic meetings. The progress meetings will be held every 30 days with the first meeting 30 days after the pre-construction meeting or 30 days after the date of Notice to Proceed.

- B. Hold called meetings as required by progress of the work.
- C. Location of the meetings: Project field office of Contractor or Owner.
- D. Attendance
  - 1. Engineer and their professional consultants as needed.
  - 2. Contractor's superintendent and key staff as appropriate to the agenda.
  - 3. Subcontractors as appropriate to the agenda.
  - 4. Suppliers as appropriate to the agenda.
  - 5. Others as appropriate.
- E. Suggested Agenda
  - 1. Review, approval of minutes of previous meeting.
  - 2. Review of work progress since previous meeting.
  - 3. Field observations, problems and conflicts.
  - 4. Problems which impede Construction Schedule.
  - 5. Review of off-site fabrication, delivery schedules.
  - 6. Corrective measures and procedures to regain projected schedule.
  - 7. Revisions to Construction Schedule.
  - 8. Progress, schedule, during succeeding work period.
  - 9. Coordination of schedules.
  - 10. Review submittal schedules; expedite as required.
  - 11. Maintenance of quality standards.
  - 12. Pending changes and substitutions.
  - 13. Review proposed changes for:
    - a. Effect on Construction Schedule and on completion date.
    - b. Effect on other contracts of the project.
  - 14. Other business.
    - a. Asset management update.
  - 15. Construction schedule.
  - 16. Critical/long lead items.

- F. Attend progress meetings and is to study previous meeting minutes and current agenda items, in order to be prepared to discuss pertinent topics such as deliveries of materials and equipment, progress of the work, etc.
- G. Provide a current submittal log at each progress meeting in accordance with Section 01300.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

## SECTION 01300 SUBMITTALS

### PART 1 GENERAL

#### 1.01 SCOPE OF WORK

- A. This Section includes the requirements for compiling, processing and transmitting submittals required for execution of the project.
- B. Submittals are categorized into two types: Action Submittals and Informational Submittals, as follows:
  - 1. Action Submittal: Written and graphic information submitted by the Contractor that requires the Engineer's approval. The following are examples of action submittals:
    - a. Shop drawings (including working drawings, valve schedule in accordance with Section 01170, and product data).
    - b. Samples.
    - c. Operation & maintenance manuals.
    - d. Site Usage Plan (Contractor's staging - including trailer siting and material laydown area).
    - e. Schedule of values.
    - f. Payment application format.
  - 2. Informational Submittal: Information submitted by the Contractor that does not require the Engineer's approval. The following are examples of informational submittals:
    - a. Shop Drawing Schedule.
    - b. Construction Schedule.
    - c. Statements of Qualifications.
    - d. Health and Safety Plans.
    - e. Construction Photography and Videography.
    - f. Asset Management.
    - g. Work Plans.
    - h. Maintenance of Traffic Plans.
    - i. Outage Requests.
    - j. Proposed Testing Procedures.
    - k. Test Records and Reports.
    - l. Vendor Training Outlines/Plans.
    - m. Test and Start-Up Reports.
    - n. Certifications.
    - o. Record Drawings.
    - p. Record Shop Drawings.
    - q. Submittals required by laws, regulations and governing agencies.
    - r. Submittals required by funding agencies.
    - s. Other requirements found within the technical specifications.
    - t. Warranties and Bonds.
    - u. As-Built Surveys.
    - v. Contract Close-out Documents.

## 1.02 RELATED WORK

- A. Additional requirements may be specified in the General Conditions for the Contract.
- B. Additional submittal requirements may be specified in the respective technical Specification Sections.
- C. Operation and Maintenance manuals are included in Section 01730.
- D. Contract closeout submittals are included in Section 01700.
- E. Warranties and Bonds are included in Section 01740.
- F. Construction Photos are included in Section 01380.
- G. Applications for Payment are included in Section 01026.
- H. Construction Schedules are included in Section 01310.
- I. Project Controls (Surveying) are included in Section 01050.
- J. Project Record Documents are included in Section 01720.

## 1.03 CONTRACTOR'S RESPONSIBILITIES

- A. All submittals shall be clearly identified as follows:
  - 1. Date of Submission.
  - 2. Project Number.
  - 3. Project Name.
  - 4. Contractor Identification.
    - a. Contractor.
    - b. Supplier.
    - c. Manufacturer.
    - d. Manufacturer or supplier representative.
  - 5. Identification of the Product.
  - 6. Reference to Contract Drawing.
  - 7. Reference to specification section number, page and paragraph(s).
  - 8. Reference to applicable standards, such as ASTM or Federal Standards numbers.
  - 9. Indication of Contractor's approval.
  - 10. Contractor's Certification statement.
  - 11. Identification of deviations from the Contract Documents, if any.

12. Reference to previous submittal (for resubmittals).
  13. Made in America (when required by the Contract).
- B. Submittals shall be clear and legible, and of sufficient size for legibility and clarity of the presented data.
- C. Maintain a log of all submittals. The submittal log shall be kept accurate and up to date. This log should include the following items (as applicable):
1. Description.
  2. Submittal Number.
  3. Date transmitted to the Engineer.
  4. Date returned to Contractor (from Engineer).
  5. Status of Submittal (Approved/Not Approved/etc.).
  6. Date of Resubmittal to Engineer and Return from Engineer (if applicable and repeat as necessary).
  7. Date material released for fabrication.
  8. Projected (or actual) delivery date.
- D. Numbering System. Utilize the following submittal identification numbering system:
1. The first character shall be a D, S, M or I which represents Shop Drawing (including working drawings and product data), Sample, Manual (Operating & Maintenance) or Informational, respectively.
  2. The next five digits shall be the applicable Section Number.
  3. The next three digits shall be the sequential number of each separate item or drawing submitted under each Specification Section, in the chronological order submitted, starting at 001.
  4. The last character shall be a letter, A to Z, indicating the submission (or resubmission) of the same submittal, i.e., "A" = 1st submission, "B" = 2nd submission, "C" = 3rd submission, etc. A typical submittal number would be as follows:
    - a. D-03300-008-B.
    - b. D = Shop Drawing 03300 = Section for Concrete.
    - c. 008 = the eighth different submittal under this Section.
    - d. B = the second submission (first resubmission) of that particular shop drawing.

E. Variances

1. Notify the Engineer in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.
2. Notify the Engineer in writing, at the time of re-submittal (resubmission), of all deviations from previous submissions of that particular shop drawing, except those deviations which are the specific result of prior comments from the Engineer.

F. Action Submittals

1. Shop Drawings, Working Drawings, Product Data and Samples.
  - a. Shop Drawings.
    - 1) Shop drawings as defined in the General Conditions, and as specified in individual Sections may include, but are not necessarily limited to, custom prepared data such as fabrication and erection/installation (working) drawings, scheduled information, setting diagrams, actual shop work manufacturing instructions, custom templates, valve schedules, wiring diagrams, coordination drawings, equipment inspection and test reports, and performance curves and certifications, as applicable to the work.
    - 2) Contractor shall verify all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and coordinate each item with other related shop drawings and the Contract requirements.
    - 3) All details on shop drawings shall clearly show the relation of the various parts to the main members and lines of the structure and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the drawings before being submitted.
    - 4) All shop drawings submitted by subcontractors and vendors shall be reviewed by the Contractor. Contractor shall confirm, materials, dimensions, catalog numbers, technical data and performance criteria; and shall coordinate with other related shop drawings and the Contract requirements. In addition, Contractor shall confirm existing field conditions and dimensions and assure that the submittal is coordinated and compatible with existing conditions. Submittals directly from subcontractors or vendors will not be accepted by the Engineer.
    - 5) The Contractor shall be responsible the accuracy of the subcontractor's or vendor's submittal; and, for their submission in a timely manner to support the requirements of the Contractor's construction schedule. Shop drawings found to be inaccurate or otherwise in error shall be returned to the subcontractor or vendor to correct, before submission to the Engineer. All shop Drawings shall be approved by the Contractor.
    - 6) Delays to construction due to the untimely submission of submittals will constitute inexcusable delays, for which Contractor shall not be eligible for additional cost nor additional contract time. Inexcusable delays consist of any delay within the Contractor's control.
    - 7) Submittals for equipment specified under Divisions 11, 13, 14, 15 and 16 shall include a listing of installations where identical or similar equipment manufactured by that manufacturer has been installed and in operation for a period of at least five years.
  - b. Working Drawings.
    - 1) Detailed installation drawings (sewers, equipment, piping, electrical conduits and controls, HVAC work, and plumbing, etc.) shall be prepared and submitted for

- review and approval by the Engineer prior to installing such work. Installation drawings shall be to-scale and shall be fully dimensioned.
- 2) Piping working drawings shall show the laying dimensions of all pipes, fittings, valves, as well as the equipment to which it is being connected. In addition, all pipe supports shall be shown.
  - 3) Equipment working drawings shall show all equipment dimensions, anchor bolts, support pads, piping connections and electrical connections. In addition, show clearances required around such equipment for maintenance of the equipment.
  - 4) Electrical working drawings shall show conduits, junction boxes, disconnects, control devices, lighting fixtures, support details, control panels, lighting and power panels, and Motor Control Centers. Coordinate all locations with the Contract Documents and the Contractor's other working drawings.
- c. Product Data.
- 1) Product data, as specified in individual Specification Sections, include, but are not limited to, the manufacturer's standard prepared data for manufactured products (catalog data), such as the product specifications, installation instructions, availability of colors and patterns, rough-in diagrams and templates, product photographs (or diagrams), wiring diagrams, performance curves, quality control inspection and reports, certifications of compliance (as specified or otherwise required), mill reports, product operating and maintenance instructions, recommended spare parts and product warranties, as applicable.
- d. Samples.
- 1) Furnish, samples required by the Contract Documents for the Engineer's approval. Samples shall be delivered to the Engineer as specified or directed. Unless specified otherwise, provide at least two samples of each required item. Materials or equipment for which samples are required shall not be used in the work unless and until approved by the Engineer.
  - 2) Samples specified in individual Specification Sections, include, but are not limited to: physical examples of the work (such as sections of manufactured or fabricated work), small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols, and other specified units of work.
  - 3) Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify and Contract Requirements.
  - 4) Approved samples not destroyed in testing shall be sent to the Engineer or stored at the site of the work. Approved samples of the hardware in good condition will be marked for identification and may be used in the work. Materials and equipment incorporated in work shall match the approved samples. Samples which fail testing or are not approved will be returned to the Contractor at his expense, if so requested at time of submission.
- e. Professional Engineer (P.E.) Certification Form.
- 1) If specifically required in any of the technical Specification Sections, submit a Professional Engineer (P.E.) Certification for each item required, using the form appended to this Section.
2. Contractor's Certification
- a. Each shop drawing, working drawings, product data, and sample shall have affixed to it the following Certification Statement:

- 1) "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements."
  - b. Shop drawings, working drawings, and product data sheets 11-in x 17-in and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The transmittal cover sheet for each identified shop drawing shall fully describe the packaged data and include a listing of all items within the package.
3. The review and approval of shop drawings, working drawings, product data, or samples by the Engineer shall not relieve the Contractor from the responsibility for the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor and the Engineer will have no responsibility therefor.
4. Project work, materials, fabrication, and installation shall conform to approved shop drawings (including working drawings and product data) and applicable samples.
5. No portion of the work requiring a shop drawing (including working drawings and product data) or sample shall be started, nor shall any materials be fabricated or installed before approval of such item. Procurement, fabrication, delivery or installation of products or materials that do not conform to approved shop drawings shall be at the Contractor's risk. Furthermore, such products or materials delivered or installed without approved shop drawings, or in non-conformance with the approved shop drawings will not be eligible for progress payment until such time as the product or material is approved or brought into compliance with approved shop drawings. Neither the Owner nor Engineer will be liable for any expense or delay due to corrections or remedies required to accomplish conformity.
6. Operation and Maintenance Data
  - a. Operation and maintenance data shall be submitted in assembled manuals as specified. Such manuals shall include detailed instructions for Owner personnel on safe operation procedures, controls, start-up, shut-down, emergency procedures, storage, protection, lubrication, testing, trouble-shooting, adjustments, repair procedures, and other maintenance requirements.
7. Schedule of Values
  - a. On projects consisting of lump sums (in whole or in part) submit a proposed schedule of values providing a breakdown of lump sum items in to reasonably small components – generally disaggregated by building, area, and/or discipline. The purpose of the schedule of values is for processing partial payment applications. If requested by the Engineer, provide sufficient substantiation for all or some items as necessary to determine the proposed schedule of values is a reasonable representation of the true cost breakdown of the Work. The schedule of values shall not be unbalanced to achieve early payment or over-payment in excess of the value of work or any other mis-distribution of the costs. If, in the opinion of the Engineer, the schedule of values is unbalanced, Contractor shall reallocate components to achieve a balanced schedule acceptable to Engineer.

8. Payment Application Format
  - a. If an application form is included in the Contract Documents, use that form unless otherwise approved by the Engineer and Owner. If an application form is not included in the Contract Documents, Contractor may propose a form for approval.
9. Site Usage
  - a. Submit a proposed site staging plan, including but not limited to the location of office trailers, storage trailers and material laydown. Such plan shall be a graphic presentation (drawing) of the proposed locations; and, shall include on-site traffic modifications, and temporary utilities, as may be applicable.

G. Informational Submittals

1. Shop Drawing Schedule.
  - a. Prepare and submit a schedule indicating when shop drawings are required to be submitted to support the as-planned construction schedule. The submittal schedule shall allow sufficient time for preparation and submittal, review and approval, and fabrication and delivery to support the construction schedule.
2. Construction Schedule.
  - a. Prepare and submit construction schedules and monthly status reports as specified.
3. Statements of Qualifications.
  - a. Provide evidence of qualification, certification, or registration, as required in the Contract Documents, to verify qualifications of licensed land surveyor, professional engineer, materials testing laboratory, specialty subcontractor, technical specialist, consultant, specialty installer, and other professionals.
  - b. Health and Safety Plans.
    - 1) When specified, prepare and submit a general company Health and Safety Plan (HSP), modified or supplemented to include job-specific considerations.
4. Construction Photography and Videography.
  - a. Provide periodic construction photographs and videography as specified – including but not limited to preconstruction photographs and/or video, monthly progress photos and/or video and post-construction photographs and/or video.
5. Work Plans.
  - a. Prepare and submit copies of all work plans needed to demonstrate to the Owner that Contractor has adequately thought-out the means and methods of construction and their interface with existing facilities.
6. Maintenance of Traffic Plans.
  - a. Prepare maintenance of traffic plans where and when required by the Contract Documents and by local ordinances or regulations. If Contractor is not already knowledgeable about local ordinances and regulations regarding maintenance of traffic requirements, become familiar with such requirements and include all costs for preparation and submittal of traffic management plans and all associated costs for permits and fees to implement the traffic management plan, in the bid amount. In addition, unless a supplemental payment provision is provided in the bid form, include the cost of police attendance, when required.

7. Outage Requests.
  - a. Provide sufficient notification of any outages required (electrical, flow processes, etc.) as may be required to tie-in new work into existing facilities. Unless specified otherwise elsewhere, a minimum of seven calendar days' notice shall be provided.
8. Proposed Testing Procedures.
  - a. Prepare and submit testing procedures it proposes to use to perform testing required by the various technical specifications.
9. Test Records and Reports.
  - a. Provide copies of all test records and reports as specified in the various technical specifications.
10. Vendor Training Outlines/Plans.
  - a. At least two weeks before scheduled training of Owner's personnel, provide lesson plans for vendor training in accordance with the specification for O&M manuals.
11. Test and Start-up Reports.
  - a. Manufacture shall perform all pre-start-up installation inspection, calibrations, alignments, and performance testing as specified in the respective Specification Section. Provide copies of all such test and start-up reports.
12. Certifications.
  - a. Provide various certifications as required by the technical specifications. Such certifications shall be signed by an officer (of the firm) or other individual authorized to sign documents on behalf of that entity.
  - b. Certifications may include, but are not limited to:
    - 1) Welding certifications and welders' qualifications.
    - 2) Certifications of Installation, Testing and Training for all equipment.
    - 3) Material Testing reports furnished by an independent testing firm.
    - 4) Certifications from manufacturer(s) for specified factory testing.
    - 5) Certifications required to indicate compliance with any sustainability or LEEDS accreditation requirements indicated in the Contract Documents.
13. Record Drawings.
  - a. No later than Substantial Completion, submit a record of all changes during construction not already incorporated into drawings – in accordance with specification on Project Record Documents.
14. Record Shop Drawings.
  - a. Before final payment is made, furnish one set of record shop drawings to the Engineer. These record shop drawings shall be in conformance with the approved documents and should show any field conditions which may affect their accuracy.
  - b. Submittals required by laws, regulations and governing agencies.
    - 1) Prepare and submit all documentation required by state or local law, regulation or government agency directly to the applicable agency. This includes, but is not limited to, notifications, reports, certifications, certified payroll (for projects subject to wage requirements) and other documentation required to satisfy all requirements. Provide to Engineer one copy of each submittal made in accordance with this paragraph.

- c. Submittals required by funding agencies.
  - 1) Prepare and submit all documentation required by funding agencies. This includes, but is not limited to segregated pay applications and change orders when required to properly allocate funds to different funding sources; and certified payrolls for projects subject to wage requirements. Provide one copy of each submittal made in accordance with this paragraph to the Engineer.
- 15. Other requirements of the technical Specification Sections.
  - a. Comply with all other requirements of the technical specifications.
- 16. Warranties and Bonds.
  - a. Assemble a booklet or binder of all warranties and bonds as specified in the various technical specifications and in accordance with the specification on Warranties and Bonds; and provide two originals to the Engineer.
- 17. As-Built Surveys.
  - a. Engage the services of a licensed land surveyor in accordance with the Project Controls (Surveying) specification. Prior to Final Completion, provide an as-built survey of the constructed facility, as specified.
- 18. Contract Close-Out Documents.
  - a. Submit Contract documentation as indicated in the specification for Contract Close-out.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 SUBMITTAL SCHEDULE

- A. Provide an initial submittal schedule at the pre-construction meeting for review by Owner and Engineer. Incorporate comments from Owner or Engineer into a revised submittal schedule.
- B. Maintain the submittal schedule and provide sufficient copies for review by Owner and Engineer. An up-to-date submittal schedule shall be provided at each project progress meeting.

### 3.02 TRANSMITTALS

- A. Prepare separate transmittal sheets for each submittal. Each transmittal sheet shall include at least the following: Contractor's name and address, Owner's name, project name, project number, submittal number, description of submittal and number of copies submitted.
- B. Submittals shall be transmitted or delivered directly to the office of the Engineer, as indicated in the Contact Documents or as otherwise directed by the Engineer.
- C. Provide copies of transmittals forms or cover letters (without attachments) directly to the Resident Project Representative.

### 3.03 PROCEDURES

#### A. Action Submittals

##### 1. Contractor's Responsibilities.

- a. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work of other related Sections, so that the installation will not be delayed by processing times including disapproval and resubmittal (if required). Coordinate with other submittals, testing, purchasing, fabrication, delivery and similar sequenced activities. Extensions to the Contract Time will not be approved for the Contractor's failure to transmit submittals sufficiently in advance of the Work.
- b. The submittals of all shop drawings (including working drawings and product data) shall be sufficiently in advance of construction requirements to allow for possible need of re-submittals, including the specified review time for the Engineer.
- c. No less than 30 calendar days will be required for Engineer's review time for shop drawings and O&M manuals involving only one engineering discipline. No less than 45 calendar days will be required for Engineer's review time for shop drawings and O&M manuals that require review by more than one engineering discipline. Resubmittals will be subject to the same review time.
- d. Submittals of operation and maintenance data shall be provided within 30 days of approval of the related shop drawing(s).
- e. Before submission to the Engineer, review shop drawings as follows:
  - 1) make corrections and add field measurements, as required.
  - 2) use any color for its notations except red (reserved for the Engineer's notations) and black (to be able to distinguish notations on black and white documents).
  - 3) identify and describe each and every deviation or variation from Contract documents or from previous submissions, except those specifically resulting from a comment from the Engineer on a previous submission.
  - 4) include the required Contractor's Certification statement.
  - 5) provide field measurements (as needed).
  - 6) coordinate with other submittals.
  - 7) indicate relationships to other features of the Work.
  - 8) highlight information applicable to the Work and/or delete information not applicable to the Work.
- f. Submit the following number of copies:
  - 1) Shop drawings (including working drawings and product data) – Submit no fewer than six, and no more than nine; five of which will be retained by the Engineer.
  - 2) Samples – three.
  - 3) Site Usage Plan – three copies.
  - 4) Schedule of values – four copies.
  - 5) Payment application format – four copies.
- g. If Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, provide written notice thereof to the Engineer immediately; and do not release for manufacture before such notice has been received by the Engineer.
- h. When the shop drawings have been completed to the satisfaction of the Engineer, carry out the construction in accordance therewith; and make no further changes therein except upon written instructions from the Engineer.

2. Engineer's Responsibilities.
  - a. Engineer will not review shop drawings (including working drawings and product data) that do not include the Contractor's approval stamp and required certification statement. Such submittals will be returned to the Contractor, without action, for correction.
  - b. Partial shop drawings (including working drawings and product data) will not be reviewed. If, in the opinion of the Engineer, a submittal is incomplete, that submittal will be returned to the Contractor for completion. Such submittals may be returned with comments from Engineer indicating the deficiencies requiring correction.
  - c. If shop drawings (including working drawings and product data) meet the submittal requirements, Engineer will forward copies to appropriate reviewer(s). Otherwise, noncompliant submittals will be returned to the Contractor without action - with the Engineer retaining one copy.
  - d. Submittals which are transmitted in accordance with the specified requirements will be reviewed by the Engineer within the time specified herein. The time for review will commence upon receipt of submittal by Engineer.
3. Review of Shop Drawings (Including Working Drawings and Product Data) and Samples.
  - a. The review of shop drawings, working drawings, data and samples will be for general conformance with the design concept and Contract Documents. They shall not be construed:
    - 1) as permitting any departure from the Contract requirements.
    - 2) as relieving the Contractor of responsibility for any errors, including details, dimensions, and materials.
    - 3) as approving departures from details furnished by the Engineer, except as otherwise provided herein.
  - b. The Contractor remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.
  - c. If the shop drawings (including working drawings and product data) or samples as submitted describe variations and indicate a deviation from the Contract requirements that, in the opinion of the Engineer are in the interest of the Owner and are so minor as not to involve a change in Contract Price or Contract Time, the Engineer may return the reviewed drawings without noting an exception.
  - d. Only the Engineer will utilize the color "RED" in marking submittals.
  - e. Shop drawings will be returned to the Contractor with one of the following codes.
    - 1) "APPROVED" – This code is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.
    - 2) "APPROVED AS NOTED" - This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.
    - 3) "APPROVED AS NOTED/CONFIRM" - This combination of codes is assigned when a confirmation of the notations and comments is required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.

- 4) "APPROVED AS NOTED/RESUBMIT" - This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the entire package. This resubmittal is to address all comments, omissions and non-conforming items that were noted. Resubmittal is to be received by the Engineer within 30 calendar days of the date of the Engineer's transmittal requiring the resubmittal.
  - 5) "NOT APPROVED" – This code is assigned when the submittal does not meet the intent of the contract documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the requirements of the contract documents.
  - 6) "COMMENTS ATTACHED" – This code is assigned where there are comments attached to the returned submittal, which provide additional data to aid the Contractor.
  - 7) "RECEIPT ACKNOWLEDGED (Not subject to Engineer's Review or Approval)" – This code is assigned to acknowledge receipt of a submittal that is not subject to the Engineer's review and approval, and is being filed for informational purposes only. This code is generally used in acknowledging receipt of means and methods of construction work plans, field conformance test reports, and health and safety plans.
  - f. Repetitive Reviews: Shop drawings, O&M manuals and other submittals will be reviewed no more than twice at the Owner's expense. All subsequent reviews will be performed at the Contractor's expense. Reimburse the Owner for all costs invoiced by Engineer for the third and subsequent reviews.
4. Electronic Transmission.
- a. Action Submittals may be transmitted by electronic means provided the following conditions are met:
    - 1) The above-specified transmittal form is included.
    - 2) All other requirements specified above have been met including, but not limited to, coordination by the Contractor, review and approval by the Contractor, and the Contractor's Certification.
    - 3) The submittal contains no pages or sheets large than 11 x 17 inches.
    - 4) With the exception of the transmittal sheet, the entire submittal is included in a single file.
    - 5) The electronic files are PDF format (with printing enabled).
    - 6) In addition, transmit three hard-copy (paper) originals to the Engineer.
    - 7) The Engineer's review time will commence upon receipt of the hard copies of the submittal.
    - 8) For Submittals that require certification, corporate seal, or professional embossment (i.e., P.E.s, Surveyors, etc.) transmit at least two hard-copy originals to the Engineer. In addition, provide additional photocopied or scanned copies, as specified above, showing the required certification, corporate seal, or professional seal.

B. Informational Submittals

1. Contractor's Responsibilities.
  - a. Number of copies: Submit three copies, unless otherwise indicated in individual Specification sections.

- b. Refer to individual technical Specification Sections for specific submittal requirements.
- 2. Engineer's Responsibilities.
  - a. The Engineer will review each informational submittal within 15 days. If the informational submittal complies with the Contract requirements, Engineer will file for the project record and transmit a copy to the Owner. Engineer may elect not to respond to Contractor regarding informational submittals meeting the Contract requirements.
  - b. If an informational submittal does not comply with the Contract requirements, Engineer will respond accordingly to the Contractor within 15 days. Thereafter, the Contractor shall perform the required corrective action, including retesting, if needed, until the submittal, in the opinion of the Engineer, is in conformance with the Contract Documents.
- 3. Electronic Transmission.
  - a. Informational submittals may be transmitted by electronic means providing all of the following conditions are met:
    - 1) The above-specified transmittal form is included.
    - 2) The submittal contains no pages or sheets large than 11 x 17 inches.
    - 3) With the exception of the transmittal sheet, the entire submittal is included in a single file.
    - 4) The electronic files are PDF format (with printing enabled).
    - 5) For Submittals that require certification, corporate seal, or professional embossment (i.e., P.E.s, Surveyors, etc.) transmit two hard-copy originals to the Engineer.

END OF SECTION

### P.E. CERTIFICATION FORM

The undersigned hereby certifies that he/she is a professional engineer registered in the [State]  
[Commonwealth] of \_\_\_\_\_ and that he/she has been employed by

\_\_\_\_\_ to design  
(Company Name)

\_\_\_\_\_  
(Insert P.E. Responsibilities)

In accordance with Specification Section \_\_\_\_\_ for the

\_\_\_\_\_.  
(Name of Project)

The undersigned further certifies that he/she has performed the said design in conformance with all applicable local, state and federal codes, rules and regulations; and, that his/her signature and P.E. stamp have been affixed to all calculations and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to the

\_\_\_\_\_  
(Insert Name of Owner)

or Owner's representative within seven days following written request therefor by the Owner.

\_\_\_\_\_  
P.E. Name

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

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Signature

\_\_\_\_\_  
P.E. Registration Number

\_\_\_\_\_  
Title

\_\_\_\_\_  
Address

\_\_\_\_\_  
Address

## SECTION 01310 CONSTRUCTION SCHEDULING

### PART 1 GENERAL

#### 1.01 PROGRAM DESCRIPTION

- A. A Critical Path Method (CPM) construction schedule shall be used to control the Work and to provide a basis for determining job progress. The construction schedule shall be prepared and maintained by the Contractor. All work shall be done in accordance with the established CPM schedule. The Contractor and all subcontractors shall cooperate fully in developing the construction schedule and in executing the work in accordance with the CPM schedule.
- B. The construction schedule shall consist of a computerized CPM network (diagram of activities) presented in a time-scaled graphic (print-out) with reports, as specified herein.

#### 1.02 QUALIFICATIONS

- A. The Contractor shall have the capability of preparing and utilizing the specified CPM schedule, or engage the services of a specialized scheduling professional to do so. Within seven days of the Notice of Award, provide a résumé or qualifications statement for the individual within the Contractor's organization, or the outside consultant, who is being proposed as the responsible party for development and maintenance of the CPM schedule. The résumé or qualifications statement shall demonstrate that the proposed responsible party has successfully developed and maintained CPM schedules for at least three construction projects of the same size or greater than this project. The proposed responsible party for the CPM schedule is subject to approval by the Engineer and Owner. If the proposed responsible party for the CPM schedule is not approved by the Engineer and Owner, Contractor shall resubmit a more-appropriate candidate for approval.

#### 1.03 SUBMITTALS

- A. Contractor shall submit Preliminary, Baseline (also known as "as-planned") CPM schedules, revisions, and Monthly Status Reports, all including graphics, reports, and narratives, and an as-built schedule, as specified herein.
- B. Contractor shall provide breakout on submitted preliminary and baselines schedules as to construction progress and tracking in meeting the substantial and final completion dates for the Project as specified in the Contract (Front-End) documents.

### PART 2 PRODUCTS

#### 2.01 SOFTWARE

- A. Unless otherwise approved by the Engineer and Owner, the computer-based schedule shall be generated using Oracle-Primavera Contractor, or P6 Professional Project Management Software.

#### 2.02 NETWORK REQUIREMENTS

- A. Each schedule submittal shall contain the following identifying information:

1. Project Title, Owner's Contract Number, and the Engineer Project Number.
  2. Contractor's name.
  3. All Contract milestones, as specified.
  4. The project calendar(s) (including work week and holidays).
  5. Type of submittal (e.g., Preliminary, Baseline or Monthly Status Report).
  6. A summary contract milestones.
  7. Data date and run (print) date.
- B. The network of activities shall show the order and inter-dependence of activities; and, show the sequence in which the work is to be accomplished, as planned by the Contractor. The basic concept of a network analysis diagram shall be followed to show how each activity is dependent on preceding activities (predecessors) and following activities (successors).
- C. Detailed network activities shall include, but are not limited to:
1. Mobilization activities,
  2. Procurement activities (submittals, review and approval, fabrication, and delivery),
  3. Permitting and regulatory activities,
  4. Right-of-way activities (including utility agreements that require others to relocate existing utilities that affect the project),
  5. Construction activities (including demolition, rehabilitation, new construction and testing),
  6. Maintenance of existing facilities,
  7. Test and start-up activities (including testing, start-up, training, performance testing, and commissioning),
  8. Contract milestones (fixed and floating),
  9. Specified sequences, outages and coordination activities, and
  10. All other activities needed to properly identify the scope of work and contract requirements.
- D. All activities shall be sufficiently identified and/or described so that the scope of work of each activity is clear. All work tasks shall be broken down into appropriate scopes and durations to facilitate monitoring progress. Unless otherwise approved by the Engineer and Owner, no activities shall have durations of more than one month; except for off-site activities such as procurement and delivery of materials and equipment - or administrative or management activities that span the project duration that do not reflect earned progress.
- E. Network activities shall be organized (grouped) by phases (or stages), physical areas, buildings, elevations, or other portions of the project.

- F. Separate network activities shall be provided for each significant identifiable function in each trade area in each facility. Separate network activities shall be provided for subcontractors.
- G. The number of network activities, sufficiency of description, and level of breakdown shall be subject to the Engineer and Owner's review and approval to confirm conformance with the specified requirements.
- H. The format of the schedule network graphic shall be a time-scaled logic diagram - with a list of network activities and the specified data fields presented adjacent to the graphic display.
- I. The following general requirements also apply to the network diagram.
  - 1. The Critical Path (the sequence of project network activities that add up to the longest overall duration and thereby determines the shortest time possible to complete the project) shall be identified - preferably in 'red'.
  - 2. Unless otherwise approved by the Engineer and Owner the Contractor's work schedule shall be based on 'normal work week' as defined in the Contract Documents – (typically 40 hours per week, consisting of five 8-hour days).
  - 3. The graphics shall indicate the calendar(s) on which activity durations are based (i.e., 5-day workweek or 7 calendar day week). When multiple calendars or work weeks are used, the graphics shall clearly indicate which calendars are used where.
  - 4. The project calendar shall include exclusions for holidays observed by the Contractor and those indicated in the Contract Documents.
- J. Each network activity shall have the following information (fields) listed alongside the activity on the graphic display.
  - 1. Activity ID – a manually assigned designation (numeric or alphanumeric). The Contractor should use a logical approach to assigning identification to network activities to facilitate grouping (sorting) of activities.
  - 2. Activity Description.
  - 3. Original Duration – including allowances for adverse weather interruptions – normal for the project location. Normal weather shall mean seasonally average weather conditions, as recorded by NOAA.
  - 4. Percent complete – the Contractor's estimated percent complete for each network activity as of the data date for the respective report.
  - 5. Remaining Duration – a calculated value based on Original Duration of each network activity and the estimated percent of completion for each activity.
  - 6. Early Start Date.
  - 7. Early Finish Date.
  - 8. Late Start Date.
  - 9. Latest Finish Date.

10. Total Float.

2.03 SUBMITTAL REQUIREMENTS

A. Each schedule submittal shall include the following elements:

1. Graphics – unless otherwise approved by the Engineer and Owner, the network graphics shall be printed on 24-inch by 36-inch sheets; including a list of activities and the specified data fields.
2. Narrative.
  - a. The Narrative shall consist of a written report by the Contractor providing an overview of the schedule – specific to each submittal.
  - b. The Narratives for developmental submittals, i.e., Preliminary and Baseline, shall describe the Contractor's approach to executing the project Work.
  - c. The Narrative for the Baseline Schedule shall:
    - 1) explain key activities and assumptions on which the schedule is based;
    - 2) describe the Critical Path;
    - 3) discuss key deliveries that might adversely affect the project schedule; and,
    - 4) explain the Contractor's approach to adverse weather interruptions – normal for the project location. Normal weather shall mean seasonally average weather conditions, as recorded by NOAA.
  - d. The Narratives provided with Monthly Status Reports (updates) shall also identify:
    - 1) any changes the Contractor has made to the CPM logic (including any added, modified or deleted activities,
    - 2) any delays that have been encountered, and
    - 3) remedial actions or recovery steps the Contractor will employ to arrest and/or recover from such delays.

B. Reports

1. The following reports are required to be submitted with Baseline Schedule, when a major revision is made to the schedule, and when requested by the Engineer and Owner.
  - a. Activity – a report listing all network activities, sorted by activity ID.
  - b. Early Start – a report listing all network activities, sorted by Early Start date.
  - c. Total Float – a report listing all network activities, sorted by Total Float (ascending from low to high).
  - d. Predecessor/Successor – a report of all activities, sorted by Activity ID that lists all predecessor and successor activities for each network activity.

2.04 ACCEPTABILITY

- A. The Contractor shall submit the CPM schedule submittals, as specified, and resubmit as needed, until they are in compliance with Contract requirements.
- B. The Engineer and Owner's review of the Contractor's construction schedule submittals will only be for conformance with the Contract requirements – including but not limited to contract time and work sequences specified in the contract documents. The Engineer and Owner's review of the schedule shall not include the Contractor's means and methods of construction or safety. The Engineer and Owner's concurrence, acceptance, or approval of the Contractor's schedule submittals will not relieve the Contractor from responsibility for complying with the Contract Scope, Contract Time or any other contract requirement. Any indication of concurrence,

acceptance, or approval of the Contractor's schedule will only indicate a general conformance with the Contract Requirements.

- C. Engineer and Owner's review of the Contractor's construction schedule submittals shall not relieve the Contractor from responsibility for any deviations from the Contract Documents unless the Contractor has in writing called Engineer and Owner's attention to such deviations at the time of submission and Engineer and Owner has given written concurrence to the specific deviations, nor shall any concurrence by the Engineer and Owner relieve Contractor from responsibility for errors and omissions in the submittals. Concurrence of the CPM Activity Network by the Engineer and Owner is advisory only and shall not relieve the Contractor of responsibility for accomplishing the Work within the Contract completion date(s).
- D. Concurrence, acceptance, or approval of the Contractor's CPM schedule by the Engineer and Owner in no way makes the Engineer and Owner an insurer of the CPM schedule's success, nor liable for time or cost overruns resulting therefrom.
- E. Failure to include any element of work required for the performance of this Contract will not excuse the Contractor from completing all Work required within the Contract completion date(s), notwithstanding the review of the network by the Engineer and Owner.
- F. CPM schedules that contain activities with negative float, or which extend beyond the contract completion date, will not be acceptable.
- G. Except where earlier completions are specified, CPM schedules which show completion of all work prior to the contract completion date may be indicated; however, in no event shall they constitute a basis for claim for delay by the Contractor.

## PART 3 EXECUTION

### 3.01 IMPLEMENTATION SCHEDULE

#### A. Preliminary Schedule

- 1. Within 15 days following the receipt of Notice to Proceed, submit a proposed Preliminary Schedule to the Engineer and Owner. The Preliminary Schedule shall consist of a draft computer-generated CPM-schedule showing the entire Scope of Work. The Preliminary Schedule shall not include any actual progress earned during development of the schedule (i.e., the status as of the Notice to Proceed).
- 2. Within 10 days of submittal of the Preliminary Schedule (i.e., within 25 days of receipt of the Notice to Proceed), meet with the Engineer and Owner to discuss the review comments.
- 3. Provide monthly updates of the Preliminary Schedule until concurrence, acceptance, or approval of the Baseline Schedule.

#### B. Baseline (as-planned) Schedule

- 1. Within five days of the review meeting on the Preliminary Schedule submittal, the Contractor shall incorporate the Owner and Engineer's comments into the network and submit a Baseline Schedule. Resubmit the Baseline Schedule, as required until it is deemed acceptable as stated in Paragraph 2.04, above.

2. Upon concurrence, acceptance, or approval of the Contractor's initial Baseline Schedule, the status as of the Notice to Proceed date, it shall be recognized as the basis against which the Contractor's progress shall be measured.

C. Monthly Status Reports

1. Monthly Status Reports shall include updated graphics and a narrative. In addition, if requested by the Engineer or Owner, Contractor shall provide copies of one or more of the standard reports listed in Paragraph 2.03.B.
2. The Contractor shall provide Monthly Status Reports (schedule updates) commencing approximately 30 days after submission of the Preliminary Schedule. Unless approved otherwise by the Engineer and Owner, the Monthly Status Reports shall be the status as of the end of each calendar month.
3. While the Baseline Schedule is being developed, the Contractor shall update the Preliminary schedule on a monthly basis—indicating actual progress—until the Baseline Schedule is submitted.
4. While the Baseline Schedule is being developed, the Contractor shall update the Preliminary Schedule on a monthly basis—indicating actual progress—until concurrence, acceptance, or approval of the Baseline Schedule.
5. Once the initial Baseline Schedule is complete, Monthly Status Reports shall be based on the Baseline Schedule.

D. Engineer and Owner As-Built Schedule

1. Upon achieving Substantial Completion, the Contractor shall submit an as-built schedule, showing all activities from the Notice to Proceed through Substantial Completion. In addition, provide the reports listed in Paragraph 2.03.B. A Narrative is not required.

3.02 DELIVERABLES

- A. Unless approved otherwise by the Engineer and Owner, all schedule submittals shall be printed in color on sheets 24-in by 36-in and may be divided into as many separate sheets as required.
- B. Preliminary Schedule: Submit three hard (paper) copies and an electronic copy to the Engineer and Owner.
- C. Baseline Schedule: Submit three hard (paper) copies, one electronic copy (PDF), and a copy of the program files to the Engineer and Owner.
- D. Monthly Status Reports: Submit three copies and one electronic copy via email to the Engineer and Owner; and if requested, an electronic copy of the program files for the respective update.
- E. As-Built Schedule: Submit one hard copy; one electronic (PDF), and, if requested, an electronic copy of the program files.

3.03 PROGRESS REPORTING

- A. Progress under the approved CPM schedule shall be reported monthly by the Contractor by submitting a Monthly Status Report. Unless otherwise approved by the Owner, not less than

seven days prior to the due date of the Monthly Status Report, the Contractor shall meet with the Owner's representative to jointly evaluate the status of each network activity. Each activity shall be updated to reflect the actual progress (percent complete) and the actual dates activities were started and completed, as applicable.

- B. The Monthly Status Report shall include an update of the computer-generated network graphics and a Narrative report. The Narrative shall include:
  - 1. A description of the progress during the reporting period in terms of completed activities.
  - 2. A summary of the Critical Path. This should include the tracking days (+/-) for substantial completion.
  - 3. An description or explanation of each delays to network activities.
  - 4. A description of problem areas, current and anticipated delaying factors and their anticipated effect on the performance of other activities and completion dates.
  - 5. An explanation of corrective action taken or proposed.
  - 6. This report, as well as the CPM Status Report, will be discussed at each progress meeting.

### 3.04 RESPONSIBILITY FOR SCHEDULE COMPLIANCE

- A. Whenever it becomes apparent from the current CPM schedule and CPM Status Report that delays to the critical path have resulted and the contract completion date will not be met, or when so directed by the Owner, take some or all of the following actions at no additional cost to the Owner. Submit to the Owner for approval, a written statement of the steps intended to take to remove or arrest the delay to the critical path in the approved schedule.
  - 1. Increase construction manpower in such quantities and crafts,
  - 2. Increase the number of working hours per shift, shifts per day, working days per week,
  - 3. Increase the amount of construction equipment, and/or
  - 4. Reschedule activities to maximize the concurrence of activities and comply with the revised schedule.
- B. If when so requested by the Owner, failure to submit a written statement of the steps intended to take or should fail to take such steps as approved by the Owner, the Owner may direct the Contractor to increase the level of effort in man-power (trades), equipment and work schedule (overtime, weekend and holiday work, etc.) to be employed by the Contractor in order to remove or arrest the delay to the critical path in the approved schedule and the Contractor shall promptly provide such level of effort at no additional cost to the Owner.

### 3.05 ADJUSTMENT OF CONTRACT SCHEDULE AND COMPLETION TIME

- A. If the Contractor wants or needs to make changes in his/her execution of the construction schedule that would affect the approved CPM schedule, he/she shall notify the Engineer and Owner in writing stating what changes are proposed and the reasons for the changes. If the Owner approves such changes, the Contractor shall revise and submit a revised schedule for approval - without additional cost to the Owner. The CPM schedule shall be adjusted by the

Contractor only after prior approval of his/her proposed changes. Adjustments may consist of changing portions of the activity sequence, activity durations, division of approved activities, or other adjustments as may be approved by the Owner; however, the addition of extraneous, non-working activities and activities that add unapproved restraints to the CPM schedule will not be allowed.

- B. Shop drawings that are not approved on the first submittal will require the addition of network activities for the resubmittals.
- C. Equipment that does not pass the specified tests will require the addition of network activities for the retesting.
- D. The contract completion time will be adjusted only for causes specified in this Contract. In the event the Contractor requests an extension of any contract completion date, he/she shall furnish such justification and supporting evidence as the Engineer and Owner may deem necessary to determine whether the Contractor is entitled to an extension of time under the provisions of this Contract. After receipt of such justification and supporting evidence, the Engineer and Owner's shall perform an assessment or evaluation of the appropriate change in contract time based upon the currently approved CPM schedule and on all data relevant to the extension. Inexcusable delays (attributable to the Contractor) and non-critical delays (delays to activities which, according to the CPM schedule, do not affect any contract completion date shown by the Critical Path) shall not be the basis for a change in contract time. The Engineer and Owner will provide a written recommendation to the Owner based on its assessment, with a copy to the Contractor. The Contractor shall not change any fixed contract milestones or required completion dates without the approval of the Owner, evidenced by the execution of a contract change order. However, the Contractor should make note of such requests for changes in contract time in the narrative of monthly schedule status reports.
- E. The contract completion time will be adjusted only for causes specified in this Contract. In the event the Contractor requests an extension of any contract completion date, he/she shall furnish such justification and supporting evidence as the Owner may deem necessary to determine whether the Contractor is entitled to an extension of time under the provisions of this Contract. The Owner will, after receipt of such justification and supporting evidence, make findings of fact and will advise the Contractor in writing thereof. If the Owner finds that the Contractor is entitled to any extension of any contract completion date, the Owner's determination as to the total number of days of extension shall be based upon the currently approved CPM schedule and on all data relevant to the extension. Such data shall be included in the next updating of the schedule. Inexcusable delays (attributable to the Contractor) and non-critical delays (delays to activities which, according to the CPM schedule, do not affect any contract completion date shown by the Critical Path) shall not be the basis for a change in contract time.
- F. Each request for change in any contract completion date shall be submitted by the Contractor to the Owner in accordance with the notification requirements stipulated in the form of contract or general conditions. No time extension will be granted for requests that are not submitted in accordance with the Contract requirements.
- G. Total float in the approved CPM network belongs to the project; i.e., either the Owner or Contractor may take advantage of available total float on a first-come, first-served basis. Therefore, without obligation to extend either the overall completion date, or any intermediate completion dates set out in the CPM network, the Owner may initiate changes to the work or delay work that absorb available total float existing at the time of the change or delay. Owner

initiated changes or delays that affect the Critical Path on the approved CPM network shall be the sole grounds for extending (or contracting) contract completion dates or fixed milestones.

- H. The Owner controls the total float in the approved CPM network and, therefore, without obligation to extend either the overall completion date or any intermediate completion dates set out in the CPM network, the Owner may initiate changes to the work that absorb float time only. Owner initiated changes that affect the Critical Path on the approved CPM network shall be the sole grounds for extending (or contracting) said completion dates. Contractor-initiated changes that encroach on the float time identified in the approved CPM network may be accomplished with the Owner's concurrence. Such changes, however, shall give way to Owner-initiated changes competing for the same float time.

### 3.06 COORDINATING SCHEDULES WITH OTHER CONTRACT SCHEDULES

- A. Where work is to be performed under this Contract concurrently with or contingent upon work performed on the same facilities or area under other contracts, the Contractor's CPM Schedule shall be coordinated with the schedules of the other contracts. Obtain the schedules of the other appropriate contracts from the Owner for the preparation and updating of the CPM schedule and make the required changes in the schedule when indicated by changes in corresponding schedules.
- B. In case of interference between the operations of different contractors, the Owner will determine the work priority of each Contractor and the sequence of work necessary to expedite the completion of the entire project. In all such cases, the decision of the Owner shall be accepted as final. The temporary delay of the Contractor's work due to such circumstances shall not be considered as justification for claims for additional compensation.

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SECTION 01370  
SCHEDULE OF VALUES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Submit a Schedule of Values allocated to the various portions of the work, within 15 days after the effective date of the Agreement.
- B. Upon request of the Engineer, support the values with data which will substantiate their correctness.
- C. The accepted Schedule of Values shall be used only as the basis for the Contractor's Applications for Payment.

1.02 RELATED REQUIREMENTS

- A. Application for Payment is included in Section 01026.
- B. Standard General Conditions of the Construction Contract are included in the Front End Documents provided by Owner.

1.03 FORM AND CONTENT OF SCHEDULE OF VALUES

- A. Type schedule on an 8-1/2-in by 11-in or 8-1/2-in by 14-in white paper furnished by the Owner; Contractor's standard forms and automated printout will be considered for approval by the Engineer upon Contractor's request. Identify schedule with:
  - 1. Title of Project and location.
  - 2. Engineer and Project number.
  - 3. Name and Address of Contractor.
  - 4. Contract designation.
  - 5. Date of submission.
- B. Schedule shall list the installed value of the component parts of the work in sufficient detail to serve as a basis for computing values for progress payments during construction.
- C. Identify each line item with the number and title of the respective Section.
- D. For each major line item list sub-values of major products or operations under the item.
- E. For the various portions of the work:
  - 1. Each item shall include a directly proportional amount of the Contractor's overhead and profit.

2. For items on which progress payments will be requested for stored materials, break down the value into:
  - a. The cost of the materials, delivered and unloaded, with taxes paid. Paid invoices are required for materials upon request by the Engineer.
  - b. The total installed value.

F. The sum of all values listed in the schedule shall equal the total Contract Sum.

#### 1.04 SUBSCHEDULE OF UNIT MATERIAL VALUES

- A. Submit a sub-schedule of unit costs and quantities for:
  1. Products on which progress payments will be requested for stored products.
- B. The form of submittal shall parallel that of the Schedule of Values, with each item identified the same as the line item in the Schedule of Values.
- C. The unit quantity for bulk materials shall include an allowance for normal waste.
- D. The unit values for the materials shall be broken down into:
  1. Cost of the material, delivered and unloaded at the site, with taxes paid.
  2. Copies of invoices for component material shall be included with the payment request in which the material first appears.
  3. Paid invoices shall be provided with the second payment request in which the material appears or no payment shall be allowed and/or may be deleted from the request.
- E. The installed unit value multiplied by the quantity listed shall equal the cost of that item in the Schedule of Values.

#### 1.05 FORM AND CONTENT OF SCHEDULE OF ASSET VALUES

- A. **The asset table is included in Specification 01730.** It includes the assets to be accounted for in the Schedule of Asset Values.
- B. For each asset listed, provide a constructed cost which will include an allocation of construction activities including but not limited to, demolition, sitework, specialties, materials, labor, general conditions, and overhead and profit associated with the construction of the asset.
- C. The combined value of the assets will equal the bid price for the project and will require adjustments as necessary due to change orders. The schedule of asset values will be updated on a monthly basis and will be included in the monthly pay request application for approval.
- D. The Owner reserves the right to edit this list prior to the first pay request application and may add up to 10 percent more items than have been identified in the list.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01380  
AUDIO VIDEO TAPING AND PHOTOGRAPHY

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials and equipment and furnish color audio videotaping of the project site as specified herein.
- B. Furnish to the Owner an original and one copy of a continuous color audio video tape recording along the entire route of the proposed site location. The recording shall be taken prior to any construction activity.
- C. The Owner reserves the right to reject the audio videotaping because of poor quality, unintelligible audio or uncontrolled pan or zoom. Any taping rejected by the Owner shall be re-taped at no cost to the Owner. Under no circumstances shall construction begin until the Owner has received and accepted the audio video tape(s).
- D. The taping shall be performed by a qualified, established audio videotaping firm knowledgeable in construction practices and experienced in the implementation of established inspection procedures.
- E. The Contractor shall provide a competent photographer to take construction record photographs periodically during course of the Work.

1.02 PHOTOGRAPHY/VIDEOGRAPHY REQUIRED

- A. A preconstruction video is required to be taken prior to the start of construction. The preconstruction video is required to document the existing structures, equipment, existing site conditions and the existing conditions of the landscape buffer zone to establish a baseline for restoration work as required. The preconstruction video will be on DVD format and will provide the date and time of the video on the tape during playback. Two copies of the preconstruction video shall be provided to Owner, and one copy shall be provided to Engineer.
- B. The Contractor shall provide land-based photographs taken on the cutoff date for each scheduled application for payment and immediately prior to initial construction.
- C. The Contractor shall provide aerial photography to document the construction progress. The photographs shall be taken before the beginning of the construction, after 5 months from the date of the Notice to Proceed, and at the end of the construction. Aerial photographs shall be submitted with the application for payment. The submittal shall include three to five views in digital format.
- D. For the land-based photography of construction in the project site area, provide 10 photographs with at least five different views each month taken at each stage of construction for each scheduled application for payment.

E. View and quantities required for land-based photography shall include:

1. At a minimum, views for the monthly progress photos shall document the status of:
  - a. Mechanical equipment.
  - b. Existing facilities.
  - c. Electrical building, fuel tank, generator, and slabs.
  - d. Paving, grading, and drainage.
  - e. Site work.
  - f. Structural work.
  - g. Areas of construction that will be covered or buried during construction and not visible after the completion.
2. Provide four (4) CDs with each application for payment. Maintain one set of photographs with Contractor's Project Record File. Provide one set of the photographs to the Engineer, and two sets to the Owner.

F. Photographic Records

1. All photography shall be digitally produced and electronically maintained.
2. The photographer shall maintain easily accessible electronic records for the duration of the entire project and then shall convey the electronic records to the Engineer and Owner upon final acceptance of project.
3. Photographer shall agree to furnish additional prints to Engineer and Owner at commercial rates applicable at time of purchase. Photographer shall also agree to participate as required in any litigation requiring the photographer as an expert witness.
4. The photographer shall provide the electronic records of the digital photographs to Engineer and Owner with copyrights assigned to the Owner.

1.03 COSTS OF PHOTOGRAPHY

- A. The Contractor shall pay the costs for specified photography and prints. Additional prints beyond those specified here shall be charged to interested party.

PART 2 PRODUCTS

2.01 PRINTS AND ELECTRONIC DELIVERY

- A. No construction shall start until preconstruction photographs and video are completed and submitted to the Engineer and Owner and approved.
- B. Provide properly labeled CDs with electronic records of all photographs with identification for exposure number, orientation of view, and date of exposure.
- C. A digital camera with resolution of at least 8.0 mega pixels shall be used to take the construction photographs.

## PART 3 EXECUTION

### 3.01 TECHNIQUE

- A. Factual presentation
- B. Correct exposure and focus
  - 1. High resolution and sharpness.
  - 2. Maximum depth-of-field.
  - 3. Minimum distortion.

### 3.02 VIEWS REQUIRED

- A. Photograph from location to adequately illustrate condition of construction and state of progress.
  - 1. At successive periods of photography, take at least one photograph from the same overall view as previously.
  - 2. Consult with the Engineer at each period of photography to review proposed views required.

### 3.03 AUDIOVISUAL RECORDING

- A. The recordings shall contain coverage of all surface features within the construction zone of influence. These features shall include, but not be limited to, all pavement, parking spaces, curbs, driveways, sidewalks, culverts, headwalls, retaining walls, landscaping, trees, and fences. Of particular concern shall be the existence or non-existence of any faults, fractures or defects.
- B. Video coverage shall be limited to one side of the street at one time and shall include all surface conditions located within the zone of influence supported by appropriate audio description. Panning, zoom-in and zoom-out rates shall be sufficiently controlled to maintain a clear view of the object.
- C. Accompanying the video recording of each video tape shall be a corresponding and simultaneously recorded audio recording. This audio recording, exclusively containing the commentary of the camera operator, shall assist in viewer orientation and in any needed identification, differentiation, clarification, or objective description of the features being shown in the video portion of the recording. The audio recording shall also be free from any conversation between the camera operator and any other production technicians.
- D. Visibility: All recording shall be performed during times of good visibility; no recording shall be done during periods of significant precipitation, mist or fog. The recording shall only be done when sufficient sunlight is present to properly illuminate the subject and to produce sharp, bright video recordings of those subjects.
- E. In order to ensure the continuity of coverage, the coverage shall consist of a single continuous unedited recording which begins at one end of the construction area.

- F. The average rate of travel during a particular segment of coverage shall be directly proportional to the number, size, and value of the surface features within that construction area's zone of influence.
- G. Camera Operation
  - 1. Camera Height and Stability: When conventional wheeled vehicles are used as conveyances for the recording system, the vertical distance between the camera lens and the ground shall not exceed 10 feet. The camera shall be firmly mounted such that transport of the camera during the recording process will not cause an unsteady picture.
  - 2. Camera Control: Camera pan, tilt, zoom-in and zoom-out rates shall be sufficiently controlled such that recorded objects shall be clearly viewed during video tape playback. In addition, all other camera and recording system controls, such as lens focus and aperture, video level, pedestal, white balance and electrical focus shall be properly controlled or adjusted to maximize picture quality.
  - 3. Viewer Orientation Techniques: The audio and video portions of the recording shall maintain viewer orientation. To this end, overall establishing views of all visible house and business addresses shall be utilized. In areas where the proposed construction location will not be readily apparent to the video tape viewer, highly visible yellow flags shall be placed, by the Contractor, in such a fashion as to clearly indicate the proposed center line of construction.

END OF SECTION

SECTION 01410  
TESTING AND TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. The Contractor shall employ and pay for the services of an Independent Testing Laboratory to perform testing specifically indicated on the Contract Documents and may at any other time elect to have materials and equipment tested for conformity with the Contract Documents. Soil and concrete testing shall be scheduled and test by the Contractor. The Owner shall provide testing for bacteriological testing through the Owner's laboratory and the Contractor shall coordinate the appropriate time to pick up samples.
1. Cooperate with the laboratory to facilitate the execution of its required services.
  2. Employment of the laboratory shall in no way relieve Contractor's obligations to perform the work of the Contract.
  3. The Contractor shall submit the qualifications and experience of the proposed testing laboratory to the Owner and Engineer for approval prior to beginning any testing related work.
  4. The Contractor will use the testing allowance in the bid form for reimbursement of the testing performed and shall provide actual invoices for reimbursement. No markup of the invoices shall be allowed. Any portion of the unused allowance will remain with the Owner.

1.02 RELATED REQUIREMENTS

- A. Conditions of the Contract: Inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities.
- B. Respective Sections: Certification of products.
- C. Each Section listed: Laboratory tests required and standards for testing.
- D. Testing Laboratory inspection, sampling and testing is required for but not limited to the following:
1. Site preparation is included in Section 02100, and in the Section 406 in JEA's Water and Sewer Standards Manual.
  2. Earthwork is included in Section 02200, and in the JEA's Water and Sewer Standards Manual, Section 408.
  3. Trenching, Backfilling and Compaction is included in Section 02221, and in JEA's Water and Sewer Standards Manual, Section 408.
  4. Concrete and reinforcement is included in Section 03200.
  5. Grout is included in Section 03600.

### 1.03 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

- A. Laboratory is not authorized to:
  - 1. Release, revoke, alter or enlarge on requirements of Contract Documents.
  - 2. Approve or accept any portion of the work.
  - 3. Perform any duties of the Contractor.

### 1.04 CONTRACTOR'S RESPONSIBILITIES

- A. Cooperate with laboratory personnel, provide access to work, to manufacturer's operations.
- B. Secure and deliver to the laboratory adequate quantities of representational samples of materials proposed to be used and which require testing.
- C. Provide to the laboratory the preliminary design mix proposed to be used for concrete and other materials mixes which require control by the testing laboratory.
- D. Materials and equipment used in the performance of work under this Contract are subject to inspection and testing at the point of manufacture or fabrication. Standard requirements for quality and workmanship are indicated in the Contract Documents. The Engineer may require the Contractor to provide statements or certificates from the manufacturers and fabricators that the materials and equipment provided by them are manufactured or fabricated in full accordance with the standard specifications for quality and workmanship indicated in the Contract Documents. All costs of this testing and providing statements and certificates shall be a subsidiary obligation of the Contractor, and no extra charge to the Owner shall be allowed on account of such testing and certification.
- E. Furnish incidental labor and facilities:
  - 1. To provide access to work to be tested.
  - 2. To obtain and handle samples at the project site or at the source of the product to be tested.
  - 3. To facilitate inspections and tests.
  - 4. For storage and curing of test samples.
- F. Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.
  - 1. When tests or inspections cannot be performed after such notice, reimburse Owner for laboratory personnel and travel expenses incurred due to Contractor's negligence.
- G. Employ and pay for the services of the same or a separate, equally qualified independent testing laboratory to perform additional inspections, sampling and testing required for the Contractor's convenience.
- H. If the test results indicate the material or equipment complies with the Contract Documents, the Owner shall pay for the cost of the testing laboratory via the testing allowance. If the tests and

any subsequent retests indicate the materials and equipment fail to meet the requirements of the Contract Documents, the Contractor shall pay for the laboratory costs directly to the testing firm or the total of such costs shall be deducted from any payments due the Contractor. Failed tests shall not be assessed to the testing allowance.

- I. Provide Owner and Engineer with all testing reports.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01445  
PIPELINE TESTING AND CLEANING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and test and clean all new pipelines installed under this Contract as specified herein, including chlorination of all potable water lines.

1.02 RELATED WORK

- A. Buried pipelines are included in Division 2, and JEA's Water and Wastewater Standards Manual, January 2019 or later edition.
- B. Above grade, chemical piping and exposed pipelines are included in Division 15.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Furnish all necessary equipment and labor for cleaning and testing and chlorinating the pipelines. The procedures and methods shall be approved by the Engineer.
- B. Make any taps and furnish all necessary caps, plugs, etc, as required in conjunction with testing pipelines. Furnish a test pump, gauges and any other equipment required in conjunction with carrying out the hydrostatic tests.

3.02 CLEANING PIPELINES

- A. As pipe laying progresses and at the conclusion of the work thoroughly clean all new pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period. If, after this cleaning, obstructions remain, they shall be removed.

3.03 TESTING GRAVITY PIPELINES

- A. All gravity pipelines shall be tested in accordance with the JEA Water and Wastewater Standards Section 428 – IV.

3.04 TESTING PRESSURE PIPELINES

- A. All pressure pipelines shall be pressure and leakage tested following the requirements in JEA Water and Wastewater Standards Manual, latest edition, Section 350 – III-6.

### 3.05 CHLORINATION OF PIPELINES

- A. Before being placed in service, all new potable water pipelines (including plant water) shall be chlorinated using the continuous feed method specified in AWWA C651. The procedure shall be approved by the Engineer in advance.
- B. The location of the chlorination and sampling points will be determined by the Engineer in the field. Taps for chlorination and sampling shall be installed. Uncover and backfill the taps as required.
- C. The general procedure for chlorination shall be first to flush all dirty or discolored water from the lines and then introduce chlorine in approved dosages through a tap at one end, while water is being withdrawn at the other end of the line. The chlorine solution shall remain in the pipeline for 24 hours.
- D. Following the chlorination period, all treated water shall be flushed from the lines at their extremities and replaced with potable water. All treated water flushed from the lines shall be disposed of by discharging to the nearest sanitary sewer or by other approved means. No discharge to any storm sewer or natural water course will be allowed. Bacteriological sampling and analysis of the replacement water may then be made by the Engineer in full accordance with AWWA C651. Rechlorinate, if necessary, and the line shall not be placed in service until the requirements of the State Public Health Department are met.
- E. Special disinfecting procedures shall be used in connections to existing pipelines and where the method outlined above is not practical.

END OF SECTION

SECTION 01465  
EQUIPMENT TESTING AND STARTUP

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Provide a competent field services technician of the manufacturers of all equipment furnished under Divisions 11, 13, 15 and 16 to supervise installation, adjustment, initial operation and testing, performance testing, final acceptance testing and startup of the equipment.
- B. Perform specified equipment field performance tests, final acceptance tests and startup services.

1.02 RELATED WORK

- A. Operation and Maintenance Data is included in Section 01730.
- B. Performance and acceptance testing and startup requirements are included in the respective sections of Divisions 11, 13, 15 and 16.

1.03 SUBMITTALS

- A. Submit name, address and resume of proposed field services technicians at least 30 days in advance of the need for such services.
- B. Submit, in accordance with Section 01300, detailed testing procedures for shop tests, field performance tests and final acceptance tests as specified in the various equipment sections. Submittals shall include the following:
  - 1. Test procedures shall be submitted at least 30 days in advance of the proposed test dates and shall include at least the following information:
    - a. Name, classification, model and serial number of equipment to be tested, including reference to specifications section number and title.
    - b. Testing schedule of proposed dates and times for testing.
    - c. Summary of power, lighting, chemical, water, diesel, etc, needs and identification of who will provide them.
    - d. Outline specific assignment of the responsibilities of the Contractor and manufacturers' factory representatives or field service personnel.
    - e. Detailed description of step-by-step testing requirements, with reference to appropriate standardized testing procedures and laboratory analyses by established technical organizations (e.g., ASTM, WPCF Standard Methods, etc).
    - f. Samples of forms to be used to collect and record test data and to present tabulated test results.
  - 2. Copies of test reports upon completion of specified shop, performance and acceptance tests. Test reports shall incorporate the information provided in the test procedures submittals and modified to reflect actual conduct of the tests and the following additional information:
    - a. Copy of all test data sheets and results of lab analyses.
    - b. Summary comparison of specified test and performance requirements vs actual test results.

- c. Should actual test results fail to meet specified test and performance requirements, describe action to be taken prior to re-testing the equipment.
- 3. Copies of the manufacturer's field service technician's report summarizing the results of their initial inspection, operation, adjustment and pre-tests. The report shall include detailed descriptions and tabulations of the points inspected, tests and adjustments made, quantitative results obtained, suggestions for precautions to be taken to ensure proper maintenance, and the equipment supplier's Certificate of Installation in the format specified herein.

#### 1.04 REFERENCE STANDARDS

- A. American Water Works Association (AWWA)
  - 1. AWWA C653 - Disinfection for Water Treatment Plants.
- B. ASTM International
- C. Water Environment Federation (WEF)
- D. Standard Methods for the Examination of Water and Wastewater (Latest Revision)
- E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

- A. Field service technicians shall be competent and experienced in the proper installation, adjustment, operation, testing and startup of the equipment and systems being installed.
- B. Manufacturers' sales and marketing personnel will not be accepted as field service technicians unless they can prove their qualifications.

### PART 2 PRODUCTS (NOT USED)

### PART 3 EXECUTION

#### 3.01 PRELIMINARY REQUIREMENTS

- A. After installation of the equipment has been completed and the equipment is presumably ready for operation, before it is operated by others, the manufacturer's field service technician shall inspect, operate, test and adjust the equipment. The inspection shall include at least the following points where applicable:
  - 1. Soundness (without crack or otherwise damaged parts).
  - 2. Completeness in all details, as specified and required.
  - 3. Correctness of setting, alignment and relative arrangement of various parts.
  - 4. Adequacy and correctness of packing, sealing and lubricants.

- B. The operation, testing and adjustment shall be as required to prove that the equipment has been left in proper condition for satisfactory operation under the conditions specified.
- C. Upon completion of this work, the manufacturer's field service technician shall submit a signed report of the results of their inspection, operation, adjustments and tests.

### 3.02 WITNESS REQUIREMENTS

- A. Shop tests or factory tests may be witnessed by the Owner and/or Owner's representatives, as required by the various equipment specifications.
- B. Field performance and acceptance tests shall be performed in the presence of the Owner, the Owner's designed personnel and/or Owner's representatives.

### 3.03 STARTUP AND ACCEPTANCE OF THE TREATMENT PLANT AND RELATED SYSTEMS

#### A. General Requirements

- 1. Successfully execute the step-by-step procedure of startup, normal operation, shutdown, and performance demonstration specified herein.
- 2. The startup and performance demonstration shall be successfully executed prior to Substantial Completion and acceptance by the Owner of the facility and its related systems.
- 3. All performance tests and inspections shall be scheduled at least 10 working days in advance or as otherwise specified with the Owner and the Engineer. All performance tests and inspections shall be conducted during the work week of Monday through Friday, unless otherwise specified.

#### B. Preparation for Startup

- 1. Upon completion of the facility and all its related systems, all tanks shall be flushed with potable water and hydraulically checked for leaks, cracks, and defects. They shall also be disinfected in accordance with AWWA C653.
- 2. All mechanical and electrical equipment shall be checked to ensure that it is in good working order and properly connected. Preliminary run-ins of the various pumps, compressors, and other remaining equipment shall be made. All systems shall be cleaned and purged as required. All sumps, tanks, chambers, wet-wells and pipelines which are hydraulically checked shall be drained and returned to their original condition once the water testing is complete.
- 3. All instruments and controls shall be calibrated through their full range. All other adjustments required for proper operation of all instrumentation and control equipment shall be made.
- 4. Perform all other tasks needed for preparing and conditioning the facility for proper operation.

5. No testing or equipment operation shall take place until it has been verified by the Engineer that all specified safety equipment has been installed and is in good working order.
6. No testing or equipment operation shall take place until it has been verified by the Engineer that all lubricants, tools, maintenance equipment, spare parts and approved equipment operation and maintenance manuals have been furnished as specified.

C. Facilities Startup

1. Startup period shall not begin until all new treatment facilities and equipment have been tested as specified and are ready for operation. The Owner shall receive spare parts, safety equipment, tools and maintenance equipment, lubricants, approved operation and maintenance data and the specified operation and maintenance instruction prior to the startup with raw water. All valve tagging shall also be complete prior to this startup.
2. Demonstrate a seven consecutive 24-hour day period of successful operation of the facility as a prerequisite of Substantial Completion and Acceptance. This testing shall be the responsibility of the Contractor.
3. In the event of failure to demonstrate satisfactory performance of the facility on the first or any subsequent attempt, all necessary alterations, adjustments, repairs and replacements shall be made. When the facility is again ready for operation, it shall be brought on line and a new test shall be started. This procedure shall be repeated as often as necessary until the facility has operated continuously to the satisfaction of the Owner and Engineer, for the specified duration.
4. The Owner will furnish all operating personnel (other than manufacturer's or subcontractor's service personnel) needed to operate equipment during the final test period after substantial completion; however, said personnel will perform their duties under Contractor's direct supervision. Until performance tests are completed and units and systems are accepted by the Owner as substantially complete, the Contractor shall be fully responsible for the operation and maintenance of all new facilities.
5. The Owner will provide all necessary chemicals and electricity for startup. However, the Contractor shall provide all necessary personnel of the various construction trades, i.e., electricians, plumbers, etc, and field service personnel of the major equipment suppliers on an 8 hour per day basis at the facilities and on a 24 hour per day basis locally during the startup period. Major equipment suppliers shall include, but not be limited to, the following:
  - a. Instrumentation and Control Equipment: unwitnessed and witnessed factory testing.
  - b. Sodium Hypochlorite Chemical Feed and Chemical Storage Systems.
  - c. All Pumping Equipment including the Grinder Pump Station.
  - d. Electrical Control Systems.
  - e. Generator Equipment.
  - f. HVAC and Plumbing.
6. Do not, at any time, allow the facility to be operated in a manner that subjects equipment to conditions that are more severe than the maximum allowable operating conditions for which the equipment was designed.

EQUIPMENT SUPPLIER'S CERTIFICATE OF INSTALLATION

Owner \_\_\_\_\_

Project \_\_\_\_\_

Contract No. \_\_\_\_\_

EQUIPMENT SPECIFICATION SECTION \_\_\_\_\_

EQUIPMENT DESCRIPTION \_\_\_\_\_

I \_\_\_\_\_, Authorized representative of  
(Print Name)

\_\_\_\_\_  
(Print Manufacturer's Name)

hereby CERTIFY that \_\_\_\_\_  
(Print equipment name and model with serial no.)

\_\_\_\_\_  
installed for the subject project has (have) been installed in a satisfactory manner, has (have) been tested and adjusted, and is (are) ready for final acceptance testing and operation on :

Date \_\_\_\_\_

Time \_\_\_\_\_

CERTIFIED BY: \_\_\_\_\_  
(Signature of Manufacturer's Representative)

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

END OF SECTION

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SECTION 01500  
TEMPORARY FACILITIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, equipment, materials, and incidentals necessary and provide separate temporary facilities for the Contractor's use and the Engineer's use, as specified herein and as shown on the drawings. Temporary offices shall be established on the job site where approved or directed by the Owner, adequately furnished and maintained in a clean, orderly conditions by the Contractor. The Contractor or an authorized representative shall be present in the field office at all times while work is in progress.
- B. Operate and maintain temporary facilities for the duration of the project and as directed by the Engineer. All cost and use charges for temporary facilities shall be included in the Contract Price.

1.02 RELATED WORK

- A. Control of Work is included in Section 01046.
- B. Special Provisions is included in Section 01170.

1.03 SUBMITTALS

- A. Submit shop drawings and product data, in accordance with Section 01300, showing materials of construction and details of installation for:
  - 1. Site Plan: Show the proposed locations for temporary facilities including offices, temporary utilities, storage containers/buildings, vehicle access and parking areas, material laydown and staging areas, temporary fencing, and other security measures.
- B. Submittals shall be received by the Engineer no later than the date of the Preconstruction Meeting.

1.04 QUALITY ASSURANCE

- A. Temporary facilities shall comply with all applicable state and local ordinances, codes and regulations.
- B. Coordinate with authorities having jurisdiction to inspect (and test if required) temporary facilities.
- C. Obtain all required permits for temporary facilities.

1.05 DEFINITIONS

- A. Duration of the project: The period of time from the date of the Notice to Proceed to the date of Final Completion, inclusive.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Temporary Fence (if required): Fabric shall be No. 9-gauge galvanized wire woven in 2-in diamond mesh with top and bottom twisted selvage. Intermediate and terminal posts shall be galvanized steel H or pipe, minimum 2-3/8-in OD line posts, 2-7/8-in OD corner and pull posts, and 1-5/8-in OD top rails.

### 2.02 EQUIPMENT

- A. Fire Extinguishers: Provide portable, UL-rated with class and extinguishing agent required by locations and classes of fire exposure. Provide at least one for each trailer/office.

### 2.03 CONTRACTOR'S FIELD OFFICE

- A. Provide a temporary field office(s) for the Contractor's use for the duration of the project. An authorized representative of the Contractor shall be present at all times while the Work is in progress. Instructions received at the Contractor's field office from the Engineer shall be considered delivered to the Contractor.
- B. Locate field office(s) in accordance with approved shop drawings and as directed by the Owner.
- C. Establish and occupy field office within 30 days of the Notice to Proceed, unless otherwise approved by the Engineer or Owner.

### 2.04 TEMPORARY POWER AND LIGHT

- A. Owner shall provide a temporary 220 volt service for the Contractor's use for welding, lighting and power tools sufficient for the project needs. Power service for bypass pumping activities (if required) will not be provided and shall be provided by the Contractor.
- B. The Contractor shall provide connections to existing facilities sized to provide service required for power and lighting. The Contractor shall pay the costs of fuel for heating.
- C. The Contractor shall provide properly configured NEMA polarized outlets to prevent insertion of 110-120 Volt plugs into higher voltage outlets. For connection of power tools and equipment, provide outlets equipped with ground-fault circuit interrupters, reset button and pilot light.
- D. The Contractor shall provide grounded extension cords. Use heavy duty cords where exposed to abrasion and traffic. The Contractor shall provide waterproof connectors to connect separate lengths of electric cords if more than one length is required.
- E. The Contractor shall provide general service incandescent lamps as required for adequate illumination. The Contractor shall provide guard cages or tempered glass enclosures where exposed to breakage. The Contractor shall provide exterior fixtures where exposed to moisture.

### 2.05 WEATHER PROTECTION

- A. Contractor shall furnish, install and maintain temporary heat and enclosures to provide adequate working areas for personnel during the cold weather months.

- B. The Contractor shall furnish temporary heating units (UL or FM listed) to maintain reasonable temperatures within temporary enclosures.
- C. Weather protection shall comply with M.G.L. Chapter 149 Section 44G.

## 2.06 TEMPORARY AIR AND WATER

- A. Provide all air and water including temporary piping and appurtenances required for cleaning and testing pipelines and equipment. Remove temporary piping and appurtenances upon approval of equipment being tested.

## 2.07 SANITARY FACILITIES

- A. Provide self-contained, single occupant toilet units of the chemical, aerated recirculation, or combustion type, properly vented and fully enclosed in a fiberglass or other approved non-absorbent shell.

## 2.08 CONSTRUCTION AIDS

- A. Provide temporary elevators, hoists, cranes, scaffolding and platforms as necessary to perform the Work. Provide temporary stairs where ladders are not adequate. Protect permanent stairs from damage from construction operations.

## 2.09 VEHICLE ACCESS AND PARKING

- A. Provide temporary access roads, parking areas, traffic control devices and staging areas as approved by the Engineer and Owner.

## 2.10 TEMPORARY FENCE

- A. Provide temporary fence as specified herein and as the Contractor requires for site security.
  - 1. Provide 6-ft high chain link fence with at least two vehicle and two pedestrian access gates. Gates shall be equipped with locking hardware and padlocks. Furnish two sets of keys to Engineer and Owner. Coordinate with local first responders for access during non-work hours.
  - 2. Fence installation shall comply with ASTM F567. Post spacing shall not exceed 8-ft on center. Posts shall be set plumb in concrete footings.
  - 3. Perform daily inspections of fence and immediately repair or replace damaged or compromised sections and as directed by the Engineer.
  - 4. A temporary fence shall be installed prior to the removal of the existing fence. At no time shall the site not have complete fencing around the site.

## 2.11 WASTE MANAGEMENT

- A. Provide covered dumpster, minimum 4 cubic yards, dedicated for field office waste. Provide separate covered dumpster of adequate size for construction debris. Empty dumpsters on a regular basis and as directed by the Engineer. Dumpsters shall not exceed their capacities at any time.

2.12 PROJECT SIGNS

- A. Furnish and install the project signs indicated in Specification 01580. Signs shall be placed as directed by the Owner; and, shall remain maintained in good condition for the life of the construction period.
- B. Remove signs at final acceptance, unless otherwise directed.

2.13 REMOVAL AND RESTORATION

- A. Remove each temporary facility complete when need for its service has ended and as approved by the Engineer. Coordinate removal of temporary facilities with authorities having jurisdiction.
- B. Restore all improvements damaged by the installation, operation, and removal of the temporary facilities. Obtain prior approval from Owner and Engineer for restoration work. Comply with the restoration requirements of Section 01046.

END OF SECTION

SECTION 01562  
DUST CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Perform dust control operations, in an approved manner, whenever necessary or when directed by the Engineer and Owner, even though other work on the project may be suspended. Dust control shall be generally accomplished by the use of water; however, the use of calcium chloride may be used when necessary to control dust nuisance. Cost of dust control shall be included in base bid price.
- B. Calcium chloride shall conform to AASHTO M144, Type I except the requirements for "total alkali chlorides" and other impurities shall not apply.
- C. Methods of controlling dust shall meet all air pollutant standards as set forth by Federal and State regulatory agencies.

END OF SECTION

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SECTION 01580  
PROJECT IDENTIFICATION AND INFORMATIONAL SIGNS

PART 1 GENERAL

1.01 REQUIREMENTS

- A. Furnish, install and maintain project identification and informational signs.
- B. Remove sign on completion of construction.
- C. Allow no other signs to be displayed.

1.02 RELATED WORK

- A. Finishes are provided in Division 9.

1.03 SUBMITTALS

- A. Submit in accordance with the requirements of Section 01300.

1.04 INFORMATIONAL SIGNS

- A. Painted signs with painted lettering, or standard products.
  - 1. Size of signs and lettering: as required by regulatory agencies, or as appropriate to usage.
  - 2. Colors: as required by regulatory agencies, otherwise of uniform colors throughout Project.
- B. Erect at appropriate location to provide required information.

1.05 QUALITY ASSURANCE

- A. Sign Painter: Professional Experience in type of work required.
- B. Finishes, Painting: Adequate to resist weathering and fading for scheduled construction period.

PART 2 PRODUCTS

2.01 SIGN MATERIALS

- A. Structure and Framing: May be new or used, wood or metal, in sound condition structurally adequate to work and suitable for specified finish.
- B. Sign Surfaces: Exterior softwood plywood with medium density overlay, standard large sizes to minimize joints.
  - 1. Thickness: As required by standards to span framing members, to provide even, smooth surface without waves or buckles.
- C. Rough Hardware: Galvanized

- D. Paint: Exterior quality, as specified in Division 9.
  - 1. Use Bulletin colors for graphics.
  - 2. Colors for structure, framing, sign surfaces and graphics: As selected by the Engineer.

### PART 3 EXECUTION

#### 3.01 MAINTENANCE

- A. Maintain signs and supports in a neat, clean condition; repair damages to structure, framing or sign.

#### 3.02 REMOVAL

- A. Remove signs, framing, supports and foundations at completion of project.

END OF SECTION

SECTION 01600  
DELIVERY, STORAGE, AND HANDLING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies the general requirements for the delivery handling, storage and protection for all items required in the construction of the work. Specific requirements, if any, are specified with the related item.

1.02 TRANSPORTATION AND DELIVERY

- A. Transport and handle items in accordance with manufacturer's instructions.
- B. Schedule delivery to reduce long term on-site storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the Engineer.
- C. Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged or sensitive to deterioration.
- D. Deliver products to the site in manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, unpacking, protecting and installing.
- E. All items delivered to the site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.
- F. Provide necessary equipment and personnel to unload all items delivered to the site.
- G. Promptly inspect shipment to assure that products comply with requirements, quantities are correct, and items are undamaged. For items furnished by others (i.e., Owner, other contractors), perform inspection in the presence of the Engineer. Notify Engineer verbally, and in writing, of any problems.
- H. If any item has been damaged, such damage shall be repaired at no additional cost to the Owner.

1.03 STORAGE AND PROTECTION

- A. Store and protect products in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instruction shall be studied by the Contractor and shall be their responsibility. Instruction shall be carefully followed and a written record of this kept by the Contractor. Arrange storage to permit access for inspection.
- B. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- C. Cement and lime shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural, miscellaneous and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt or grease and in a position to prevent accumulations of standing water and to minimize rusting. Beams shall be stored with the webs

vertical. Precast concrete shall be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping or cracking. Brick, block and similar masonry products shall be handled and stored in a manner to reduce breakage, cracking and spalling to a minimum.

- D. All mechanical and electrical equipment and instruments subject to corrosive damage by the atmosphere if stored outdoors (even though covered by canvas) shall be stored in a weather-tight building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it must be satisfactory to the Engineer. Building shall be provided with adequate ventilation to prevent condensation. Maintain temperature and humidity within range required by manufacturer.
1. All equipment shall be stored fully lubricated with oil, grease and other lubricants unless otherwise instructed by the manufacturer.
  2. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.
  3. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment at the time of acceptance.
  4. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.
- E. All paint and other coating products shall be stored in areas protected from the weather. Follow all storage requirements set forth by the paint and coating manufacturers.

END OF SECTION

SECTION 01610  
MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Material and equipment incorporated into the Work:
  - 1. Conform to applicable specifications and standards.
  - 2. Comply with size, make, type and quality specified, or as specifically approved in writing by the ENGINEER.
  - 3. Manufactured and Fabricated Products
    - a. Design, fabricate and assemble in accord with the best engineering and shop practices.
    - b. Manufacture like parts of duplicate units to standard sizes and gages, to be interchangeable.
    - c. Two or more items of the same kind will be identical, by the same manufacturer.
    - d. Products will be suitable for service conditions.
    - e. Equipment capacities, sizes and dimensions shown or specified will be adhered to unless variations are specifically approved in writing.
  - 4. Do not use material or equipment for any purpose other than that for which it is designed or is specified.

1.02 RELATED REQUIREMENTS

- A. The Contract Documents include, but are not limited to, the following related requirements:
  - 1. Conditions of the Contract
  - 2. Summary of Work is included in Section 01010.
  - 3. Submittals are included in Section 01300.
  - 4. Cleaning is included in Section 01710.
  - 5. Operating and Maintenance Data is included in Section 01730.
  - 6. Warranties and Bonds are included in Section 01740.

1.03 APPROVAL OF MATERIALS

- A. Only new materials and equipment will be incorporated in the work. All materials and equipment furnished by the CONTRACTOR will be subject to the inspection and approval of the ENGINEER. No material will be delivered to the work without prior approval of the ENGINEER.
- B. Within 30 days after the effective date of the Agreement, the CONTRACTOR will submit to the ENGINEER, data relating to materials and equipment he/she proposes to furnish for the work. Such data will be in sufficient detail to enable the ENGINEER to identify the particular product

and to form an opinion as to its conformity to the specifications. The data will comply with Section 01300.

- C. Facilities and labor for handling and inspection of all materials and equipment will be furnished by the CONTRACTOR. If the ENGINEER requires, either prior to beginning or during the progress of the work, the CONTRACTOR will submit samples of materials for such special tests as may be necessary to demonstrate that they conform to the specifications. Such samples will be furnished, stored, packed, and shipped as directed at the CONTRACTOR's expense. Except as otherwise noted, the CONTRACTOR will make arrangements for and pay for the tests.
- D. The CONTRACTOR will submit data and samples sufficiently early to permit consideration and approval before materials are necessary for incorporation in the work. Any delay of approval resulting from the CONTRACTOR's failure to submit samples or data promptly will not be used as a basis of claim against the OWNER or the ENGINEER.
- E. In order to demonstrate the proficiency of workmen or to facilitate the choice among several textures, types, finishes and surfaces, the CONTRACTOR will provide such samples of workmanship or finish as may be required.
- F. The materials and equipment used on the work will correspond to the approved samples or other data.

#### 1.04 MANUFACTURER'S INSTRUCTIONS FOR INSTALLATION

- A. When Contract Documents require that installation of work will comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including two (2) copies to the ENGINEER.
  - 1. Maintain one set of complete instructions at the job site during installation and until completion.
- B. Handle, install, connect, clean, condition and adjust products in strict accord with such instructions and in conformity with specified requirements.
  - 1. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with ENGINEER for further instructions.
  - 2. Do not proceed with work without clear instructions.
- C. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by Contract Documents.

#### 1.05 TRANSPORTATION AND HANDLING

- A. Arrange deliveries of Products in accordance with construction schedules, coordinate to avoid conflict with work and conditions at the site.
  - 1. Deliver Products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.

2. Immediately on delivery, inspect shipments to assure compliance with requirements of Contract Documents and approved submittals, and that Products are properly protected and undamaged.
- B. Provide equipment and personnel to handle Products by methods to prevent soiling or damage to Products or packaging.

#### 1.06 STORAGE AND PROTECTION

- A. The CONTRACTOR will furnish a covered, weather-protected storage structure providing a clean, dry, noncorrosive environment for all mechanical equipment, valves, and any special equipment to be incorporated into this project. Storage of equipment will be in strict accordance with the "instructions for storage" of each equipment supplier and manufacturer including connection of heaters, placing of storage lubricants in equipment, etc. The CONTRACTOR will furnish a copy of the manufacturer's instructions for storage to the ENGINEER prior to storage of all equipment and materials. Corroded, damaged or deteriorated equipment and parts will be replaced before acceptance of the project. Equipment and materials not properly stored will not be included in a payment estimate.
- B. Store Products in accordance with manufacturer's instructions, with seals and labels intact and legible.
  1. Store products subject to damage by the elements in weather tight enclosures.
  2. Maintain temperature and humidity within the ranges required by manufacturer's instructions.
  3. Store fabricated products above the ground, on blocking or skids, prevent soiling or staining. Cover products which are subject to deterioration with impervious sheet coverings, provide adequate ventilation to avoid condensation.
  4. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.
- C. All materials and equipment to be incorporated in the work will be handled and stored by the CONTRACTOR before, during and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting and any injury, theft or damage of any kind whatsoever to the material or equipment.
- D. Cement, sand and lime will be stored under a roof and off the ground and will be kept completely dry at all times. All structural and miscellaneous steel and reinforcing steel will be stored off the ground or otherwise to prevent accumulations of dirt or grease and in a position to prevent accumulations of standing water and to minimize rusting. Beams will be stored with the webs vertical. Precast concrete beams will be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping or cracking. Brick, block and similar masonry products will be handled and stored in a manner to reduce breakage, chipping, cracking and spalling to a minimum.
- E. All materials which, in the opinion of the ENGINEER, have become so damaged as to be unfit for the use intended or specified will be promptly removed from the site of the work and the CONTRACTOR will receive no compensation for the damaged material or its removal.

- F. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored Products to assure that Products are maintained under specified conditions and free from damage or deterioration.
- G. Protection After Installation
  - 1. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. Remove covering when no longer needed.
- H. The CONTRACTOR will be responsible for all material, equipment and supplies sold and delivered to the OWNER under this Contract until final inspection of the work and acceptance thereof by the OWNER. In the event any such material, equipment, and supplies are lost, stolen, damaged, or destroyed prior to final inspection and acceptance, the CONTRACTOR will replace same without additional cost to the OWNER.
- I. Should the CONTRACTOR fail to take proper action on storage and handling of equipment supplied under this Contract within seven (7) days after written notice to do so has been given, the OWNER retains the right to correct all deficiencies noted in previously transmitted written notice and deduct the cost associated with these corrections from the CONTRACTOR's Contract. These costs may be comprised of expenditures for labor, equipment usage, administrative, clerical, engineering and any other costs associated with making the necessary corrections.

#### 1.07 WARRANTY

- A. For all major pieces of equipment, submit a warranty from the equipment manufacturer as specified in Section 01740.

#### PART 2 PRODUCTS (NOT USED)

#### PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01630  
SUBSTITUTIONS AND PRODUCT OPTIONS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Furnish and install products specified, under options and conditions for substitutions stated in this Section.
- B. Whenever a product, material or item of equipment is specified or described by using the name of a proprietary product or the name of a particular manufacturer or vendor, followed by the phrase "or equal," the specific item mentioned shall be the basis upon which bids are to be prepared, and shall be understood as establishing the type, function, dimension, appearance and quality desired. Other manufacturer's or vendor's products not named will be considered as substitutions, provided the required information is submitted in the manner set forth in this Section and provided the substitution will not require substantial revision to the Contract Documents.

1.02 RELATED WORK

- A. Bid Form is included in the Front End Documents provided by JEA.
- B. Delivery Storage and Handling is included in Section 01600.

1.03 SUBMITTAL OF LIST OF PROPOSED SUBSTITUTIONS

- A. Bidders shall submit their list of proposed substitutions and the proposed monetary changes associated therewith to the Owner on the standard form provided together with their bids. The substitution submittal process shall follow the requirements identified in the JEA front end documents. The Owner will review the proposed substitutions and decide which ones are acceptable.

1.04 CONTRACTOR'S OPTIONS

- A. For Products specified only by reference standard, select product meeting that standard, by any manufacturer.
- B. For Products specified by naming several products or manufacturers, select any one of products and manufacturers named which complies with Specifications.
- C. For products specified by naming one or more products or manufacturers and stating "or equal," submit a request as for substitutions, for any product or manufacturer which is not specifically named.
- D. For products specified by naming only one product and manufacturer, there is no option and no substitution will be allowed.

1.05 SUBSTITUTIONS

- A. Submit separate request for each substitution. Support each request with:

1. Complete data substantiating compliance of proposed substitution with requirements stated in Contract Documents:
    - a. Product identification, including manufacturer's name and address.
    - b. Manufacturer's literature; identify:
      - 1) Product description.
      - 2) Reference standards.
      - 3) Performance and test data.
      - 4) Operation and maintenance data.
    - c. Samples, as applicable.
    - d. Name and address of similar projects on which product has been used, and date of each installation.
  2. Itemized comparison of the proposed substitution with product specified; List significant variations. Substitution shall not change design intent and shall perform equal to that specified.
  3. Data relating to impact on construction schedule occasioned by the proposed substitution.
  4. Any effect of substitution on separate contracts.
  5. List of changes required in other work or products.
  6. Accurate cost data comparing proposed substitution with product specified.
    - a. Amount of any net change to Contract Sum.
  7. Designation of required license fees or royalties.
  8. Designation of availability of maintenance services, sources of replacement materials.
- B. Substitutions will not be considered for acceptance when:
1. They are indicated or implied on shop drawings or product data submittals without a formal request from Contractor.
  2. They are requested directly by a subcontractor or supplier.
  3. Acceptance will require substantial revision of Contract Documents.
- C. Requests for substitutions submitted after Notice of Award will not be considered unless evidence is submitted to the Engineer that all of the following circumstances exist:
1. The specified product is unavailable for reasons beyond the control of the Contractor. Such reasons shall consist of strikes, bankruptcy, discontinuance of manufacturer, or acts of God.
  2. The Contractor placed, or attempted to place, orders for the specified products within 10 days after Notice of Award.
  3. Request for substitution is made in writing to the Engineer within 10 days of the date on which the Contractor ascertains that he cannot obtain the item specified.

4. Complete data as set forth herein to permit complete analysis of the proposed substitution is submitted with the request.
- D. The Engineer's decision regarding evaluation of substitutions shall be considered final and binding. Requests for time extensions and additional costs based on submission of, acceptance of, or rejection of substitutions will not be allowed. All approved substitutions will be incorporated into the Agreement by Change Order.

#### 1.06 CONTRACTOR'S REPRESENTATION

- A. In making formal request for substitution, Contractor represents that:
  1. He has investigated proposed product and has determined that it is equal to or superior in all respects to that specified.
  2. He will provide same warranties or bonds for substitution as for product specified.
  3. He will coordinate installation of accepted substitution into the Work, and will make such changes as may be required for the Work to be complete in all respects.
  4. He waives claims for additional costs caused by substitution which may subsequently become apparent.
  5. Cost data is complete and includes related costs under his Contract, but not:
    - a. Costs under separate contracts.
    - b. Engineer's costs for redesign or revision of Contract Documents.

#### 1.07 ENGINEER DUTIES

- A. Review Contractor's requests for substitutions with reasonable promptness.
- B. Notify Contractor, in writing, of decision to accept or reject requested substitution.

#### PART 2 PRODUCTS (NOT USED)

#### PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01700  
CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies administrative, verification and procedural requirements for project closeout, including but not limited to:
  - 1. Final cleaning (Section 01710).
  - 2. Operation, instrumentation and control adjustments (Section 13).
  - 3. Project Record Documents (Section 01720).
  - 4. Spare parts and maintenance materials (spare paint, lubricants, special tools) (applicable Sections in Divisions 09 through 16).
  - 5. Record Shop Drawings (Section 01300).
  - 6. Warranties, guarantees, and bonds (Section 01740) and applicable Sections in Technical Divisions 10 through 16.
  - 7. Reconciliation of final accounting, final change order, final payment application and Contractor's releases.
  - 8. As-built construction schedule (Section 01310).
  - 9. Permit close-outs including Certificate of Occupancy or Certificate of Completion.

1.02 RELATED WORK

- A. Operation and Maintenance (O&M) data and manuals (Section 01730) and applicable Sections in Technical Divisions.
- B. Certified Surveyor documentation submittals (Section 01050).

1.03 CLOSEOUT PROCEDURES

- A. Provide all deliverables as specified, prior to submitting the final payment application.
- B. Provide submittals to Engineer that are required by governing or other authorities having applicable jurisdiction including but not limited to permit close out information, certificates of occupancy, etc.
- C. Submit Application for Final Payment identifying total adjusted Contract Sum, previous payments and sum remaining due, following submittal and approval of Record Documents and Record Drawings.
- D. Submit Contractor's Final Release and Release of Liens with final payment application.

1.04 FINAL CLEANING

- A. Contractor to complete final cleaning prior to submittal of the final application for payment.
- B. Contractor to comply with requirements as specified in Section 01710.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

## SECTION 01710 CLEANING

### PART 1 GENERAL

#### 1.01 SCOPE OF WORK

- A. Execute cleaning, during progress of the work, and at completion of the work, as required by General Conditions.

#### 1.02 RELATED WORK

- A. Standard General Conditions of the Construction Contract with Owner.

#### 1.03 DISPOSAL AND CLEANING

- A. The Contractor shall conduct cleaning and disposal operations to comply with codes, ordinances, regulations and anti-pollution laws.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. The Contractor shall use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.
- B. The Contractor shall use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.
- C. The Contractor shall use cleaning materials only on surfaces recommended by cleaning material manufacturer.

### PART 3 EXECUTION

#### 3.01 DURING CONSTRUCTION

- A. The Contractor shall execute periodic cleaning to keep the work, the site and adjacent properties free from accumulations of waste materials, rubbish and windblown debris, resulting from construction operations.
- B. The Contractor shall provide on-site containers for the collection of waste materials, debris and rubbish.
- C. The Contractor shall remove waste materials, debris and rubbish from the site periodically and dispose of at legal disposal areas away from the site.

#### 3.02 DUST CONTROL

- A. The Contractor shall clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

- B. The Contractor shall schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

### 3.03 FINAL CLEANING

- A. The Contractor shall employ skilled workmen for final cleaning.
- B. The Contractor shall remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels and other foreign materials from sight-exposed interior and exterior surfaces.
- C. The Contractor shall wash and shine glazing and mirrors.
- D. The Contractor shall polish glossy surfaces to a clear shine.
- E. Ventilating Systems:
  - 1. The Contractor shall clean permanent filters and replace disposable filters if units were operated during construction.
  - 2. The Contractor shall clean ducts, blowers and coils if units were operated without filters during construction.
- F. The Contractor shall broom clean exterior paved surfaces; rake clean other surfaces of the grounds.
- G. Prior to final completion, or Owner occupancy, conduct an inspection of sight-exposed interior and exterior surfaces and all work areas, to verify that the entire work is clean.

END OF SECTION

SECTION 01720  
PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 SCOPE

- A. The Contractor shall keep and maintain, at the job site, a copy of contract documents, marked up to indicate all changes made during the course of a project, as specified herein.

1.02 RELATED REQUIREMENTS

- A. Contract close-out submittals are included in Section 01700.
- B. Warranties and bonds are included in Section 01740.
- C. As-built construction schedules are included in Section 01310.
- D. As-built wiring diagrams are included in Section 01730.
- E. As-built surveys are included in Section 01050.
- F. Record shop drawings are included in Section 01300.
- G. Construction photographs are included in Section 01380.

1.03 REQUIREMENTS INCLUDED

- A. Contractor shall maintain a record copy of the following documents, marked up to indicate all changes made during the course of a project:
  - 1. Contract Drawings.
  - 2. Record Drawings.
  - 3. Specifications.
  - 4. Addenda.
  - 5. Change orders and other modifications to the contract.
  - 6. Engineer's and Owner's field orders or written instructions.
  - 7. Approved shop drawings, working drawings, and samples.
  - 8. Field test records.
  - 9. Construction photographs.
- B. Contractor shall assemble copies of the following documents for turnover to the Engineer at the end of the project, as specified.

1. Field Orders, Change Orders, Design Modifications, and RFIs.
2. Field Test records.
3. Permits and permit close-outs (final approvals).
4. Certificate of Occupancy or Certificate of Completion, as applicable.
5. Laboratory test reports (e.g., bacteriological and primary & secondary water quality).
6. Certificates of Compliance for materials and equipment.
7. Record Shop Drawings.
8. Samples.
9. Record Drawings and Specifications.

#### C. RECORD DRAWINGS

1. The Contractor shall annotate (mark-up) the Contract Drawings to indicate all project conditions, locations, configurations, and any other changes or deviations that vary from the original Contract Drawings. This requirement includes, but is not limited to, buried or concealed construction, and utility features that are revealed during the course of construction. Special attention shall be given to recording the locations (horizontal and vertical) and material of all buried utilities that are encountered during construction – whether or not they were indicated on the Contract Drawings. The record information added to the drawings may be supplemented by detailed sketches, if necessary, clearly indicating, the Work, as constructed.
2. These annotated Contract Drawings constitute the Contractor's Record Drawings and are actual representations of as-built conditions, including all revisions made necessary by change orders, design modifications, requests for information and field orders.
3. Record drawings shall be accessible to the Owner and Engineer at all times during the construction period.

#### PART 2 PRODUCTS (NOT USED)

#### PART 3 EXECUTION

##### 3.01 MAINTENANCE OF RECORD DOCUMENTS AND SAMPLES

- A. Store documents and samples in Contractor's field office apart from documents used for construction.
  1. Provide files and racks for storage of the record documents.
  2. Provide locked cabinet(s) or secure storage space for storage of samples.
- B. File documents and samples in accordance with Construction Specifications Institute (CSI) format.

- C. Maintain documents in a clean, dry, legible, condition and in good order. Do not use record documents for construction purposes.
- D. Make documents and sample available for inspection by the Engineer or Owner at all times.
- E. Up-to-date Record Drawings may be a pre-requisite of processing periodic monthly pay applications, if so specified under the section for progress payments.

### 3.02 MARKING METHOD

- A. Use the color Red (indelible ink) to record information on the Drawings and Specifications.
- B. Label each document "PROJECT RECORD" in neat large printed letters.
- C. Unless otherwise specified elsewhere, notations shall be affixed to hardcopies of documents.
- D. Record information contemporaneously with construction progress.
- E. Legibly mark drawings with as-built information:
  - 1. Elevations and dimensions of structures and structural elements.
  - 2. All underground utilities (piping and electrical), structures, and appurtenances.
    - a. Changes to existing structure, piping and appurtenance locations.
    - b. Record horizontal and vertical locations of underground structures, piping, utilities and appurtenances, referenced to permanent surface improvements.
    - c. Record actual installed pipe material, class, size, joint type, etc.

### 3.03 RECORD INFORMATION COMPILATION

- A. Do not conceal any work until the required information is acquired.
- B. Drawings: Legibly mark to record actual construction.
- C. Do not conceal any work until the required information is acquired.
- D. Items to be recorded include, but are not limited to:
  - 1. Location of internal utilities and appurtenances concealed in the construction – referenced to visible and accessible features.
  - 2. Field changes of dimensions and/or details.
    - a. Interior equipment and piping relocations.
    - b. Architectural and structural changes, including relocation of doors, windows, etc.
    - c. Architectural schedule changes.
  - 3. Changes made by field order, change order, design modification, and RFI, and approved shop drawings.
  - 4. Details not indicated on the original contract drawings.

5. Specifications - legibly mark each section to record: Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed, and changes made by Field Order, Change Order, RFI, and approved shop drawings.
  6. Coordinates and elevations of each valve and fitting.
  7. All underground duct banks with elevations and dimensions, horizontal and vertical locations of underground duct banks, and manholes along duct banks.
  8. Depths of various elements of foundations in relation to finish first floor datum.
  9. All underground piping with elevations and dimensions. Changes to piping location. Horizontal and vertical locations of all underground utilities, valves, and appurtenances, referenced to permanent surface improvements. Actual installed pipe material, class, etc. All pipes shall be labeled using the method as per the contract drawings.
  10. All underground cable elevations and horizontal locations of underground cables.
  11. All existing and new structures clearly identified.
  12. All elevations of new structures (including weirs) clearly indicated.
  13. Architectural schedule changes according to Contractor's records and shop drawings.
  14. Location, elevation, and datum of Benchmark used.
  15. Easements as shown on approved paving and drainage drawings.
  16. Locations, elevations, sizes, types and material of the following must be accurately shown and labeled (as applicable).
    - a. Manholes (including specialty lining material, pipe invert, manhole rim, and bottom elevations).
    - b. Valves.
    - c. Water and sewer services.
    - d. Fire Hydrant and all associated structures.
    - e. Fittings.
  17. All water and sewer mains must be identified on the record drawings by their size, material, and DR/SDR classification. Horizontal locations and top of pipe elevations must also be labeled every 100 linear feet. **All valves shall be labeled using the method as per the contract drawings.**
  18. All new hydrant locations shall be identified based upon the Florida State Plane Coordinate System.
- E. Specifications - legibly mark each Section to record:
1. Manufacturer, trade name, catalog number, and Supplier of each product and item of equipment actually installed.
  2. Changes made by Field Order, Change Order, RFI, and approved shop drawing.

F. Shop Drawings (after final review and approval):

1. Five sets of record drawings for each process equipment, piping, electrical system and instrumentation system.

3.04 SUBMITTAL

- A. If specified under the section for progress payments, monthly applications for payment will be contingent upon up-to-date Record Drawings. If requested by the Engineer or Owner, Contractor shall provide a copy of the Record Drawings, or present them for review prior to processing monthly applications for payment.
- B. Upon substantial completion of the Work and prior to final acceptance, the Contractor shall finalize and deliver a complete set of Record Drawings to the Engineer conforming to the construction records of the Contractor. The set of drawings shall consist of corrected and annotated drawings showing the recorded location(s) of the Work. Unless specified otherwise elsewhere, Record Drawings shall be in the form of a set of prints with annotations carefully and neatly superimposed on the drawings in red.
- C. Upon substantial completion of the Work and prior to final acceptance, the Contractor shall finalize and deliver a complete set of Record Documents to the Engineer conforming to the construction records of the Contractor. The set of documents shall consist of corrected and annotated documents showing the as-installed equipment and all other as-built conditions not indicated on the Record Drawings.
- D. The information submitted by the Contractor into the Record Drawings and Record Documents will be assumed to be correct, and the Contractor shall be responsible for the accuracy of such information, and shall bear the costs resulting from the correction of incorrect data.
- E. Delivery of Record Drawings and Record Documents to the Engineer will be a prerequisite to Final payment.
- F. The Contractor shall maintain a copy of all books, records, and documents pertinent to the performance under this Agreement for a period of five years following completion of the contract.

END OF SECTION

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SECTION 01730  
OPERATION AND MAINTENANCE DATA AND ASSET MANAGEMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes procedural requirements for compiling and submitting operation and maintenance data required to complete the project. In addition to the requirements specified herein, Contractor operations and maintenance data shall be as required in JEA Water and Wastewater Standards – Section 445.

1.02 RELATED WORK

- A. Submittals are included in Section 01300.
- B. Contract closeout is included in Section 01700.
- C. Warranties and Bonds are included in Section 01740.

1.03 OPERATING MANUALS

- A. The Manufacturer shall provide specific operation and maintenance instructions for all electrical, mechanical, and instrumentation & controls equipment furnished under various technical specifications Sections.
- B. Six complete sets of operation and maintenance manuals approved by the Engineer covering all equipment furnished under Divisions 11, 13, 15 and 16 shall be delivered at least 30 days prior to scheduled start-up directly to the Owner. One set of originals must be part of the six sets of operation and maintenance instructions required, including original manuals covering components manufactured by others.
- C. An electronic copy of the manual will be provided with each hard copy submittal.
- D. Separate manuals shall be provided for each type of equipment, or each Section number. Each manual shall contain the following specific requirements. Manuals that do not meet the requirements will be rejected and Equipment Supplier/Manufacturer will bear all expenses to resubmit the manual to meet the following requirements.
  - 1. Format and Materials.
    - a. Binders:
      - 1) Commercial quality three ring binders with durable and cleanable plastic covers.
      - 2) Maximum ring width capacity: 3 inches.
      - 3) When multiple binders are used, correlate the data into related consistent groupings/volumes.
    - b. Identification: Identify each volume on the cover and spine with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". Include the following:
      - 1) Title of Project.
      - 2) Identify the general subject matter covered in the manual.
      - 3) Identify structure(s) and/or location(s), of the equipment provided.
      - 4) Specification Section number.

- c. 20 lb loose leaf paper, with hole reinforcement.
  - d. Page size: 8-1/2 inch by 11 inch.
  - e. Provide heavy-duty fly leafs (section separators), matching the table of contents, for each separate product, each piece of operating equipment, and organizational sections of the manual.
  - f. Provide reinforced punched binder tab; bind in with text.
  - g. Reduce larger drawings and fold to the size of text pages - but not larger than 11 inches x 17 inches - or provide a suitable clear plastic pocket (with drawing identification) for such folded drawings/diagrams.
2. Contents.
- a. A table of contents/Index, divided into section reflective of the major components provided.
  - b. Specific description of each system and components.
  - c. Name, address, telephone number(s) and e-mail address(es) of vendor(s) and local service representative(s).
  - d. Equipment Supplier/Manufacturer shall clearly strike out portions of manual that do not apply to the project. Manual will be rejected until inapplicable information is deleted and only applicable information is clearly indicated.
  - e. Specific on-site operating instructions (including starting and stopping procedures).
  - f. Safety considerations.
  - g. Project specific operational procedures and recommended log sheet(s).
  - h. Project specific maintenance procedures.
  - i. Manufacturer's operating and maintenance instructions – specific to the project.
  - j. Copy of each wiring diagram.
  - k. Copy of approved shop drawing(s) and Contractor's coordination/layout drawing(s).
  - l. List of spare parts and recommended quantities.
  - m. Product Data: Mark each sheet to clearly identify specific products and component parts and data applicable to installation. Delete inapplicable information.
  - n. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
  - o. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified.
  - p. Warranties and Bonds, as specified in the General Conditions.
  - q. Equipment attributes sheet for submittal of nameplate data.
  - r. Electronic copy of manual on CD.
  - s. Equipment Attribute Information:
    - 1) Equipment Attribute Worksheets as presented at the end of this Specification shall be provided for all equipment meeting the asset definition as follows:
      - a) Maintenance is recommended.
      - b) Assets have a value greater than \$1,000.00.
      - c) Assets are complete and usable, and perform a distinct function independently.
    - 2) This asset definition is intended to give a general indication of which equipment must be included in the Equipment Attribute Worksheets. The Engineer will provide the specific list of equipment that the Contractor must provide information for:
      - a) The information requirements are shown in detail in the table at the end of this Specification. The data requirements include nameplate data, manufacturer and supplier information, information specific to the type of equipment, and recommended preventative maintenance activities.

- b) An electronic copy of the Equipment Attribute Worksheets must be delivered in Excel format and submitted to the Engineer on CD-ROM and submitted with the O&M Manuals. It is not necessary to submit printed copies of the Equipment Attribute Worksheets.
- 3. Transmittals.
  - a. Prepare separate transmittal sheets for each manual. Each transmittal sheet shall include at least the following: Contractor's name and address, Owner's name, project name, project number, submittal number, description of submittal and number of copies submitted.
  - b. Submittals shall be transmitted or delivered directly to the office of the Engineer, as indicated in the Contact Documents or as otherwise directed by the Engineer.
  - c. Provide copies of transmittals (only, i.e., without copies of the respective submittal) directly to the Resident Project Representative.
- E. Manuals for Equipment and Systems - In addition to the requirements listed above, for each System, provide the following:
  - 1. Overview of system and description of unit or system and component parts. Identify function, normal operating characteristics and limiting conditions. Include legible performance curves, with engineering data and tests and complete nomenclature and commercial number of replaceable parts.
  - 2. Panelboard circuit directories including electrical service characteristics, controls and communications and color-coded wiring diagrams as installed.
  - 3. Operating procedures: include start-up, break-in and routine normal operating instructions and sequences; regulation, control, stopping, shut-down and emergency instructions; and summer, winter and any special operating instructions.
  - 4. Maintenance Requirements.
    - a. Procedures and guides for trouble-shooting; disassembly, repair, and reassembly instructions.
    - b. Alignment, adjusting, balancing and checking instructions.
    - c. Servicing and lubrication schedule and list of recommended lubricants.
    - d. Manufacturer's printed operation and maintenance instructions.
    - e. Sequence of operation by instrumentation and controls manufacturer.
    - f. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
  - 5. Control diagrams by controls manufacturer as installed (as-built).
  - 6. Contractor's coordination drawings, with color coded piping diagrams, as installed (as-built).
  - 7. Charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams. Include equipment and instrument tag numbers on diagrams.
  - 8. List of original manufacturer's spare parts and recommended quantities to be maintained in storage.

9. Test and balancing reports, as required.
  10. Additional Requirements as specified in individual product specification.
  11. Design data for systems engineered by the Contractor or its Suppliers.
  12. Equipment attribute information.
    - a. Equipment Attribute Worksheets as presented at the end of this Section shall be provided for all equipment meeting the asset definition as follows:
      - 1) Asset Definition.
        - a) Maintenance is recommended.
        - b) Assets have a value greater than \$1,000.
        - c) Assets are complete and usable, and perform a distinct function independently (i.e., they pump waste, remove solids, etc.).
      - b. This asset definition is intended to give a general indication of which equipment must be included in the Equipment Attribute Worksheets. The Engineer will provide the specific list of equipment that the Vendor must provide information for.
      - c. The information requirements are shown in detail in the table. The data requirements include nameplate data, manufacturer and supplier information, information specific to the type of equipment, and recommended preventative maintenance activities.
      - d. An electronic copy of the Equipment Attribute Worksheets must be delivered in Excel format and submitted to the Engineer on CD-ROM and submitted with the O&M manuals. It is not necessary to submit printed copies of the Equipment Attribute Worksheets.
- F. Manual for Materials and Finishes - In addition to the requirements listed above, for each material or finish, provide the following:
1. Building Products, Applied Materials and Finishes: Include product data, with catalog number, size, composition and color and texture designations. Provide information for re-ordering custom manufactured products.
  2. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods and recommended schedule for cleaning and maintenance.
  3. Moisture Protection and Weather Exposed Products: Include product data listing, applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance and repair.
  4. Additional Requirements: As specified in individual product specifications.
- G. Electronic Transmission of O&M Manuals
1. Unless otherwise approved by the Engineer, O&M manuals may not be transmitted by electronic means other than by CD-ROM or USB flash drive. Electronic O&M manuals shall meet the following conditions:
    - a. The above-specified transmittal form is included.
    - b. All other requirements specified above have been met, including, but not limited to, coordination by the Contractor, review and approval by the Contractor.
    - c. The submittal contains no pages or sheets large than 11 x 17 inches.

- d. With the exception of the transmittal sheet, the entire submittal is included in a single file.
  - e. Files are Portable Document Format (PDF) – with the printing function enabled.
  - f. The Vendor provided equipment, sub-system, or system manuals shall be in PDF format, compliant with the Adobe PDF Specification Version 1.7. The manual shall be Searchable Image. The Optical Character Recognition of the image shall be at a 95% confidence level. The manuals shall be linked and bookmarked as follows:
    - 1) Provide links from all Table of Contents, List of Tables, List of Figures, etc., entries to the actual occurrence in the body of the manual.
    - 2) Create bookmarks for all linked Table of Content entries.
  - g. All drawings shall be in PDF format, compliant with the Adobe PDF Specification Version 1.7. The manual shall be PDF Searchable Image. The Optical Character Recognition of the image shall be at a 95% confidence level. The drawings shall be linked as follows:
    - 1) External links from the Drawing Index (if it exists) to each drawing.
    - 2) External links from references within drawings to other drawings.
  - h. All scanned manufacturer's O&M manuals must be quality checked after scanning to ensure the page are not crooked and all information is legible.
2. When electronic copies are provided, transmit two hard copy (paper) originals to the Engineer with an electronic copy on CD-ROM.
  3. The electronic copy of the O&M manual shall be identical in organization, format and content to the hard copies of the manual.
  4. The electronic O&M Manual shall be bookmarked identically to the paper manual table of contents to allow quick access to information. Electronic submittals that require extensive scrolling will not be accepted. The document shall be indexed and searchable.

#### H. Quick Reference Sheets for Equipment

1. For each item of equipment furnished under Divisions 11, 15, and 16 provide the following:
  - a. A minimum of one 8 ½ x 11-inch laminated quick reference sheet. Sheets shall be three hole punched and may be double sided.
  - b. Each quick reference sheet shall include the following minimum information:
    - 1) Safety Procedures:
      - a) Brief descriptions of each piece of equipment and components;
      - b) Starting and stopping procedures;
      - c) Special operating instruction;
      - d) Routine maintenance procedures;
      - e) Calibration procedures;
      - f) Pump curves;
      - g) Trouble shooting procedures; and
      - h) Name, address, and telephone numbers of local service representative.
  - c. Provide three copies of quick reference sheets for review by the Engineer.
  - d. After quick reference sheets have been approved, provide four copies of laminated quick reference sheets to the Engineer in one commercial coiled three-ring binder with durable and cleanable plastic cover.

#### 1.04 SERVICES OF MANUFACTURERS' REPRESENTATIVE

- A. All electrical, mechanical, and instrumentation & controls equipment furnished under various technical specifications Sections shall include the cost of a competent representative of the manufacturers of all equipment to supervise the installation, adjustment and testing of the equipment; and, to instruct the Owner's operating personnel on operation and maintenance. This supervision may be divided into two or more time periods to suit the Contractor's schedule and/or the Owner's personnel availability.
- B. See the detailed specifications for additional requirements for furnishing the services of manufacturer's representatives.
- C. The manufacturer's representative shall certify that the installation of the equipment is satisfactory; that the unit has been satisfactorily tested; that the equipment is ready for operation; and, that the operating personnel have been suitably instructed in the operation, maintenance, care, and safe operation of the equipment. The Equipment Manufacturer's Certificate of Installation, Testing, and Instruction attached to this Section shall be used for this certification.
- D. For other materials furnished under other specification Sections, furnish the services of approved representative(s) of the manufacturer when, in the opinion of the Engineer, some evident product failure or malfunction makes such services necessary.

#### PART 2 PRODUCTS (NOT USED)

#### PART 3 EXECUTION

##### 3.01 SUBMITTAL SCHEDULE

- A. Operation and maintenance manuals shall be delivered directly to the office of the Engineer, as follows:
  - 1. Provide preliminary copies of each manual to the office of the Engineer, no later than 30 days following approval of the respective shop drawings.
  - 2. Provide final copies of each completed manual prior to testing.
  - 3. Provide a letter that grants the Engineer and Owner to the limited right to use and reproduce each manual (in its entirety or any portion thereof) from the respective equipment manufacturer(s). Such limited right shall allow the Engineer and Owner to use each manual or any portion thereof for:
    - a. The potential assembly of a comprehensive facility operation and maintenance manual for the sole benefit of the Owner; and,
    - b. Supplemental training of the Owner's personnel and operators, over and above the required vendor's training, regarding operation of the facility as a system.
- B. The Engineer will review Operation and Maintenance manuals submittals for operating equipment for conformance with the requirements of the applicable specification Section. The review will generally be based on the O&M Manual Review Checklist appended to this Section.

- C. If during test and start-up of equipment, any changes were made to the equipment, provide two hard copies of as-built drawings or any other amendments for insertion, by the Contractor, in the previously transmitted final manuals. In addition, provide one revised electronic version including the as-built drawings and any other amendments. The manuals shall be completed, including updates, if any, within 30 days of start-up and testing of the facility.

### 3.02 VENDOR TRAINING/INSTRUCTIONS (TO OWNER'S PERSONNEL)

- A. Before final initiation of operation, Contractor's vendors shall train/instruct Owner's designated personnel in the operation, adjustment, and maintenance of products, equipment and systems at times convenient to the Owner.
- B. Unless specified otherwise under the respective equipment specification section, vendor training/instruction shall consist of eight hours of training for each type of equipment. Such training/instruction shall be scheduled and held at times to accommodate the work schedules of Owner's personnel, including splitting the required training/instruction time into separate sessions and/or presented at reasonable times other than the Contractor's "normal working hours" or the Owner's normal day shift.
- C. Use operation and maintenance manuals as basis for instruction. Train/instruct the Owner's personnel, in detail, based on the contents of manual explaining all aspects of operation and maintenance of the equipment. If the respective equipment is inter-related to the operation of other equipment, all interlock, constraints, and permissives shall be explained.
- D. At least two weeks prior to the schedule for vendor training, a detailed lesson plan, representative of the material to be covered during instruction, shall be submitted to the Engineer for approval. Lesson plans shall consist of in-depth outlines of the training material, including a table of contents, resume of the instructor, materials to be covered, start-up procedures, maintenance requirements, safety considerations, and shut-down procedures.
- E. Prepare and insert additional data in each Operation and Maintenance Manual when the need for such data becomes apparent during training/instruction.
- F. Vendor's training/instruction will be considered acceptable based on the completed Owner's Acknowledgement of Manufacturer's Instruction as indicated on the Equipment Manufacturer's Certification of Installation, Testing, and Instruction appended to this Section.
- G. Training Video
  - 1. All equipment suppliers shall supply to the Engineer three copies of a training video specific to the equipment furnished for the project. The film shall be of a high quality, with both picture and sound.
  - 2. The training video shall be organized so as to show and identify each element of the equipment; including a clear explanation of its function, troubleshooting criteria; disassembly and reassembly.
  - 3. Portions of the training video shall be recorded at the on-site O&M training sessions conducted by the equipment manufacturer's representative.

4. The video shall be submitted to the Engineer for approval not less than 30 calendar days after the start-up of the equipment.
5. The video recording should be playable on VCD recorded discs using MPEG-1 video (MP3 audio) and thereby able to be replayed through Windows Media Player, QuickTime or RealPlayer on PCs and most DVD players. VCD stored on CD-ROMs have the capacity to hold up to 74/80 minutes on a 650MB/700MB CD respectively, of video with stereo quality sound. All video and audio should be of the highest quality. All CD-ROMs shall bear a label identifying the Equipment(s) trained on, general Training topic (i.e., Maintenance, Operations, Storage, or O&M, etc.), the date of the video, trainer and his affiliation (i.e. John Doe, XYZ Company), and video file one of how many on the topic (Video 1 of 2) if the video exceeds the recording time of the CD.

### 3.03 VIDEOGRAPHY OF VENDOR TRAINING/INSTRUCTION

- A. Audio/video (A/V) record (in DVD format) training/instructions as they are being provided to the Owner's personnel. Such recording shall include the entire training/instruction session(s) as well as all questions and answers. A/V recording shall be performed by a professional organization experienced in the production of such recordings. Self-recording by the Contractor may be considered, provided that Contractor can demonstrate, in advance, proficient examples of such recordings.
- B. To avoid audio problems, training/instruction shall be held in a location sufficiently removed from construction activity, insulated from the noise of construction activity, or during a time when construction activity is not occurring in the vicinity.
- C. The audio portion of the A/V recording should be done with a microphone (wired or wireless) attached to the trainer/instructor to maximize the quality of speech.
- D. Each A/V recording should have "chapters" to segregate the distinct portions of the training/instruction, or have visual cues at the start of a change in subject.
- E. Two copies of the A/V recordings shall be submitted to the Engineer on DVD disk(s). The DVDs will become the property of the Owner.

END OF SECTION

## O&M Manual Review Checklist

Submittal No.: \_\_\_\_\_

Project No.: \_\_\_\_\_

Manufacturer: \_\_\_\_\_

Equipment Submitted: \_\_\_\_\_

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

Date of Submittal: \_\_\_\_\_

| <b>General Data</b>                    |   |  |
|--|---|--|
| 1.                                     | Are the area representative's name, address, e-mail address and telephone number included?  |  |
| 2.                                     | Is the nameplate data for each component included?  |  |
| 3.                                     | Are all associated components related to the specific equipment included?   |  |
| 4.                                     | Is non-pertinent data crossed out or deleted?   |  |
| 5.                                     | Are drawings neatly folded and/or inserted into packets?  |  |
| 6.                                     | Are all pages properly aligned and scanned legibly?   |  |
| 7.                                     | Is the .PDF document bookmarked according to the table of contents?   |  |
| <b>Operations and Maintenance Data</b> |   |  |
| 8.                                     | Is an overview description of the equipment and/or process included?  |  |
| 9.                                     | Does the description include the practical theory of operation?   |  |
| 10.                                    | Does each equipment component include specific details (design characteristics, operating parameters, control descriptions, and selector switch positions and functions)? |  |
| 11.                                    | Are alarm and shutdown conditions specific to the equipment provided on this project clearly identified? Does it describe possible causes and recommended remedies?       |  |
| 12.                                    | Are step procedures for starting, stopping, and troubleshooting specific to the equipment provided included?  |  |
| 13.                                    | Is a list of operational parameters to monitor and record specific to the equipment provided included?  |  |
| 14.                                    | Is a proposed operating log sheet specific to the equipment provided included?  |  |
| 15.                                    | Is a spare parts inventory list included for each component?  |  |
| 16.                                    | Is a lubrication schedule for each component specific to the equipment provided included - or does it clearly state "No Lubrication Required"?                            |  |
| 17.                                    | Is a maintenance schedule for each component specific to the equipment provided included?   |  |
| 18..                                   | Is a copy of the warranty information included?   |  |

## Review Comments

Is the submittal fully approved (yes/no)? \_\_\_\_\_

If not, the following points of rejection must be addressed and require resubmittal by the Contractor:

### Item No.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_
10. \_\_\_\_\_
11. \_\_\_\_\_
12. \_\_\_\_\_
13. \_\_\_\_\_
14. \_\_\_\_\_
15. \_\_\_\_\_

Reviewed By: \_\_\_\_\_ Date: \_\_\_\_\_

### Legend

1 = OK

2 = Not Adequate

3 = Not Included

Note: This submittal has been reviewed for compliance with the Contract Documents.

| <b>Table 01730 Schedule of Assets</b>                   |
|---|
| <b>02605</b>  |
| PRECAST STRUCTURE - NaOCI INJECTION VAULT               |
| PRECAST STRUCTURE - GST No. 2 DRAIN VAULT               |
| <b>02616</b>  |
| 8" DI PIPING  |
| 12" DI PIPING   |
| 16" DI PIPING   |
| 16" PVC DR-25 PIPING                                    |
| 20" DI PIPING   |
| 24" DI PIPING   |
| 30" DI PIPING   |
| <b>11214</b>  |
| WELL NO 3 PUMP  |
| WELL NO 3 PUMP MOTOR                                    |
| <b>11216</b>  |
| HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMP                  |
| HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMP MOTOR            |
| <b>11245</b>  |
| NaOCI METERING PUMP SKID                                |
| <b>13205</b>  |
| 1.1 MILLION GALLON GROUND STORAGE TANK AND TRAY AERATOR |
| <b>13321</b>  |
| FIBER OPTIC INTERFACE PANEL                             |
| <b>13330</b>  |
| WELL NO 3 RIO CONTROL PANEL                             |
| WELL NO 3 INSTRUMENT RACK                               |
| <b>13340</b>  |
| MAGNETIC FLOWMETER FE/FIT-325                           |
| THERMAL DISPERSION FLOW SWITCH FSL-313A                 |
| THERMAL DISPERSION FLOW SWITCH FSL-313B                 |
| THERMAL DISPERSION FLOW SWITCH FSL-313C                 |
| SUBMERSIBLE LEVEL TRANSMITTER LE/LIT-320                |
| ELECTRODE RELAY LEVEL SWITCH LSH/LSL-237                |
| PRESSURE TRANSMITTER LIT-236                            |
| PRESSURE TRANSMITTER PIT-322                            |
| PRESSURE TRANSMITTER PIT-3620-3                         |
| PRESSURE TRANSMITTER PIT-3640-3                         |
| PRESSURE GAUGE PI-322                                   |
| PRESSURE GAUGE PI-316A                                  |
| PRESSURE GAUGE PI-316B                                  |
| PRESSURE GAUGE PI-316C                                  |

| <b>Table 01730 Schedule of Assets</b>                      |
|--|
| PRESSURE GAUGE PI-405A                                     |
| PRESSURE GAUGE PI-405B                                     |
| PRESSURE GAUGE PI-3630-3                                   |
| DIAPHRAGM SEAL PE-3620-3                                   |
| DIAPHRAGM SEAL PE-3640-3                                   |
| DIAPHRAGM SEAL PE-316A                                     |
| DIAPHRAGM SEAL PE-316B                                     |
| DIAPHRAGM SEAL PE-316C                                     |
| CONDUCTIVITY ANALYZER AE/AIT-324                           |
| OZONE-IN-WATER RESIDUAL ANALYZER AE/AIT-3770-2             |
| <b>15072</b>   |
| 6" DI PIPING   |
| 10" DI PIPING  |
| 12" DI PIPING  |
| 16" DI PIPING  |
| 20" DI PIPING  |
| <b>15100</b>   |
| 16" GATE VALVE, PUMP NO 4 SUCTION                          |
| 16" CHECK VALVE (RUBBER FLAPPER), PUMP No. 5 DISCHARGE     |
| 16" BUTTERFLY VALVE, PUMP No. 5 DISCHARGE                  |
| 12" CHECK VALVE (RUBBER FLAPPER), BACKUP WELL No. 3 HEADER |
| 12" BUTTERFLY VALVE, BACKUP WELL No. 3 HEADER              |
| 12" BUTTERFLY VALVE, BACKUP WELL No. 3 HEADER              |
| 24" GATE VALVE, GST No. 1 TO GST No. 2                     |
| <b>15600</b>   |
| FUEL STORAGE TANK FOR DIESEL ENGINE DRIVEN GENERATOR       |
| <b>16216</b>   |
| DIESEL ENGINE DRIVEN GENERATOR                             |
| <b>16370</b>   |
| PUMP No. 3 VARIABLE FREQUENCY DRIVE VFD                    |
| <b>16450</b>   |
| 480V SWITCH GEAR SWGR-X                                    |
|  |
|  |
|  |
|  |
|  |

SECTION 01731  
ASSET MANAGEMENT DATA

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes procedural requirements for compiling and submitting asset management data required to complete the project. In addition to the requirements specified herein, Contractor asset management data shall be as required in JEA Water and Wastewater Standards – Section 445.

1.02 RELATED REQUIREMENTS

- A. Application for Payment is included in Section 01026.
- B. Standard General Conditions of the Construction Contract are included in the Front-End Documents provided by Owner.

1.03 ENTERPRISE ASSET MANAGEMENT DATA (EAM WORKSHEET)

- A. Equipment Attribute Information:
  - 1. Equipment Attribute Worksheets as presented at the end of this Specification shall be provided for all equipment meeting the asset definition as follows:
    - a. Maintenance is recommended.
    - b. Assets have a value greater than \$1,000.00.
    - c. Assets are complete and usable, and perform a distinct function independently.
  - 2. This asset definition is intended to give a general indication of which equipment must be included in the Equipment Attribute Worksheets. The Engineer will provide the specific list of equipment that the Contractor must provide information for:
    - a. The information requirements are shown in detail in the table at the end of this Specification. The data requirements include nameplate data, manufacturer and supplier information, information specific to the type of equipment, and recommended preventative maintenance activities.
    - b. An electronic copy of the Equipment Attribute Worksheets must be delivered in Excel format and submitted to the Engineer on CD-ROM at closeout. It is not necessary to submit printed copies of the Equipment Attribute Worksheets.

1.04 SCHEDULE OF ASSET VALUES

- A. **The asset table is included in this Section.** It includes the assets to be accounted for in the Schedule of Asset Values.
- B. For each asset listed, provide a constructed cost which will include an allocation of construction activities including but not limited to, demolition, sitework, specialties, materials, labor, general conditions, and overhead and profit associated with the construction of the asset.

- C. The combined value of the assets will equal the bid price for the project and will require adjustments as necessary due to change orders. The schedule of asset values will be updated on a monthly basis and will be included in the monthly pay request application for approval.
- D. The Owner reserves the right to edit this list prior to the first pay request application and may add up to 10 percent more items than have been identified in the list.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 SUBMITTAL SCHEDULE

- A. The Engineer will review the EAM data and SCHEDULE OF ASSET VALUES data for conformance with the requirements listed on each worksheet.
- B. The EAM worksheet and SCHEDULE OF ASSET VALUES worksheets will be updated on a monthly basis and submitted to the Engineer for review with the monthly payment application.

END OF SECTION

**SCHEDULE OF ASSET VALUES (TO BE ADDED AT 90-PERCENT DESIGN MILESTONE)**

| <b>ACTIVITY<br/>(NEW, RETIRE,<br/>REHAB)</b> | <b>FIXED ASSET TYPE</b> | <b>FIXED ASSET DESCRIPTION</b> |
|--|-------------------------|--------------------------------|
| <b>PIPING</b>                                |                         |                                |
|  |                         |                                |
| <b>ELECTRICAL</b>                            |                         |                                |
|  |                         |                                |
| <b>INSTRUMENTATION</b>                       |                         |                                |
|  |                         |                                |
| <b>PUMPS</b>                                 |                         |                                |
|  |                         |                                |
| <b>SCADA</b>                                 |                         |                                |
|  |                         |                                |
| <b>BUILDING</b>                              |                         |                                |
|  |                         |                                |
| <b>HVAC</b>                                  |                         |                                |
|  |                         |                                |
| <b>SECURITY</b>                              |                         |                                |

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## SECTION 01740 WARRANTIES AND BONDS

### PART 1 GENERAL

#### 1.01 SCOPE OF WORK

- A. This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including Equipment Supplier/Manufacturer's standard warranties on products and special warranties.

#### 1.02 RELATED WORK

- A. General closeout requirements are included in Section 01700 Project Closeout.
- B. Specific requirements for warranties for the work and products and installations that are specified to be warranted are included in the individual Sections.

#### 1.03 SUBMITTALS

- A. The individual Equipment Supplier/Manufacturer shall submit written warranties to the Owner prior to the date fixed by the Engineer for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the work, or a designated portion of the work, submit written warranties upon request of the Owner.
- B. When a designated portion of the work is completed and occupied or used by the Owner, by separate agreement with the Equipment Supplier/Manufacturer (as applicable) during the construction period, submit properly executed warranties to the Owner via the Engineer within 15 days of completion of that designated portion of the Work.
- C. When a special warranty is required to be executed by the Equipment Supplier/Manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner via the Engineer for approval prior to final execution.
- D. Forms for special warranties are included at the end of this Section. Prepare a written document utilizing the appropriate form, ready for execution by the Contractor, or the Contractor and subcontractor, or Equipment Supplier/Manufacturer. Submit a draft to the Owner for approval prior to final execution.
- E. Refer to individual Sections for specific content requirements, and particular requirements for submittal of special warranties.
- F. At Final Completion the Contractor shall compile two copies of each required warranty and bond properly executed by the Equipment Supplier/Manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- G. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents and sized to receive 8-1/2-inch by 11-inch paper.

- H. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the Section in which specified and the name of the product or work item.
- I. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address and telephone number of the installer or Equipment Supplier/Manufacturer.
- J. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS", the project title or name and the name, address and telephone number of the Equipment Supplier/Manufacturer.
- K. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

#### 1.04 WARRANTY REQUIREMENT

- A. Related Damages and Losses: When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.
- B. Reinstatement of Warranty: When work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that work covered by a warranty has failed, replace or rebuild the work to an acceptable condition complying with requirements of Contract Documents. The Equipment Supplier/Manufacturer is responsible for the cost of replacing or rebuilding defective work regardless of whether the Owner has benefited from use of the work through a portion of its anticipated useful service life.
- D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
- E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- F. The Owner reserves the right to refuse to accept work for the Project where a special warranty, certification, or similar commitment is required on such work or part of the work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- G. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Equipment Supplier/Manufacturer (as applicable) of the warranty on the work that incorporates the products, nor does it relieve Equipment Supplier/Manufacturer and subcontractors required to countersign special warranties with the Contractor.

#### 1.05 MANUFACTURERS CERTIFICATIONS

- A. Where required, the Contractor shall supply evidence, satisfactory to the Engineer, that the Equipment Supplier/Manufacturer can obtain manufacturers' certifications as to the Contractor's installation of equipment.

#### 1.06 DEFINITIONS

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

#### 1.07 EQUIPMENT WARRANTIES

- A. All equipment supplied under this Contract shall be guaranteed to be free from defects in workmanship, design, and/or materials for a period of one (1) year unless otherwise specified. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner and provided that the equipment demonstrates satisfactory performance during the thirty (30)-day operational period after equipment startup. If the equipment does not perform satisfactorily during the thirty (30)-day startup operational period, the start of the warranty period shall be delayed until the equipment demonstrates proper operation. Warranties and guarantees shall be indicated on the Warranty for Equipment Item form appended to this Section. The Equipment Supplier/Manufacturer shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the warranty period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified level.
- B. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced in the equipment(s) and the equipment and/or unit(s) restored to service at no expense to the Owner.
- C. Obtain equipment warranties in accordance with Section 01740 from each of the respective Equipment Supplier/Manufacturer for all the equipment specified under Divisions 11, 13, 15 and 16 of these Specifications. The form of warranty is included at the end of this Section.
- D. The Equipment Supplier/Manufacturer's warranty period shall run concurrently with the Contractor's warranty or guarantee period. No exception to this provision shall be allowed. In the event that the Equipment Supplier/Manufacturer is unwilling to provide a one (1)-year warranty commencing at the time of Owner acceptance, obtain from the Equipment Supplier/Manufacturer a two (2)-year warranty starting at the time of equipment delivery to the job site. This two (2)-year warranty shall not relieve the Contractor of the one (1)-year warranty starting at the time of Owner acceptance of the equipment.

1.08 FINAL GUARANTEE

- A. All work shall be guaranteed by the Contractor for a period of 1 year from and after the date of acceptance of the work by the Owner.
- B. If, within the guarantee period, repairs or changes are required in connection with guaranteed work, which, in the opinion of the Engineer, is rendered necessary as the result of the use of materials, equipment or workmanship which are inferior, defective, or not in accordance with the terms of the Contract, promptly upon receipt of notice from the Owner and without expense to the Owner, replace any part of equipment which is defective or showing undue wear within the warranty period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

WARRANTY FOR EQUIPMENT ITEM

LOCATION OF PROJECT: \_\_\_\_\_  
OWNER: \_\_\_\_\_  
PROJECT NUMBER: \_\_\_\_\_  
EQUIPMENT ITEM: \_\_\_\_\_  
SECTION NO. / ITEM NO.: \_\_\_\_\_  
SUPPLIER/MANUFACTURER: \_\_\_\_\_  
SUPPLIER/MANUFACTURER'S ADDRESS: \_\_\_\_\_  
\_\_\_\_\_  
SUPPLIER/MANUFACTURER'S REFERENCE NO.: \_\_\_\_\_

The undersigned guarantees that the above equipment is of good merchantable quality, free from defects in material or workmanship, fully meets the type, quality, design and performance requirements defined in the Contract Documents of the above project, and that the equipment will in actual operation satisfactorily perform the functions for which installed.

The undersigned agrees to repair, replace, or otherwise make good, any defect in workmanship or materials in the above described equipment which may develop within a period of one year from the date of final acceptance by the Owner of the above named project.

COMPANY \_\_\_\_\_

COMPANY ADDRESS \_\_\_\_\_

BY \_\_\_\_\_

TITLE \_\_\_\_\_

SIGNED \_\_\_\_\_

DATE \_\_\_\_\_

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SECTION 02050  
DEMOLITION AND MODIFICATIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and demolish, modify, remove and dispose of work shown on the Drawings and as specified herein.
- B. Included, but not limited to, are demolition, modifications and removal of existing materials, equipment or work necessary to install the new work as shown on the Drawings and as specified herein and to connect with existing work in approved manner.
- C. Demolition, modifications and removals which may be specified under other Sections shall conform to requirements of this Section.
- D. Demolition and modifications include but are not limited to:
  - 1. Existing Diesel Engine Driven Generator.
  - 2. Existing Fuel Tank.
- E. Blasting and the use of explosives will not be permitted for any demolition work.

1.02 RELATED WORK

- A. Summary of Work is included in Section 01010.
- B. Environmental Protection is included in Section 01110.
- C. Submittals are included in Section 01300.
- D. Construction Schedule is included in Section 01310.
- E. Clearing is included in Section 02100.
- F. Earthwork is included in Section 02200.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, six copies of proposed methods and operations of demolition of the structures and modifications prior to the start of work. Include in the schedule the coordination of shutoff, capping and continuation of utility service as required.
- B. Furnish a detailed sequence of demolition and removal work to ensure the uninterrupted progress of the Owner's operations. Sequence shall be compatible with sequence of construction and shutdown coordination requirements as specified in Section 01014.
- C. Before commencing demolition work, all modifications necessary to bypass the affected structure shall be completed. Actual work shall not begin until the Engineer has inspected and approved the modifications and authorized commencement of the demolition work in writing.

## 1.04 JOB CONDITIONS

### A. Protection

1. Execute the demolition and removal work to prevent damage or injury to structures, occupants thereof and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use, and free and safe passage to and from adjacent structures.
2. Closing or obstructing of roadways, sidewalks and passageways adjacent to the work by the placement or storage of materials will not be permitted and all operations shall be conducted with a minimum interference to traffic on these ways.
3. Erect and maintain barriers, lights, sidewalk sheds and other required protective devices.

### B. Scheduling

1. Carry out operations so as to avoid interference with operations and work in the existing facilities.

### C. Notification

1. At least 48 hours prior to commencement of a demolition or removal, notify the Engineer in writing of proposed schedule therefor. Owner shall inspect the existing equipment and to identify and mark those items which are to remain the property of the Owner. No removals shall be started without the permission of the Engineer and Owner.

### D. Conditions of Structures

1. The Owner and the Engineer assume no responsibility for the actual condition of the structures to be demolished or modified.
2. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner insofar as practicable. However, variations within a structure may occur prior to the start of demolition work.

### E. Repairs to Damage

1. Promptly repair damage caused to adjacent facilities by demolition operation when directed by Engineer and at no additional cost to the Owner. Repairs shall be made to a condition at least equal to that which existed prior to construction.

### F. Traffic Access

1. Conduct demolition and modification operations and the removal of equipment and debris to ensure minimum interference with roads, streets, walks both onsite and offsite and to ensure minimum interference with occupied or used facilities.
2. Special attention is directed towards maintaining safe and convenient access to the existing facilities by plant personnel and plant associated vehicles.

3. Do not close or obstruct streets, walks or other occupied or used facilities without permission from the Engineer. Furnish alternate routes around closed or obstructed traffic in access ways.

#### 1.05 RULES AND REGULATIONS

- A. The Building Code of the State of Florida, shall control the demolition, modification or alteration of the existing buildings or structures.
- B. No building or structure, or any part thereof, shall be demolished until an application has been filed with the Building Inspector and a permit issued. The fee for this permit shall be the Contractor's responsibility.

#### 1.06 DISPOSAL OF MATERIAL

- A. Salvageable material and equipment listed hereinafter shall become the property of the Owner. Dismantle all such items to a size that can be readily handled and deliver them to a designated storage area.
- B. The following materials and items of equipment shall remain the property of the Owner and stored where directed on the site. Contractor shall coordinate with Owner for any additional materials or equipment to be salvaged. Any such material damaged due to improper handling will not be accepted and the replacement value of the material deducted from the payment to the Contractor.
  1. All mechanical equipment (pumps, meters, controllers, control valves, etc).
  2. All valves greater than 8-in diameter.
- C. All other material and items of equipment shall become the Contractor's property and must be removed from the site.
- D. The storage or sale of removed items on the site will not be allowed.

#### PART 2 PRODUCTS (NOT USED)

#### PART 3 EXECUTION

##### 3.01 GENERAL

- A. All materials and equipment removed from existing work shall become the property of the Contractor, except for those which the Owner has identified and marked for his/her use. All materials and equipment marked by the Owner to remain shall be carefully removed, so as not to be damaged, cleaned and stored on or adjacent to the site in a protected place specified by the Engineer or loaded onto trucks provided by the Owner.
- B. Dispose of all demolition materials, equipment, debris and all other items not marked by the Owner to remain, off the site and in conformance with all existing applicable laws and regulations.
- C. Pollution Controls

1. Use water sprinkling, temporary enclosures and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.
  - a. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding and pollution.
  - b. Clean adjacent structures, facilities, and improvements of dust, dirt and debris caused by demolition operations. Return adjacent areas to conditions existing prior to the start of the work.

#### D. Building Demolition

1. Unless otherwise approved by Engineer, proceed with demolition from the top of the 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 by means of hoists, derricks, or other suitable methods.
4. Break up and remove foundations and slabs-on-grade, unless otherwise shown to remain.
5. Locate demolition equipment throughout the structure and remove material so as to not impose excessive loads to supporting walls, floors or framing.

### 3.02 STRUCTURAL REMOVALS

- A. Remove structures to the lines and grades shown unless otherwise directed by the Engineer. Where no limits are shown, the limits shall be 4-in outside the item to be installed. The removal of masonry beyond these limits shall be at the Contractor's expense and these excess removals shall be reconstructed to the satisfaction of the Engineer with no additional compensation to the Contractor.
- B. All concrete, brick, tile, concrete block, roofing materials, reinforcement, structural or miscellaneous metals, plaster, wire mesh and other items contained in or upon the structure shall be removed and taken from the site, unless otherwise approved by the Engineer. Demolished items shall not be used in backfill adjacent to structures or in pipeline trenches.
- C. After removal of parts or all of masonry walls, slabs and like work which tie into new work or existing work, the point of junction shall be neatly repaired so as to leave only finished edges and surface exposed.

### 3.03 MECHANICAL REMOVALS

- A. Mechanical removals shall consist of dismantling and removing of existing piping, pumps, motors, equipment and other appurtenances as specified, shown, or required for the completion of the work. It shall include cutting, capping, and plugging as required, except that the cutting of existing piping for the purpose of making connections thereto will be included under Division 15.

- B. Existing process, water, chemical, gas, fuel oil and other piping not required for the new work shall be removed where shown or where it will interfere with new work. Piping not indicated to be removed or which does not interfere with new work shall be removed to the nearest solid support, capped and left in place. Chemical and fuel lines and tanks shall be purged and made safe prior to removal or capping. Where piping that is to be removed passes through existing walls, it shall be cut off and properly capped on each side of the wall.
- C. When underground piping is to be altered or removed, the remaining piping shall be properly capped. Abandoned underground piping may be left in place unless it interferes with new work or is shown or specified to be removed.
- D. Waste and vent piping shall be removed to points shown. Pipe shall be plugged with cleanouts and plugs. Where vent stacks pass through an existing roof that is to remain, they shall be removed and the hole in the roof properly patched and made watertight.
- E. Any changes to potable water piping and other plumbing system work shall be made in conformance with all applicable codes and under the same requirements as other underground piping. All portions of the potable water system that have been altered or opened shall be pressure tested and disinfected in accordance with Section 01445 and local codes. Other plumbing piping shall be pressure tested only.

### 3.04 ELECTRICAL REMOVALS

- A. Electrical removals shall consist of the removal of existing transformers, distribution switchboards, control panels, motors, conduits and wires, poles and overhead wiring, panelboards, lighting fixtures and miscellaneous electrical equipment all as shown on the Drawings, specified herein, or required to perform the work.
- B. All existing electrical equipment and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to maintain the integrity of the grounding systems.
- C. Conduits and wires shall be abandoned or removed where shown. All wires in abandoned conduits shall be removed, salvaged and stored. Abandoned conduits concealed in floor or ceiling slabs or in walls, shall be cut flush with the slab or wall at the point of entrance. The conduits shall be suitably plugged and the area repaired in a flush, smooth and approved manner. Exposed conduits and their supports shall be disassembled and removed from the site. Repair all areas of work to prevent rust spots on exposed surfaces.
- D. Where shown or otherwise required, wiring in the underground duct system shall be removed. All such wiring shall be salvaged and stored as specified. Verify the function of all wiring before disconnection and removing it. Ducts which are not to be reused shall be plugged where they enter buildings and made watertight.
- E. Where shown, direct-burial cable shall be abandoned. Such cable shall be disconnected at both ends of the run. Where it enters a building or structure the cable shall be cut back to the point of entrance. All opening in buildings for entrance of abandoned direct-burial cable shall be patched and made watertight.
- F. Poles and overhead wiring shall be abandoned as shown and specified. Existing substation and poles owned by the power company will be removed by the power company. Poles not owned

by the power company shall be completely removed from the site. The overhead wires shall be salvaged and stored. Perform this work after the proposed service has been completed and energized, and in accordance with the approved schedule.

- G. Lighting fixtures shall be removed or relocated as shown. Fixtures not relocated shall be removed from the site. Relocated fixtures shall be carefully removed from their present location and rehung where shown.
- H. Wall switches, receptacles, starters and other miscellaneous electrical equipment, shall be removed and disposed of off the site as required. Care shall be taken in removing all equipment so as to minimize damage to architectural and structural members. Any damage incurred shall be repaired.

### 3.05 CLEAN-UP

- A. Remove from the site all debris resulting from the demolition operations as it accumulates. Upon completion of the work, all materials, equipment, waste and debris of every sort shall be removed, and premises shall be left, clean, neat and orderly.

END OF SECTION

SECTION 02100  
SITE PREPARATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials and equipment required and perform all site preparation, complete as specified in the JEA Water and Wastewater Standards (January 2019 or latest Edition), Site Preparation, Cleanup & Restoration – Section 406, and as specified herein. The Contractor may provide this Work through a qualified Subcontractor who specializes in site preparation including land clearing. The Contractor shall clear, strip, grub and dispose all of the areas required for construction as shown on the plans and approved by the Owner prior to the beginning of any work. All site work shall conform to the JEA Water and Wastewater Standards (January 2019 or latest Edition), Site Preparation, Cleanup & Restoration – Section 406.

1.02 RELATED WORK

- A. Final Geotechnical Report for JEA Greenland Water Treatment Plant Expansion, dated March 13, 2019
- B. Addendum Report of Geotechnical Exploration for JEA Greenland Water Treatment Plant Expansion, New Ground Storage Tank Location, dated July 31, 2019
- C. JEA Water and Wastewater Standards (January 2019 or latest Edition) – Section 406.
- D. Earthwork is included in Section 02200, and Section 408 in JEA's Water and Wastewater Standards Manual.
- E. Temporary Erosion and Sedimentation Control is included in Section 02276.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, copies of all permits required prior to clearing, grubbing, and stripping work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CLEARING

- A. The surface of the ground, for the area to be cleared and grubbed shall be completely cleared of all timber, trees, stumps, brush, shrubs, roots, grass, weeds, rubbish and any other objectionable material resting on or protruding through the surface of the ground. Clearing operations shall be conducted so as to prevent damage to existing structures and utilities and to structures and utilities under construction, and also to provide for the safety of employees and others.

### 3.02 GRUBBING

- A. Grub and remove all stumps, roots in excess of 1-1/2-inches in diameter, matted roots, brush, timber, logs, concrete rubble and other debris encountered to a depth of 18-inches below original grade or 18-inches beneath the bottom of foundations, whichever is deeper.
- B. Refill all grubbing holes and depressions excavated below the original ground surface with suitable materials and compact to a density conforming to the surrounding ground surface in accordance with JEA Standard Water and Wastewater Section 406.

### 3.03 STRIPPING

- A. Topsoil shall be free from brush, trash, large stones and other extraneous material. Avoid mixing topsoil with subsoil.
- B. Stockpile and protect topsoil until it is used in landscaping, loaming and seeding operations. Dispose of surplus topsoil after all work is completed.

### 3.04 DISPOSAL

- A. Dispose of material and debris from site preparation operations by hauling such materials and debris to an approved offsite disposal area. No rubbish or debris of any kind shall be buried on the site.

### 3.05 PROTECTION AND CONTROL

- A. Trees and other vegetation designated on the Drawings or directed by the Owner to remain shall be protected from damage by all construction operations by erecting suitable barriers, guards and enclosures, or by other approved means. Conduct clearing operations in a manner to prevent falling trees from damaging trees and vegetation designated to remain and to the work being constructed and so as to provide for the safety of employees and others.
- B. Maintain protection until all work in the vicinity of the work being protected has been completed.
- C. Do not operate heavy equipment or stockpile materials within the branch spread of existing trees.
- D. Immediately repair any damage to existing tree crowns, trunks, or root systems. Roots exposed and/or damaged during the work shall immediately be cut off cleanly inside the exposed or damaged area. Treat cut surfaces with an acceptable tree wound paint and topsoil spread over the exposed root area.
- E. Restrict construction activities to those areas within the limits of construction designated on the Drawings, within easements provided by the Owner. Adjacent properties and improvements thereon, public or private, which become damaged by construction operations, shall be promptly restored to their original condition, to the full satisfaction of the property owner.

END OF SECTION

## SECTION 02140 DEWATERING

### PART 1 GENERAL

#### 1.01 RELATED WORK

- A. Submittals are included in Section 01300.
- B. Site preparation is included in JEA's Water and Wastewater Manual, Section 406 – Site Preparation, Cleanup and Restoration, and Section 02100.
- C. Excavation and Earthwork are included in JEA's Water and Wastewater Standards Manual, Section 408 – Excavation and Earthwork, and Section 02200.
- D. Trenching, Backfilling and Compaction is included in JEA's Water and Wastewater Standards Manual, Section 408- Excavation and Earthwork, and Section 02221.
- E. Temporary erosion and sedimentation control are included in Section 02276.

#### 1.02 SCOPE OF WORK

- A. The Contractor shall design, furnish, install, operate, monitor, maintain and remove a temporary dewatering system as required and lower and control water levels at least 2-feet below subgrades of excavations and to permit construction to proceed in-the-dry.
- B. The Contractor shall furnish, maintain and remove temporary surface water control measures adequate to drain and remove surface water entering excavations.
- C. The Contractor shall retain the services of a professional engineer registered in the State of Florida to prepare dewatering and drainage system designs and submittals described herein.
- D. Work shall include the design, equipment, materials, installation, protection, and monitoring of geotechnical instrumentation required to monitor the performance of the dewatering and drainage system as required herein.
- E. The Contractor shall collect and properly dispose of all discharge water from the dewatering and drainage systems in accordance with all Federal, State and local agency requirements.
- F. The Contractor shall obtain and pay for all permits required for temporary dewatering and drainage systems. Original permits shall be prominently displayed on the site prior to constructing dewatering and drainage systems.
- G. The Contractor shall repair damage caused by dewatering and drainage system operations.
- H. The Contractor shall perform all work in accordance with current applicable regulations and codes of all Federal, State and local agencies.

#### 1.03 SUBMITTALS

- A. The Contractor shall submit, in accordance with Section 01300, detailed plans of the proposed dewatering methods. Dewatering and drainage system designs shall be prepared by a Professional

Engineer licensed in the State of Florida, and retained by the Contractor, and having a minimum of five (5) years of professional experience in the design and construction of dewatering and drainage systems.

- B. The plan shall include a description of the proposed dewatering system and include the proposed installation methods to be used for dewatering and drainage system elements and for observation wells. The plan shall include equipment, drilling methods, hole sizes, filter sand placement techniques, sealing materials, development techniques, the number and location of dewatering points and observations wells, etc. Include the dewatering system design calculations in the plan.
- C. Submittal will be for information only. The Contractor shall remain responsible for adequacy and safety of construction means, methods and techniques.
- D. The Contractor shall coordinate dewatering and drainage submittals with the excavation and support of excavation submittals. The submittal shall show the areas and depths of excavation to be dewatered. Sheet piles may be used for the advantage for reducing groundwater flow into the excavation if they can be embedded in confining or semi-confining layer(s). The plan shall also include detailed plans for settlement monitoring of existing structures within 150 feet of dewatering activities before and during construction, and provisions to address settlement of existing structures, should it occur, resulting from dewatering activities.
- E. The Contractor shall not proceed with any excavation or dewatering activities until the dewatering submittals have been provided to the Engineer and permits have been obtained.

#### 1.04 DESIGN AND PERFORMANCE RESPONSIBILITY

- A. The Contractor is responsible for the proper design and implementation of methods for controlling surface water and groundwater.
- B. The primary purpose of the groundwater control system is to preserve the natural undisturbed condition of the subgrade soils in the areas of the proposed excavations. Prior to excavation, the Contractor shall lower the groundwater to 2-ft below the lowest excavation subgrade elevation. For the excavation in the vicinity of existing 1.0 MG Ground Storage Tank (GST), dewatering operation shall not lower the groundwater more than 10 feet below ground surface (ft-bgs) to minimize the potential impact on the existing GST. Additional groundwater lowering may be necessary beyond the 2-ft requirement, depending on construction methods and equipment used and the prevailing groundwater and soil conditions. The Contractor is responsible for lowering the groundwater as necessary to complete construction in accordance with the plans and specifications at no additional cost to the Owner.
- C. The Contractor shall be responsible for damage to properties, buildings or structures, sewers and other utility installations, pavements and work that may result from dewatering of surface water control operations.
- D. Design review and field monitoring activities by the Owner or of the Engineer shall not relieve the Contractor of his/her responsibilities for the work.

#### 1.05 DEFINITIONS

- A. Where the phrase "in-the-dry" is used in this Section, it shall be defined as an excavation subgrade where the groundwater level has been lowered to at least 2-ft below the lowest level of

the excavation, is stable with no ponded water, mud, or muck, is able to support construction equipment without rutting or disturbance and is suitable for the placement and compaction of fill material, pipe or concrete foundations.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Pipe for observation wells shall consist of minimum 2-in I.D., Schedule 40 PVC pipe and machine slotted PVC wellpoints, maximum slot size 0.010-in.
- B. The Contractor shall provide piping, pumping equipment and all other materials required to provide control of surface water and groundwater in excavation, and equipment provided shall be suitable for the intended purpose.
- C. The Contractor shall maintain at all sites standby pumping systems and a source of standby power.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Control surface water and groundwater such that excavation to final grade is made in-the-dry, the natural undisturbed condition of the subgrade soils are maintained, and softening and/or instability or disturbance due to the presence or seepage of water does not occur. All construction and backfilling shall proceed in-the-dry and flotation of completed portions of work shall be prohibited.
- B. Methods of groundwater control may include but are not limited to: perimeter trenches and sump pumping, perimeter groundwater cutoff, well points, ejectors and combinations thereof.
- C. Where groundwater levels are above the proposed bottom of excavation level, a pumped dewatering system will be required for pre-drainage of the soils prior to excavation, and for maintaining the lowered groundwater level until construction has been completed to such an extent that the structure, pipeline or fill will not be floated or otherwise damaged.
- D. It is expected that the type of system, spacing of dewatering units and other details of the work will have to be varied depending on soil/water conditions at a particular location.
- E. All work included in this Section shall be done in a manner which will protect adjacent structures and utilities and shall not cause loss of ground or disturbance to the pipe bearing soils or to soils which support overlying or adjacent structures.
- F. Install, monitor and report data from observation wells. Evaluate the collected data relative to groundwater control system performance and modify systems as necessary to dewater the site in accordance with the Contract requirements.
- G. Locate groundwater control system components where they will not interfere with construction activities adjacent to the work area or interfere with the installation and monitoring of geotechnical instrumentation including observation wells. Excavations for sumps or drainage

ditches shall not be made within or below 1H:1V slopes extending downward and out from the edges of existing or proposed foundation elements or from the downward vertical footprint of the pipe.

### 3.02 SURFACE WATER CONTROL

- A Remove surface runoff controls when no longer needed.

### 3.03 DEWATERING SYSTEMS

- A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.
- B. For excavations related to pipe installations, lift station, sewer, etc., dewatering systems shall include wells or well points, and other equipment and appurtenances installed outside limits of excavations and sufficiently below lowest point of excavation, or to maintain specified groundwater elevation.
- C. Design and Operate Dewatering Systems:
  - 1. To prevent loss of ground as water is removed.
  - 2. To avoid inducing settlement or damage to existing facilities, completed work, or adjacent property.
  - 3. To relieve artesian pressures and resultant uplift of excavation bottom.
- D. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.
- E. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.
- F. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering

### 3.04 OBSERVATION WELLS

- A. Install observation wells in accordance with the approved submittal to monitor groundwater levels beneath and around the excavated area until adjacent structures and pipelines are completed and backfilled.
- B. Observation Well Locations and Depths:
  - 1. A minimum of two wells shall be installed around the excavation near the existing 1.0 MG GST. They shall be located in critical areas with respect to groundwater control to monitor performance of dewatering systems designed by the Contractor's Engineer.
  - 2. Observation wells required shall be installed to a depth of at least 10 feet below the deepest level of excavation, unless otherwise approved by the Engineer, and to whatever depth is

necessary to indicate that the groundwater control system designed by the Contractor's Engineer is performing as intended. Additional observation wells may be required by the Engineer if deemed necessary to monitor the performance of the Contractor's groundwater control system.

3. Locations and depths of observation wells are subject to approval by the Engineer.
- C. Protect the observation wells at ground surface by providing a lockable box or outer protective casing with lockable top and padlock. Design the surface protection to prevent damage by vandalism or construction operations and to prevent surface water from infiltrating.
1. Observation wells shall be developed so as to provide a reliable indication of groundwater levels. Wells shall be re-developed if well clogging is observed, in the event of apparent erroneous readings, or as directed by the Engineer.
  2. Submittal observation well installation logs, top of casing elevation, and well locations to the Engineer within 24 hours of completion of well installation.
- D. Observation Well Maintenance
1. The Contractor shall maintain each observation well until adjacent structures and pipelines are completed and backfilled. Clean out or replace any observation well which ceases to be operable before adjacent work is completed.
  2. It is the Contractor's obligation to maintain observation wells and repair or replace them at no additional cost to the Owner, whether or not the observation wells are damaged by the Contractor's operations or by third parties.
- E. Monitoring and Reporting of Observation Well Data
1. The Contractor shall begin daily monitoring of groundwater levels in work areas prior to initial operation of drainage and dewatering system. Daily monitoring in areas where groundwater control is in operation shall continue until the time that adjacent structures and pipelines are completed and backfilled and until the time that groundwater control systems are turned off.
  2. The Contractor is responsible for processing and reporting observation well data to the Engineer. Data is to be provided to the Engineer on a form, which shall include the following information: observation well number, depth to groundwater, total depth of well, top of casing elevation, groundwater level elevation and date and time of reading.
- F. The groundwater level shall be kept at a minimum of 2-ft below the lowest subgrade level for a given excavation, but shall not lower than 10 ft-bgs in the vicinity of existing 1.0 MG GST.

### 3.05 DISPOSAL OF WATER

- A. Contractor shall obtain discharge permit for water disposal from authorities having jurisdiction prior to commencement of work.
- B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

- C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.
- D. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

### 3.06 PROTECTION OF PROPERTY

- A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.
- B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

### 3.06 REMOVAL OF SYSTEMS

- A. At the completion of the excavation and backfilling work, and when approved by the Engineer, all pipe, deep wells, wellpoints, pumps, generators, observation wells, other equipment and accessories used for the groundwater and surface water control systems shall be removed from the site. All materials and equipment shall become the property of the Contractor. All areas disturbed by the installation and removal of groundwater control systems and observation wells shall be restored to their original condition.
- B. Leave in place any casings for deep wells, wellpoints or observation wells located within the plan limits of structures or pipelines or within the zone below 1H:1V planes extending downward and out from the edges of foundation elements or from the downward vertical footprint of the pipe, or where removal would otherwise result in ground movements causing adverse settlement to adjacent ground surface, utilities or existing structures.
- C. Where casings are pulled, holes shall be filled with cement grout. Where left in place, casings should be filled with cement grout and cut off a minimum of [3-ft] below finished ground level or 1-ft below foundation level so as not to interfere with finished structures or pipelines.
- D. When directed by the Engineer, observation wells should be left in place for continued monitoring. When so directed, cut casings flush with final ground level and provide protective lockable boxes with locking devices. The protective boxes shall be suitable for the traffic and for any other conditions to which the observation wells will be exposed.

END OF SECTION

SECTION 02200  
EARTHWORK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment and incidentals required and perform all excavation, backfill, fill and grading required to complete the work as shown on the Drawings and as specified in the JEA Water and Wastewater Standards (January 2019 or latest Edition), Excavation & Earthwork – Section 408, and as specified herein.
- B. The Contractor shall furnish and install temporary excavation support systems, if required, including trench box, drilled-in soldier piles with lagging, interlocking steel sheeting, or other methods, to insure the safety of personnel and protect adjacent structures, piping, etc. in accordance with Federal, State, and local laws, regulations and requirements. Temporary excavation support systems shall be in accordance with the JEA Water and Wastewater Standards (January 2019 or latest Edition), Excavation & Earthwork – Section 408.
- C. The Contractor shall prepare the subgrade of the proposed new Ground Storage Tank (GST) for inspection by the Geotechnical Engineer. Specifically, any unengineered fill or organic, loose, soft, or otherwise unstable soils encountered at the subgrade shall be over excavated and replaced with compacted Structural Fill material. The Engineer is the sole judge as to whether the work has been accomplished satisfactory. Over-excavation of approximately 4 to 8 feet below existing grade is anticipated at the west portion of the new GST. The Backfill shall be compacted to 98 percent of its maximum density as determined by the Laboratory Modified Proctor Test per ASTM D1557.

1.02 RELATED WORK

- A. Site Preparation is included in Section 02100.
- B. Dewatering and Drainage is included in Section 02140.
- C. Trenching, Backfilling and Compaction is included in Section 02221.
- D. Addendum Report of Geotechnical Exploration for JEA Greenland Water Treatment Plant Expansion, New Ground Storage Tank Location, dated July 31, 2019 (included with Contract Documents).

END OF SECTION

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## SECTION 02210 SITE GRADING

### PART 1 GENERAL

#### 1.01 THE REQUIREMENT

- A. The CONTRACTOR shall perform grading Work within the limits, elevations and grades indicated on the Drawings and as specified herein.

#### 1.02 QUALITY CONTROL

- A. The site shall be graded to the required elevations. Spot elevations are shown on the Drawings and the finished surfaces shall be uniformly sloped between these locations.
- B. Suitable excavated material shall be used in the formation of embankments as shown on the Drawings. The CONTRACTOR shall provide all additional fill material required to complete the embankments.

### PART 2 PRODUCTS

#### 2.01 FILL

- A. Suitable fill material shall be noncohesive, nonplastic, granular mixture of local sand and limerock, shall be free from vegetation, organic material or muck and shall contain no more than 10 percent material by weight which passes the No. 200 sieve. Broken concrete shall not be used in the fill. Fill material containing limerock shall have sufficient sand to fill the voids in the limerock, and no individual rocks or pieces of hard material that will not pass a 6-inch diameter ring shall be used in the fill; except that the upper 4 inches of all backfill or fills shall not contain any rock or hard material that will not pass a 3-inch diameter ring. All fill material shall be provided by the CONTRACTOR from any excess suitable on-site material or from offsite sources, borrow areas or other sources for this material all be reviewed by the Engineer prior to use. The CONTRACTOR must determine the volume of material required for the site.

### PART 3 -- EXECUTION

#### 3.01 GRADING AND COMPACTION

- A. Fill material shall be placed in lifts not to exceed 8-inches and compacted to a density of not less than 95 percent of maximum density at optimum moisture as determined by ASTM D 1557. Fill material shall be within plus or minus 2 percentage points of optimum moisture content. The minimum density acceptable at any location within the pavement subgrade shall be as shown on the plans.

#### 3.02 FINE GRADING

- A. After structures, bases and pavements are completed and the yard piping trenches backfilled, the disturbed areas of the site shall be fine graded. All construction debris, regardless of size, shall be removed. The completed surface shall be shaped and sloped to drain away from the structures. The completed surface shall be within 0.1 foot of the elevations shown on the

Drawings, unless otherwise directed by the Engineer. Minor adjustments to line and grade may be required as the work progresses in order to satisfy field conditions.

END OF SECTION

SECTION 02221  
TRENCHING, BACKFILLING AND COMPACTION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment and incidentals required and perform all trenching for pipelines and appurtenances, including drainage, filling, backfilling, disposal of surplus material and restoration of trench surfaces and easements as shown on the Drawings and as specified in the JEA Water and Wastewater Standards (January 2019 or latest), Excavation & Earthwork – Section 408, and as specified herein.

1.02 RELATED WORK

- A. Final Geotechnical Report for JEA Greenland Water Treatment Plant, dated March 13, 2019 (Included with Contract Documents) and to be revised upon amended submittal (not received as of July 10, 2019).
- B. Addendum Report of Geotechnical Exploration for JEA Greenland Water Treatment Plant Expansion, New Ground Storage Tank Location, dated July 31, 2019 (included with Contract Documents).
- C. Site Preparation is included in Section 02100.
- D. Dewatering and Drainage is included in Section 02140.
- E. Earthwork is included in Section 02200.
- F. Sodding and Seeding is included in Section 02932.

END OF SECTION

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SECTION 02230  
GRANULAR FILL MATERIALS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install granular fill materials as shown on the Drawings and as specified herein. Associated work includes testing, sample collection, excavation, loading, shipping, delivering, stockpiling, placement and installation of granular fill materials.

1.02 RELATED WORK

- A. Dewatering and Drainage is included in Section 02140.
- B. Earthwork is included in Section 02200.
- C. Trenching, Backfilling and Compaction is included in Section 02221.
- D. Asphaltic and Rigid Concrete Pavement is included in Section 02510.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, complete product data for materials specified in this Section.

1.04 REFERENCE STANDARDS

- A. American Society of Testing and Materials (ASTM)
  - 1. ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.
  - 2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)).
  - 3. ASTM D2974 - Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
  - 4. ASTM C33 - Standard Test Method for Concrete Aggregates.
  - 5. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- B. Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction and Roadway Design Standards (latest editions).

PART 2 PRODUCTS

2.01 MATERIAL

- A. Individual fill materials may be specified elsewhere in Division 2.

- B. Materials for use directly under, and in, Roadways are specified under Section “Asphaltic Concrete Paving”.
- C. Structural Fill:
1. Structural Fill shall be non-plastic, clean sand, free of organic material, loam, wood, trash, and other deleterious or objectionable materials which may be compressible or which cannot be properly moisture conditioned and compacted. Structural fill shall not contain stones larger than 2 inches in any dimension. Structural fill shall not have an organic content greater than 4 percent as determined by ASTM D2974 (Method C). Structural fill shall not contain granite blocks, broken concrete, rubble, or other similar materials. It shall have physical properties such that it can be readily spread, moisture conditioned, and compacted. Structural fill shall have a particle-size distribution, as determined by ASTM D422, within the following limits:

| <u>Sieve Size</u> | <u>Percent Finer by Weight</u> |
|-------------------|--------------------------------|
| 3-in              | 100                            |
| No. 4             | 70 – 100                       |
| No. 40            | 5 – 100                        |
| No. 200           | 0 - 10                         |

2. The Contractor shall submit to the Engineer all representative bulk samples of proposed structural fill, weighing approximately 50 lbs., at least five (5) days prior to the date of anticipated use of such material.
- D. Common Fill shall consist of non-plastic, mineral soil substantially free from organic materials, loam, wood, trash and other objectionable materials which may be compressible, or which cannot be properly compacted. Common fill shall not contain stones larger than 2 inches in largest diameter and shall have a maximum of 70 percent passing the No. 40 sieve and a maximum of 20 percent passing No. 200 sieve. Common fill shall not have an organic content exceeding 4 percent, as determined by ASTM D2974 (Method C). Common fill shall not contain granite blocks, broken concrete, masonry rubble or other similar materials. It shall have physical properties such that it can be readily spread, moisture conditioned, and compacted during filling. In general, common fill shall consist of sand, sand with gravel, sand with silt, sand with clay, silty sand, or clayey sand classified as SP, SW, SP-SM, SP-SC, SW-SM, SW-SC, SM, OR SC in accordance with the Unified Soil Classification System, ASTM D 2487. Soil excavated from the structure areas and which meets the above requirements may be used in embankments.
- E. Select Common Fill shall be as specified above for Common Fill except that the material shall contain no stones larger than 2 inches in any dimension.
- F. Screened Gravel:
1. Screened gravel shall be used for pipe bedding as detailed and at other locations indicated on the Drawings.
  2. Screened gravel shall consist of hard, durable, rounded or subangular particles of proper size and gradation and shall be free from sand, loam, clay, excess fines and deleterious materials. The material shall conform to the gradation requirements provided by the Florida Department of Transportation (FDOT) for No. 57 Stone. Filter fabric in accordance

with FDOT Index 199 between the subgrade soils and the gravel/stone shall be required. Screened gravel or crushed stone shall be compacted by mechanical means and vibratory action during construction. The gravel shall be graded within the following limits:

| <u>Sieve Size</u> | <u>Percent Finer by Weight</u> |
|-------------------|--------------------------------|
| 5/8-in            | 100                            |
| 1/2-in            | 40 - 100                       |
| 3/8-in            | 15 - 45                        |
| No. 10            | 0 - 15                         |

G. Sand:

1. Sand shall conform to ASTM C33 for fine aggregate.

PART 3 EXECUTION

3.01 INSTALLATION

- A. See other parts of the Specifications and Drawings for where these materials should be used.
- B. Sand shall be utilized and placed in areas as shown, as specified, and as may be directed by the Engineer.
- C. Common fill and/or select common fill shall be used and placed in areas as shown, as specified, and as may be directed by the Engineer.

END OF SECTION

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SECTION 02276  
TEMPORARY EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall design, provide, maintain and remove temporary erosion and sedimentation controls as necessary.
- B. Temporary erosion controls may include, but are not limited to, mulching, netting, and watering, on site surfaces and spoil and borrow are surfaces and providing interceptor ditches at ends of berms and at those locations which will ensure that erosion during construction will be either eliminated or maintained within acceptable limits as established by Owner.
- C. Temporary sedimentation controls include, but are not limited to, silt dams, traps, barriers and appurtenances at the foot of sloped surfaces which will ensure that sedimentation pollution will be either eliminated or maintained within acceptable limits as established by Owner.
- D. Contractor shall provide effective temporary erosion and sediment control measures during construction or until final controls become effective.

1.02 SUBMITTALS

- A. Submit schedule for temporary erosion and sedimentation control.

PART 2 PRODUCTS

2.01 EROSION CONTROL

- A. Seeding and mulching, fertilization and watering shall be in accordance with Section 570-1 through 570-3 of the FDOT Specifications.
- B. Netting: Fabricated of material acceptable to Owner or Engineer.

2.02 SEDIMENTATION CONTROL

- A. Bales: Clean, seed free cereal hay type.
- B. Netting: Fabricated of material acceptable to Owner or Engineer.
- C. Filter Stone: Crushed stone conforming to FDOT Specifications.

PART 3 EXECUTION

3.01 EROSION CONTROL

- A. Seeding shall be in accordance with Section 570-4 through 570-5 of the FDOT Specifications. The Contractor shall insure that all seeded areas have sustained growth prior to acceptance.
- B. Mulching shall be in accordance with Section 570-4.6 of the FDOT Specifications.

C. Minimum procedures for mulching and netting are:

1. Apply mulch loosely to a thickness of between 0.75 inches and 1.5 inches.
2. Apply netting over mulched areas on sloped surfaces.

3.02 SEDIMENTATION CONTROL

- A. Install and maintain silt dams, traps and barriers as shown on the approved schedule. Hay bales which deteriorate and filter stone which is lodged shall be replaced as required.

3.03 PERFORMANCE

- A. Should any of the temporary erosion and sediment control measures employed by the Contractor fail to produce results which comply with the requirements of Owner, Contractor shall immediately take whatever steps are necessary to correct the deficiency at his own expense.

END OF SECTION

SECTION 02500  
SURFACE RESTORATION

PART 1 GENERAL

1.01 THE REQUIREMENT

- A. Items specified in this Section include repairs to landscaped and grassed areas that may be damaged or disturbed by Contractor activities.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02210 - Site Grading

1.03 SUBMITTALS

- A. The Contractor shall submit submittals for review in accordance with the Section 01300 - Submittals.

1.04 DEFINITIONS

- A. The phrase "DOT Specifications" shall refer to the Florida Department of Transportation Standard Specifications for Road and Bridge Construction. The DOT Specifications are referred to herein and are hereby made a part of this Contract to the extent of such references, and shall be as binding upon the Contract as though reproduced herein in their entirety.

1.05 PROTECTION OF EXISTING IMPROVEMENTS

- A. The Contractor shall be responsible for the protection of all pavements and other improvements within the work area. All damage to such improvements, as a result of the Contractor's operations, beyond the limits of the work of pavement replacement shall be repaired by the Contractor at his expense.

1.06 GUARANTEE

- A. The Contractor shall guarantee all trees, ground cover or shrubs planted or replanted under this Contract for a period of one year beyond acceptance of the project. In the event that any new tree, plant or shrub dies within the guarantee period, the Contractor shall be responsible for replacement in kind. In the event that a transplanted (reused) tree dies within the guarantee period, the Contractor shall be responsible for replacement in kind, except that the maximum height of any new tree shall be eight feet as measured from the ground surface, once planted, to the top of the tree.

PART 2 PRODUCTS

2.01 REPLACEMENT TREES, GROUND COVER AND SHRUBS

- A. Replacement trees, ground cover and shrubs shall be of the same type and size and sound, healthy and vigorous, well branched and densely foliated when in leaf. They shall have healthy, well developed root systems and shall be free of disease and insect pests, eggs or larvae.

## 2.02 MULCH

- A. Mulch shall be windproof shredded eucalyptus. Mulch shall be clean, fresh, free of branches and other foreign matter. Mulch shall be used around all shrubs, ground covers and tree trunks, and placed to a minimum depth of 2 inches extending from the tree trunk outward two feet.

## 2.03 GRAVEL BEDS

- A. Filter Fabric: Filter fabric shall be nonwoven polyester material Trevia Type 1120 as manufactured by Hoechst Fibers Industries, or equal. Fabric weight shall be 6 ounces per square yard, puncture strength maximum 40 pounds, minimum Flux 240 gallons per minute per square foot. Fabric shall be installed in accordance with the manufacturer's recommendations, with precautions taken to avoid tearing the fabric. Fabric shall be laid in strips with a minimum overlap of one foot.
- B. Limerock: Limerock shall meet ASTM A57 standards and shall be prewashed. Maximum size shall be 3/4 inches. Limerock shall be carefully placed and spread on the fabric to a minimum depth of 6 inches. Final grades and locations shall be as designated on the Drawings.

## PART 3 EXECUTION

### 3.01 GRADING AND SODDING

- A. The Contractor shall regrade the work areas disturbed by his construction activities to the existing grade prior to commencement of construction.
- B. Sod shall be placed on all grassed areas disturbed by construction activities, unless otherwise indicated on the Drawings. Sodding shall be in accordance with Sections 575 and 981 of the DOT Specifications.
- C. Maintenance: Sufficient watering shall be done by the Contractor to maintain adequate moisture for optimum development of the sodded areas. Sodded areas shall receive no less than 1.5 inches of water per week.
- D. Repairs to Lawn Areas Disturbed by Contractor's Operations: Lawn areas damaged by Contractor's operations shall be repaired at once by proper sod bed preparation, fertilization and resodding, in accordance with these specifications. Regardless of the condition of the lawn area (weed content etc.) prior to the Contractor working in the area, all repairs shall be made with sod.

### 3.02 TREES, GROUND COVER AND SHRUBS

- A. Excavation and Plant Holes: Plant hole excavations shall be roughly cylindrical in shape, with the side approximately vertical. Plants shall be centered in the hole. Bottoms of the holes shall be loosened at least six inches deeper than the required depth of excavation.
- B. Holes for balled and burlaped plants shall be large enough to allow at least eight inches of backfill around the earth ball. For root balls over 18 inches in diameter, this dimension shall be increased to 12 inches. Where excess material has been excavated from the plant hole, the excavated material shall be disposed of as and where directed by the Engineer.

- C. **Setting of Plants:** When lowered into the hole, the plant shall rest on a prepared hole bottom such that the roots are level with, or slightly above, the level of their previous growth and so oriented such as to present the best appearance. The Contractor, when setting plants in holes, shall make allowances for any anticipated settling of plants.
- D. **Palms of the sabal species** may be set deeper than the depth of their original growth, provided that the specified clear trunk height is attained.
- E. The backfill shall be made with planting mixture and shall be firmly rodded and watered-in, so that no air pockets remain. The quantity of water applied immediately upon planting shall be sufficient to thoroughly moisten all of the backfilled earth. Plants shall be kept in a moistened condition for the duration of the Contract.
- F. **Staking and Guying:** Plants shall be staked in accordance with the following provisions:
  - 1. **Small Trees:** For trees and shrubs of less than one-inch caliper, the size of stakes and the method of tying shall be such as to rigidly support the staked plant against damage caused by wind action or other effects. Trees larger than one inch and smaller than one and one-half inch caliper shall be staked with a two-inch stake, set at least 24 inches in the ground and extending to the crown of the plant. The plant shall be firmly fastened to the stake with two strands of 14 gauge soft wire, enclosed in rubber hose, or other approved covering. The wire shall then be nailed or stapled to the stake to prevent slippage.
  - 2. **Medium Trees:** All trees, other than palm trees, larger than one and one-half inch caliper and smaller than two and one-half inch caliper shall be staked with two or more, two-inch by two-inch stakes, eight feet long, set two feet in the ground. The tree shall be midway between the stakes and held firmly in place by two strands of 12-gauge wire, applied as specified above for single stakes. The wires shall be tightened and kept tight by twisting.
  - 3. **Large Trees:** All trees, other than palm trees, larger than two and one-half inch caliper, shall be braced with three or more two-inch by four-inch wood braces, toenailed to cleats which are securely banded at two points to the palm, at a point at least six feet above the ground. The trunk shall be padded with five layers of burlap under the cleats. Braces shall be approximately equidistantly spaced and secured underground with two-inch by four-inch by 24-inch stake pads. In firm rock soils, Number 4 steel reinforcing rods or one-half inch pipe is acceptable.
  - 4. **Palm Trees:** Palm trees shall be braced with three or more two-inch by four-inch wood braces, toenailed to cleats which are securely banded at two points to the palm, at a point at least six feet above the ground. The trunk shall be padded with five layers of burlap under the cleats. Braces shall be approximately equidistantly spaced and secured underground with two-inch by four-inch by 24-inch stake pads. In firm rock soils, Number 4 steel reinforcing rods or one-half inch pipe is acceptable.
- G. **Pruning:** All broken or damaged roots shall be cut off smoothly, and the tops of all trees shall be pruned in a manner complying with standard horticultural practice. At the time pruning is completed, all remaining wood shall be alive. All cut surfaces of one inch or more in diameter, above the ground, shall be treated with an approved commercial tree paint.
- H. **Maintenance:** Maintenance shall begin immediately after each plant is planted and shall continue until all work under this Contract has been completed and accepted by Owner. Plants

shall be watered, mulched, weeded, pruned, sprayed, fertilized, cultivated and otherwise maintained and protected. Settled plants shall be reset to proper grade position, planting saucer restored and dead material removed. Guys shall be tightened and repaired.

- I. Defective work shall be corrected as soon as possible after it becomes apparent. Upon completion of planting, the Contractor shall remove excess soil and debris, and repair any damage to structures, etc., resulting from planting operations.

### 3.03 GRAVEL BEDS

- A. Clean, grade and place geotextile prior to placing gravel in gravel beds.

END OF SECTION

SECTION 02605  
PRECAST CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install precast concrete structures, access hatches, rungs and appurtenances all as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Excavation and backfill is included in Section 02222.
- B. Screened gravel bedding is included in Section 02230.
- C. Cast-in-place concrete is included in Section 03300.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings showing details of construction, reinforcing, joints, pipe connection to structure, access hatches and rungs.
- B. Submit for review, structural calculations and drawings for all precast structures.
- C. Concrete design mix data and concrete test cylinder reports from an approved concrete testing laboratory certifying that the concrete used in the precast structures conforms with the strength requirements specified herein.

1.04 REFERENCE STANDARDS

- A. ASTM International
  - 1. ASTM A48 - Standard Specification for Gray Iron Castings
  - 2. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  - 3. ASTM C150 - Standard Specification for Portland Cement.
  - 4. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
  - 5. ASTM D4101 - Standard Specification for Polypropylene Plastic Injection and Extrusion Materials.
- B. American Concrete Institute (ACI)
  - 1. ACI 318 - Building Code Requirement for Structural Concrete.
- C. American Association of State Highway and Transportation Officials (AASHTO)

- D. Occupational Safety and Health Administration (OSHA)
- E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

- A. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by the Engineer, or other representative of the Owner. Such inspection may be made at the place of manufacture, or on the work after delivery, or at both places and the materials shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein; even though samples may have been accepted as satisfactory at the place of manufacture. Material rejected after delivery to the job shall be marked for identification and shall be removed from the job at once. All materials which have been damaged after delivery will be rejected, and if already installed, shall be acceptably repaired, if permitted, or removed and replaced, entirely at the Contractor's expense.
- B. At the time of inspection, the materials will be carefully examined for compliance with the ASTM standard specified below and this Section and with the approved manufacturer's drawings. All precast structure sections shall be inspected for general appearance, dimension, "scratch-strength", blisters, cracks, roughness, soundness, etc. The surface shall be dense and close-textured.
- C. Imperfections in precast structure sections may be repaired, subject to the approval of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at 7 days and 5,000 psi at 28 days, when tested in 3-in by 6-in cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs subject to the approval of the Engineer.

### PART 2 PRODUCTS

#### 2.01 PRECAST CONCRETE STRUCTURES (SODIUM HYPOCHLORITE AND SODIUM HYDROXIDE INJECTION POINT VAULT)

- A. The precast reinforced concrete structures shall be manufactured by Hanson Pipe & Precast, Inc.; Forterra Pipe and Precast or equal. The inside dimensions, headroom requirements and minimum thickness of concrete (if applicable) shall be as indicated on the Drawings.
- B. Structural design calculations and Drawings shall be prepared and stamped by a professional engineer registered in the State of Florida.
- C. All precast concrete shall have a minimum compressive strength of 5000 psi at 28 days. Water shall be kept to a minimum to obtain concrete which is as dense and watertight as possible. The maximum water-to-cement ratio shall be 0.40 by weight and the minimum cement content shall be 600 lbs of cement per cubic yard of concrete. The above ratios shall be revised for sacks of cement weighing different from 94 pounds per sack.
- D. Design Criteria
  - 1. All precast concrete members shall conform to ACI 318.

2. When the design yield strength "fy" for tension reinforcement exceeds 40,000 psi, the "z" values referred to in ACI 318 shall not exceed 95 kips/in. The flexural stress in reinforcement under service loads "fs" shall be calculated and shall not be greater than 50 percent of the specified yield strength fy.
  3. The precast concrete structure's elements shall be designed to support their own weight, the weight of soil above at 120 pcf and shall be capable of withstanding a live load equal to a 300 psf applied to the top slab.
  4. The base slab and walls shall be cast together to form a monolithic base section.
  5. All exterior walls shall be designed for an equivalent fluid pressure of 90 lbs/sq ft. The top of the pressure diagram shall be assumed to originate at finished ground level.
  6. The structural design shall take into account discontinuities in the structure produced by openings and joints in the structure.
  7. The structures shall be designed to prevent flotation without the benefit of skin friction when the ground water level is at finished ground surface. Flotation forces shall be resisted by the dead load of the structure and soil directly above the anti-flotation collar of the structure. Weight of equipment and piping within the structure and soil frictional forces shall not be considered as being effective in resisting flotation forces.
  8. All walls and slabs shall be analyzed by accepted engineering principles. Openings shall be completely framed as required to carry the full design loads to support walls. All slabs and walls shall be fully reinforced on both faces and the minimum reinforcing shall be No. 5 at 12-in E.F.E.W. Additional reinforcing shall be provided around all openings.
  9. The horizontal wall joints shall not be located within 18-in of the horizontal centerline of wall penetrations.
- E. The structure shall be built by the manufacturer in no more than three major sections including the top slab if required.
- F. Where top slabs are used or required, lifting hooks shall be provided.
- G. As required, access openings and pipe penetrations shall be formed openings and located as shown on the Drawings.

## 2.02 JOINTING PRECAST STRUCTURE SECTIONS

- A. Tongue and groove joints of precast structure sections shall be sealed with either a round rubber O-ring gasket or a preformed flexible joint sealant. The O-ring shall conform to ASTM C443. The preformed flexible joint sealant shall be Kent Seal No. 2 by Hamilton-Kent; Ram-Nek by K.T. Snyder Company or equal.
- B. Joints shall be designed and manufactured so that the completed joint will withstand an internal water pressure of 15 psi without leakage or displacement of the gasket or sealant.

## 2.03 PRECAST STRUCTURE RUNGS

- A. Precast Structure rungs shall be either of the following types:
1. Precast Structure rungs shall be of cast aluminum alloy 6061-T6, drop front design, 12-in wide with an abrasive step surface. The precast structure rungs shall conform to the requirements of OSHA.
  2. Precast Structure rungs shall be steel reinforced copolymer polypropylene plastic. Rungs shall be 14-in wide, M.A. Industries Type PS2-PF-SL or equal. Copolymer polypropylene shall conform to ASTM D4101, PP0344 B33534 Z02. Steel reinforcing shall be 1/2-in diameter, grade 60 conforming to ASTM A615 and shall be continuous throughout the rung. The portion of the legs to be embedded in the precast section shall have fins and be tapered to insure a secure bond.

## 2.04 ACCESS HATCH(ES)

- A. The precast structures shall be furnished with the necessary aluminum access hatches as shown on the drawings and specified herein, complete with hinged and pad-lockable covers.
- B. The hatches shall be securely mounted above the injection point. Hatches shall be coordinated with the Drawings. Covers shall be aluminum 1/4" diamond pattern plate reinforced on the underside to withstand a 300 psf load with a maximum deflection of 1/150<sup>th</sup> of the span. Channel frame shall be 1/4" aluminum with full anchor flange around the perimeter.
- C. Covers shall be equipped with heavy stainless steel hinges with stainless steel pins and shall pivot so cover does not protrude into the channel frame. Hinges shall be through bolted to the cover and frame with tamper proof stainless steel lock bolts. Covers shall be equipped with compression springs enclosed in telescopic tubes. Upper tube shall be the outer tube to prevent accumulation of moisture, grit and debris inside the tube assembly. Lower tube shall interlock with a flanged support shoe fastened to a formed 1/4" gusset support plate.
- D. Covers shall be fitted with the required number and size of compression springs operators to afford ease of operation through the entire arc of opening and to act as a check in retarding downward motion when being closed. Covers shall be equipped with a hold-open arm that automatically locks the cover in the open position. A conveniently located handle shall release the cover for closing.
- E. A stainless steel snap lock with fixed turn handle shall be mounted on the underside of the cover. A removable exterior latch handle shall be provided, and the latch release shall be protected by flush, gasketed, removable screw type of plug. Cover shall have a lift handle that is designed to be flushed with the walking surface when not in use. Hardware shall be 316 stainless steel - including tubes, springs, lifting, mechanism supports and tube caps, support shoes, hold-open arms, hinges hinge pins, safety chains snap lock and lock strike. Hold-open arm guide shall be manufactured of aluminum or stainless steel.
- F. Factory finish shall be mill finish aluminum with bituminous coating applied to exterior of frame that will be in contact with concrete.
- G. Hatches shall be U.S. Foundry Corporation, Bilco Company, Halliday Products Company or approved equal.

## 2.05 PIPE OPENING SEALS FOR PRECAST STRUCTURES

- A. The opening for the pipe in the Precast Structures shall be sealed with non-shrink waterproof grout, Hallemite; Waterplug; Embeco or equal, after the pipe has been successfully installed and inspected by the Owner's representative.

## 2.06 DAMPPROOFING

- A. Dampproofing shall be applied to all portions of the precast structure which are in contact with soil from the top of the footings up to 6-inches below finished grade. Carry dampproofing over exposed top and outside edge of footing or anti-flotation collar.
- B. Brushed dampproofing shall be an asphalt emulsion reinforced with fibers conforming to ASTM D1227, Type II, Class 1. The dampproofing shall be Hydrocide 700B by Sonneborn Building Products, Division of ChemRex Inc., Minneapolis, MN; Karnak 220 Asphalt Emulsion by Karnak Corporation, Clark, NJ or equal.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Precast Structure Installation
  - 1. Precast Structure shall be constructed to the dimensions shown on the Drawings and as specified herein. All work shall be protected against flooding and flotation.
  - 2. The bases of precast structures shall be placed on a bed of 4-inch flowable fill as shown on the Drawings.
  - 3. Holes in the precast structure sections required for handling or other purposes shall be plugged with a non-shrinking grout or non-shrinking grout in combination with concrete plugs and finished flush on the inside.
  - 4. Where holes must be cut in the precast sections to accommodate pipes, cutting shall be done prior to setting precast structure sections in place to prevent any subsequent jarring which may loosen the mortar joints.
- B. Dampproofing
  - 1. Outer surfaces of precast structures shall dampproofed at the rate of 30 to 35 sq ft per gallon as directed by the Engineer and in accordance with manufacturer's instructions.

### 3.02 LEAKAGE TESTS

- A. Leakage Tests for Precast Structures
  - 1. The Engineer will visually inspect structure(s) for possible leaks before backfilling of structures is allowed. All joints shall be sealed to the satisfaction of the Engineer.

3.03 CLEANING

- A. All new precast structures shall be thoroughly cleaned of all silt, debris and foreign matter of any kind, prior to final inspection.

END OF SECTION

SECTION 02616  
DUCTILE IRON PIPE AND FITTINGS (BELOW GRADE)

PART 1 GENERAL

1.01 POTABLE WATER PIPING

- A. All below grade ductile iron pipe, fittings, gaskets, nuts, bolts, interior and exterior lining/coating, marking, locate wire, testing and all other required appurtenances shall be as specified in the JEA Water and Wastewater Standards (January 2019 or latest), Potable Water Piping – Section 350.

END OF SECTION

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SECTION 02622  
POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

PART 1 GENERAL

1.01 POLYVINYL CHLORIDE (PVC) PIPING

- A. All below grade PVC pipe and fittings shall be as specified in JEA Water and Wastewater Standards (January 2019 or latest), Potable Water Piping – Section 350.

END OF SECTION

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SECTION 02626  
DOUBLE WALL CHEMICAL PIPE SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install and test, buried double walled plastic chemical pipe system as well as the above grade plastic chemical pipe system as shown on the Drawings and as specified herein.
- B. Pipe system refers to all primary carrier and containment pipe, fittings, material and appurtenances required to construct the chemical pipe complete, in place.

1.02 RELATED WORK

- A. Testing of pipe is included in Section 01445.
- B. Granular bedding materials are included in Section 02230.
- C. Pavement repair and resurfacing are included in Section 02500.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data including the following:
  - 1. Shop drawings including piping layouts and schedules shall be submitted to the Engineer and shall include dimensioning, fittings, types and locations of valves and appurtenances, joint details, methods and locations of supports, anchorage, grade of material and all other pertinent technical information for all items to be furnished.
  - 2. Shop drawing submittals for piping under this Section shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished.

1.04 REFERENCE STANDARDS

- A. ASTM International
  - 1. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds.
  - 2. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
  - 3. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
  - 4. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

- ## 1.05 QUALITY ASSURANCE

- ## 1.06 SYSTEM DESCRIPTION

- |   |                                   |
|---|-----------------------------------|
| 1. System:                              | Sodium Hypochlorite               |
| Carrier Pipe and Fittings               | Schedule 80 PVC Pipe and Fittings |
| Material:                               | Schedule 80 PVC Pipe and Fittings |
| Containment Pipe and Fittings Material: | Schedule 80 PVC Pipe and Fittings |
| Pressure:                               | Atmosphere to 100 psig            |
| Flow Velocity:                          | Up to 7 fps                       |
| Temperature:                            | 35 to 100 degrees F               |
| Special Conditions:                     | Pulsation from diaphragm pumps    |

## 1.07 DELIVERY, STORAGE AND HANDLING

- ## Double Wall Chemical Pipe System

- C. Pipe and fittings shall be stored in a manner that will keep them at ambient outdoor temperatures and out of sunlight. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings that allows temperature buildup or direct or indirect sunlight will not be permitted.
- D. Any pipe or fitting showing a crack, or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. All buried chemical piping, fittings, and valves shall be a prefabricated double wall containment piping system.
- B. The sodium hypochlorite double wall piping system shall consist of Schedule 80 PVC carrier piping system supported within the Schedule 80 PVC secondary containment housing. Above grade carrier piping at the sodium hypochlorite system shall be Schedule 80 PVC. Above grade PVC piping shall be painted per Specification Section 09902.

### 2.02 MATERIALS

#### A. Primary Carrier Pipe and Fittings

- 1. The PVC primary carrier pipe and fittings shall be manufactured from PVC compounds meeting ASTM D1784, Class 12454-B.
- 2. The pipe shall be manufactured in accordance with ASTM D1785, PVC 1120. The pipe shall have a minimum hydrostatic design stress of 2000 psi at 73 degrees F and shall be suitable for field cutting and solvent welding. Pipe shall be Schedule 80.
- 3. The burst pressure of fittings shall be not less than the burst pressure of the size and thickness of the pipe with which it is to be used in accordance with ASTM D2467.

#### B. Secondary Containment Pipe and Fittings

- 1. The PVC secondary containment pipe and fittings shall be manufactured from PVC compounds meeting ASTM D1784, Class 12454-B.
- 2. The pipe shall be manufactured in accordance with ASTM D1785, PVC 1120. The pipe shall have a minimum hydrostatic design stress of 2000 psi at 73 degrees F and shall be suitable for field cutting and solvent welding. Pipe shall be of the sizes indicated above and shall be Schedule 80.
- 3. The burst pressure of fittings shall be not less than the burst pressure of the size and thickness of the pipe with which it is to be used in accordance with ASTM D2467.
- 4. Containment pipe size shall be based on the size of the primary carrier pipe as follows:

| Carrier Pipe | Containment Pipe |
|--------------|------------------|
|--------------|------------------|

| Diameter | Diameter |
|----------|----------|
| 3/4-in   | 3-in     |

- C. Double wall containment fittings shall be prefabricated. Splitting and rewelding of fittings and two piece gasketed fittings will not be accepted.
- D. Interstitial supporting devices used to center and support the primary piping and fittings within the secondary containment piping and fittings shall be PVC and shall be installed prior to delivery of the pipe and fittings. The spacers shall be designed to permit the carrier and containment pipes to expand and contract without stress or wear on the pipes as well as provide for drainage and free air circulation.
- E. Solvent cement for PVC piping shall be as specified in ASTM D2564. For sodium hypochlorite piping PVC cement shall be silica-free, such as Lo-V.O.C. PVC Heavy Duty Gray - Industrial Grade, by Oatey Corp., Cleveland OH or Weld-On CPVC-724 Grey by IPS Corp., Compton, CA or equal.
- F. The double walled chemical piping system shall be Guardian as manufactured by IPEX USA, LLC, New Baltimore, MI, or equal by Asahi-America or approved equal.

## 2.03 PAINTING

- A. All above grade or non-buried PVC piping shall be painted in the field per Section 09902.

## PART 3 EXECUTION

### 3.01 INSTALLATION OF DOUBLE WALLED CHEMICAL PIPE SYSTEM

- A. Double walled chemical pipe systems shall be installed in accordance with the manufacturer's technical data, printed instructions and field instruction. All installers shall be trained and qualified to the ASME B31.3 solvent welder training program.
- B. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.
- C. As soon as the excavation is complete to normal grade of the bottom of the trench, screened gravel bedding shall be placed, compacted and graded to provide firm, uniform and continuous support for the pipe. The pipe shall be laid accurately to the lines and grades indicated on the Drawings. Blocking under the pipe will not be permitted. Screened gravel shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to force the screened gravel under the haunches of the pipe to give firm continuous support for the pipe. Screened gravel shall then be placed to 12-in above the top of the pipe. The initial 3-ft of backfill above the screened gravel backfill shall be placed in 1-ft layers and carefully compacted. Generally, the compaction shall be done evenly on each side of the pipe and compaction equipment shall not be operated directly over the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe. Equipment used in compaction of the initial 3-ft of backfill shall be approved by the pipe manufacturer's representative prior to use.

- D. All piping shall be sound and clean before installation. When installation is not in progress, including lunchtime, the open ends of the double walled chemical pipe systems shall be closed by watertight plug or other approved means. Good alignment shall be preserved during installation.
- E. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe.
- F. Joints for PVC pipe shall be solvent welded. In making solvent welded connections, clean dirt and moisture from the pipe, bevel pipe ends slightly with emery cloth to remove any shoulder or burrs created by the cutting of the pipe. Solvent welded joints shall be made in accordance with ASTM D2855. Primer shall be used whenever recommended by the pipe manufacturer and in all cases for joints on the pipe systems 4-in in diameter or larger.
- G. Precautions shall be taken to prevent flotation of the pipe in the trench.
- H. Where plastic pipe passes through wall sleeves, the space between the pipe and sleeve shall be sealed with a mechanical sealing element.
- I. The entire length of buried chemical piping systems shall slope to the piping gallery terminal points to allow any chemical leaks to be detected. At the terminal points, the containment piping shall extend through the building wall a distance of at least 2-in. The terminal ends of the pipe shall be equipped with end seals consisting of a bulkhead plate of the same material as the containment pipe, solvent welded to the containment and carrier pipes. As a means of checking for and draining chemical leaks in the pipes, end seals shall be equipped with drain and vent openings with ball valves located diametrically opposite on the vertical centerline of the plate.

### 3.02 FIELD TESTING

- A. All pipelines shall remain undisturbed for the minimum curing time specified for each type of pipe material but no less than 24 hours to develop full curing and complete strength at all joints. Primary carrier pipe systems shall be flushed clean and then subjected to a hydrostatic pressure test for 4 hours at 200 psi. The system pressure shall be maintained to within 5 psi of the test pressure over the entire duration of the test.
- B. After testing of the carrier pipe, the containment system shall be tested pneumatically at 5 psi for 2-hour duration prior to backfilling. All containment piping joints shall be checked for leaks by applying a soapy solution to the joints. Furnish all necessary equipment and labor to perform the air test, including air compressor, gauges, conduit caps, temporary pipe and connections, etc. and complete the test to the satisfaction of the Engineer.
- C. After backfilling is completed, a 5 psig air test of the containment pipe shall be conducted to the satisfaction of the Engineer.
- D. All leaks detected during the pressure test shall be repaired and the pressure/temperature test rerun.
- E. Prior to testing, the pipelines shall be supported in an approved manner to prevent movement during the tests.

END OF SECTION

SECTION 02630  
STORM SEWERS AND STRUCTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Storm sewer systems as specified in this Section and as shown on the Drawings.

1.02 REFERENCES

- A. General: As specified in Section titled Reference Standards.
- B. ASTM Standards
  - 1. ASTM A615 Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
  - 2. ASTM C76 Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
  - 3. ASTM C91 Specification for Masonry Cement
  - 4. ASTM C144 Specification for Aggregate for Masonry Mortar.
  - 5. ASTM C150 Specification for Portland Cement
  - 6. ASTM C270 Specification for Mortar for Unit Masonry
  - 7. ASTM D1784 Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
  - 8. ASTM D2729 Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
  - 9. ASTM D3034 Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
  - 10. ASTM D3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
  - 11. ASTM F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
  - 12. ASTM F679 Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

1.03 DEFINITIONS

- A. Pipe sizes and references to pipe diameter on the Drawings and in the Specifications are intended to be nominal size or diameter and shall be interpreted as nominal size or diameter.

#### 1.04 SYSTEM DESCRIPTION

- A. Furnish and install pipe, fittings, and structures required for complete and properly functioning storm sewer systems.

#### 1.05 SUBMITTALS

- A. General as specified in

- 1. Section 01300 entitled "Submittals"
  - 2. This Section

- B. Shop Drawings

- 1. Shop Drawings for pipe, fittings, castings, precast structures, and appurtenances include the information specified in Section 01300 as well as the following in each submittal:
    - a. Specification Section number;
    - b. Catalog data including the following:
      - 1) Specifications
      - 2) Intended Service
      - 3) Illustration in sufficient detail to serve as a guide for evaluation.
    - c. Materials of construction;
    - d. Dimensions;
    - e. Additional information required to evaluate the proposed product's compliance with the Contract Documents.
  - 2. Shop Drawings for storm sewer systems layout and installation: include dimensions and elevations in each storm sewer system layout and installation submittal.

- C. Certifications

- 1. Prior to delivery at project site, furnish an Affidavit of Compliance certified by the product manufacturer that the pipe, fittings, castings, and precast structures furnished under this Contract comply with all applicable provisions of applicable referenced standards and these Specifications.

#### 1.06 QUALITY ASSURANCE

- A. Marking

- 1. Mark pipe, fittings, and castings.
  - 2. Markings shall meet the requirements of applicable Standards.

- B. Factory Tests

- 1. Test materials used in the manufacture of the pipe, fittings, castings, and precast structures.
  - 2. Tests shall meet the requirements of applicable Specifications and Standards.

- C. Castings

1. Casting manufacturer shall provide letter of guarantee for a period of 15 years.
2. Upon request of Engineer, manufacturers shall also furnish an independent testing laboratory's report of castings supplied.
3. Frame and cover surfaces shall be machined and any tendency to rattle, as determined by tests before or after installation, will be sufficient cause for rejection of the frame and cover.

#### 1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Contractor shall be responsible for the delivery, storage and handling of products. Load and unload storm sewer materials and appurtenances by hoists or skidding. Do not drop products. Do not skid or roll products on or against other products. Pad slings and hooks in a manner which prevents damage to products.
- B. Deliver pipe, fittings, castings, precast structures, and accessories in a clean and undamaged condition. Store pipe, fittings, castings, and accessories off the ground.
- C. Keep stored products safe from damage or deterioration. Keep the interior of pipe, fittings, castings, and appurtenances free from dirt or foreign matter. Store gaskets, plastic pipe and fittings, and other products which will be deteriorated by sunlight in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products.
- D. Do not stack sewer pipe, fittings, castings, or precast structures.
- E. Promptly remove damaged products from the job site. Replace damaged products with undamaged products.

### PART 2 PRODUCTS

#### 2.01 REINFORCED CONCRETE PIPE

- A. Pipe Standard: ASTM C76, Class III with Wall Type B reinforcement
- B. Pipe Joints
  1. Type: Bell and spigot.
  2. Joint Standard: Rubber gasket joints conforming to Sections 941 and 942 of FDOT Standard Specifications.
- C. Lifting Holes: Do not use lifting holes in circular pipe 30 inches in diameter or less.

#### 2.02 POLYVINYL CHLORIDE (PVC) STORM SEWER PIPE (8 INCHES THROUGH 15 INCHES)

- A. Material Standard: ASTM D1784, Cell Classification 12454-B or 12454-C.
- B. Pipe and Fitting Standard: ASTM D3034
- C. Minimum Wall Thickness: SDR35.

- D. Maximum Pipe Section Length: 12 feet 6 inches
  - E. Joints
    - 1. Type: Bell and spigot with rubber gaskets
    - 2. Joint Standard: ASTM D3212
    - 3. Gasket Standard: ASTM F477
- 2.03 CORRUGATED HIGH-DENSITY POLYETHYLENE (HDPE) STORM SEWER PIPE (12 INCHES THROUGH 60 INCHES)
- A. Material Standard: ASTM D3350, Minimum Cell Classification 435400C
  - B. Pipe and Fitting Standard: CLASS I, AASHTO M294
  - C. Corrugations: Annular.
  - D. Maximum Pipe Section Length: 20 feet
  - E. Joints
    - 1. Type: Bell and spigot with rubber gaskets
    - 2. Joint Standard: ASTM D3212
    - 3. Gasket Standard: ASTM F477
- 2.04 POLYVINYL CHLORIDE (PVC) STORM SEWER PIPE (18 INCHES THROUGH 36 INCHES)
- A. Material Standard: ASTM D1784, Cell Classification 12454-C
  - B. Pipe and Fitting Standard: ASTM F679
  - C. Minimum Wall Thickness: T-1.
  - D. Maximum Pipe Section Length: 12 feet 6 inches
  - E. Joints
    - 1. Type: Bell and spigot with rubber gaskets
    - 2. Joint Standard: ASTM D3212
    - 3. Gasket Standard: ASTM F477
- 2.05 POLYVINYL CHLORIDE (PVC) PERFORATED DRAIN PIPE
- A. Material Standard: ASTM D1784, Cell Classification 12454-B.

B. Pipe and Fitting Standard: ASTM D2729.

C. Joints

1. Type: Bell and spigot with rubber gaskets
2. Joint Standard: ASTM D3212
3. Gasket Standard: ASTM F477.

## 2.06 PRECAST CONCRETE STRUCTURES

- A. Precast concrete storm water drainage structures and precast concrete storm sewer structures shall conform to City of Jacksonville Standard Specifications and Details.
- B. Precast concrete storm water drainage structures and precast concrete storm sewer structures shall be as manufactured by U.S. Precast Corp., Miami, Florida, or equal.
- C. Precast concrete storm water drainage structure size and precast concrete storm sewer structure size shall be as indicated on the Drawings.

## 2.07 MORTAR FOR STORM SEWER STRUCTURES

- A. Standard: ASTM C270.
- B. Mortar Type: Portland cement/hydrated lime mixture or Portland cement mixture with masonry cement added for improved workability; use same materials throughout the project.
- C. Mortar Materials
  1. Proportioning: By volume.
  2. Mix
    - a. One-part Type II Portland Cement (ASTM C150).
    - b. Three parts aggregate (sand) (ASTM C144).
  3. Masonry Cement: Addition of masonry cement (ASTM C91 will be permitted to improve workability of mortar.

## 2.08 REINFORCING BARS

- A. Standard: ASTM A615.
- B. Placement: Lapped and placed in accordance with ACI requirements and specifications.

## 2.09 CASTINGS

- A. Castings shall conform to City of Jacksonville Standard Specifications and Details.
- B. Manufacturers
  1. USF

- 2. Neenah
- 3. or equal casting by U.S. manufacturer.
- C. Standard: ASTM Specifications for Class 30 Grey Iron.
- D. Molds: Closed molds with controlled sand.
- E. Casting Quality: Free from blow holes and porosity, well cleaned, with fine and sharp edges ground smooth.
- F. Finish: Machined bearing surfaces to prevent rattling under traffic.
- G. Lettering: Cast "Storm Sewer" on covers.
- H. Matching Square and Rectangular Frames and Covers: Square and rectangular frames, covers and grates shall be individually fitted as sets and installed as sets.

### PART 3 EXECUTION

#### 3.01 LAYING PIPE

- A. Complete trenching and backfilling as specified. Inspect sewers when line is completed and backfill has been placed to a depth of one foot over the pipe. Complete backfill only after approval of each section has been given for line and grade.
- B. Remove and relay faulty sections of line rejected by Engineer.
- C. Center pipe so installed storm sewer has a uniform invert.
- D. Keep pipe joints clean at all times and use no pipe in the work which does not conform to Specifications.
- E. Place a suitable stopper in the end of pipe last laid at all times when pipe-laying operations are not in process (including lunch hours). Stoppers shall prevent water, mud or other foreign materials from entering the pipe.
- F. Ensure all construction conforms to Section 430 of FDOT Standard Specifications.

#### 3.02 JOINTING PIPE

- A. Joint pipe by rubber gasket O-ring joints installed in accordance with recommendations of pipe manufacturer.
- B. Corrugated metal pipe joints shall consist of bolted galvanized metal connecting band installed with neoprene gasket.
- C. Joints shall be designed to limit movement due to expansion, contraction and normal settlement.

3.03 CATCH BASINS, STORM SEWER MANHOLES AND CONCRETE HEADWALLS

- A. Construct junction boxes, storm sewer manholes, and concrete headwalls at location and to depth indicated on Drawings and in accordance with details shown on the Drawings.
- B. Excavate and backfill in accordance with applicable sections of Specifications.
- C. Concrete for the catch basins, storm sewer manholes and concrete headwalls, shall develop a compressive strength of 3000 psi in 28 days.
- D. Seal joints between walls and incoming and outgoing pipes with Portland cement mortar to form a watertight joint.
- E. Cut off pipes with junction boxes, storm sewer manholes, and concrete headwalls flush with the face of the structure. Grout cut or broken ends of pipes with Portland cement mortar to a smooth uniform covering with no steel exposed.
- F. Structures shall conform to Sections 400, 415 and 425 of FDOT Standard Specifications.
- G. Construct grated inlets and junction boxes to elevations and dimensions shown on the Drawings. Include any reasonable adjustment and realignment of the grate necessary, or installation on inlet grates. Secure frames in mortar struck smooth inside and out.

3.04 CLEANING

- A. Clean dirt and debris from the interior of storm sewers and structures.

3.05 MANUFACTURERS' REPRESENTATIVE

- A. Provide services of pipe and precast structure manufacturers' representative as required to obtain correct pipe installation, jointing, connections to structures, and connections to existing piping systems.
- B. Provide assistance of pipe and precast structure manufacturers' representatives at no additional cost to Owner.

END OF SECTION

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SECTION 02640  
VALVES (BELOW GRADE), HYDRANTS AND APPURTENANCES

PART 1 GENERAL

1.01 VALVES, HYDRANTS AND APPURTENANCES

- A. Valves (below grade), hydrants and appurtenances shall be as specified in the JEA Water and Wastewater Standards (January 2019 or latest), Water Meters, Valves and Appurtenances – Section 351.

END OF SECTION

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SECTION 02668  
CONNECTIONS TO AND WORK ON THE EXISTING SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials and equipment required and maintain flow in existing drains, handle existing drain flow, construct and maintain all temporary connections and bypasses and construct the permanent connections to the new system as shown on the Drawings and as directed by the Engineer.
- B. Furnish all labor, materials, equipment required and plug existing pipes if required, all work on existing manholes (including all work and materials required to reshape existing manhole inverts with brick or concrete and connecting new drain pipes to existing manholes) and all additional work required.
- C. Should damage of any kind occur to the existing pipes, at the Contractor's own expense and as part of the work under this Item, make repairs to the satisfaction of the Engineer.
- D. Notify the Engineer immediately of any discrepancies in elevations of existing drains and manholes between those shown on the Drawings and those established during construction in order that the Engineer can make the necessary modifications.
- E. All work on existing system and utilities must comply with permits

1.02 RELATED WORK

- A. Excavation and backfill are included in Division 2.
- B. Concrete manholes are specified Section 427 of JEA's Water and Wastewater Standards Manual, January 2019 or latest edition.
- C. Concrete is specified in Division 3.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 HANDLING WASTEWATER FLOWS

- A. Furnish all labor, equipment and materials necessary to maintain existing flows, including temporary bypasses and all pumping of drainage that may be required to prevent backing up of drains and shall immediately cart away and remove all offensive matter at Contractor's own expense.
- B. Permission will not be given to overflow, bypass, pump or by any other means convey drainage to any brook, or other water course without permission of the Engineer.

- C. All procedures for maintaining flows must meet the approval of the Engineer and submit to the Engineer, for approval, a detailed written plan of all methods of flow maintenance 10 days in advance of flow interruption.

### 3.02 MAINTAINING WATER SERVICE

- A. The Contractor shall provide all labor, equipment, and materials necessary to maintain existing service connections, including temporary bypasses and all disinfection testing that may be required to bacteriologically clear any temporary piping and shall provide assurances that repairs for interruption of service from the temporary service are available 24 hours a day/7 days a week.
- B. All procedures for maintaining service must meet the approval of the Engineer and the Owner. The Contractor shall be required to submit to the Engineer, for approval, a detailed written plan of all methods of flow maintenance ten days in advance of flow interruption.

END OF SECTION

SECTION 02830  
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 CHAIN LINK FENCES

- A. Fencing and gates shall be as specified in the JEA Water and Wastewater Standards (January 2019 or latest Edition), Fencing – Section 492.
- B. Fencing shall match existing fence.

END OF SECTION

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SECTION 02932  
SODDING AND SEEDING

PART 1 GENERAL

1.01 SODDING

- A. Grassing and Sodding shall be as specified in the JEA Water and Wastewater Standards (January 2019 or latest), Grassing – Section 441.
- B. The Contractor shall sod all disturbed areas.

1.02 SEEDING

- A. Seeding shall be as specified in the JEA Water and Wastewater Standards (January 2019 or latest), Grassing – Section 441.

END OF SECTION

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SECTION 03301  
CONCRETE AND REINFORCING STEEL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all concrete work complete as shown on the Drawings and as specified herein.
- B. Furnish, as required to establish concrete mixes, all sampling and laboratory testing of products and materials performed by an independent testing laboratory engaged by and at the expense of the Contractor. Provide field sampling, testing, inspection and related laboratory tests.

1.02 RELATED WORK

- A. Grout is included in Section 03600.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data for:
  - 1. Placing drawings and bar bending details in conformity with the recommendations of ACI 315.
  - 2. Sources of cement, fly ash, aggregates, and batched concrete. Indicate name and address of mill or quarry, as applicable.
  - 3. Air-entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
  - 4. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
  - 5. Sheet curing material. Product data including catalogue cut, technical data and conformity to ASTM standard.
  - 6. Material Safety Data Sheets (MSDS) for all concrete components and admixtures.
  - 7. Cold weather and hot weather concreting plans demonstrating how concrete will meet the requirements of this Section including but not limited to concrete mixes, placement, curing and protection.
  - 8. Liquid membrane forming curing compound. Product data including catalogue cut, technical data, storage requirements, product life, application rate and conformity to ASTM standards. Identify proposed locations of use.
- B. Test Reports

1. Aggregates: Conformance to ASTM standards, including sieve analysis, mechanical properties, deleterious substance content, and mortar bar expansion test results.
2. Cement and fly ash Conformance to ASTM standards, including chemical analysis and physical tests.
3. Concrete mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, air content, concrete slump, type and manufacturer of cement and type and manufacturer of fly ash or ground granulated blast furnace slag. Provide either Paragraph a. or b., below, for each mix proposed.
  - a. Standard deviation data for each proposed concrete mix based on statistical records.
  - b. Provide the following for each strength data point used in the calculation of the standard deviation for determination of the minimum required average strength:
    - 1) Date of sampling and name of testing laboratory.
    - 2) Name of concrete batch plant.
    - 3) Water cementitious ratio.
    - 4) Slump of batch.
    - 5) Air content of batch.
    - 6) Compressive strengths of all cylinders tested at that age in that batch.
    - 7) If available, temperature and unit weight of batch.
    - 8) Provide data from projects not more strictly controlled than outlined in these specifications. Provide summary sheet showing all pertinent data and the computation of the standard deviation.
  - c. Water cementitious ratio curve for concrete mixes based on laboratory tests. Provide average cylinder strength test results at 7, 14, and 28 days for laboratory concrete mix designs.

#### C. Certifications

1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.
2. Certificate of conformance for concrete production facilities from NRMCA.
3. Certify that the Contractor is not associated with the independent testing laboratory proposed for use by the Contractor nor does the Contractor or officers of the Contractor's organization have a beneficial interest in the laboratory.
4. Certify that cement is produced by a manufacturer that does not use hazardous waste derived fuel as an energy source for its kilns.

#### D. Qualifications

1. Independent Testing Laboratory
  - a. Name and address
  - b. Names and positions of principal officers and the name, position, and qualifications of the responsible registered professional engineer in charge.
  - c. Listing of technical services to be provided. Indicate external technical services to be provided by other organizations.
  - d. Names and qualifications of the supervising laboratory technicians.

- e. Statement of conformance provided by evaluation authority defined in ASTM C1077. Provide report prepared by evaluation authority when requested by the Engineer.
- f. Submit as required above for other organizations that will provide external technical services.

#### 1.04 REFERENCE STANDARDS

##### A. ASTM International

1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
3. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
4. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
5. ASTM C33 - Standard Specification for Concrete Aggregates.
6. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
7. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
8. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete
9. ASTM C150 - Standard Specification for Portland Cement
10. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
11. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
12. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
13. ASTM C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for use in Portland Cement Concrete.
14. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
15. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Portland Cement Concrete.

##### B. American Concrete Institute (ACI).

1. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.

2. ACI 232.2R - Use of Fly Ash in Concrete
  3. ACI 301 - Specification for Structural Concrete.
  4. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
  5. ACI 305R - Hot Weather Concreting.
  6. ACI 306R - Cold Weather Concreting.
  7. ACI 315 - Details and Detailing of Concrete Reinforcement.
  8. ACI 318 - Building Code Requirements for Structural Concrete.
- C. Concrete Reinforcing Steel Institute (CRSI)
1. MSP - Manual of Standard Practice
- D. National Ready Mixed Concrete Association (NRMCA)
1. Quality Control Manual, Section 3- Certification of Ready Mixed Concrete Production Facilities
- E. Truck Mixer Manufacturers Bureau (TMMB)
1. TMMB 100 - Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards.
- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- 1.05 QUALITY ASSURANCE
- A. Comply with ACI 318, and other stated specifications, codes and standards. Apply the most stringent requirements of stated specifications, codes, standards, and this Section when conflicts exist.
  - B. Independent testing laboratory shall meet the requirements of ASTM E329 and ASTM C1077 and be acceptable to the Engineer. Laboratories affiliated with the Contractor or in which the Contractor or officers of the Contractor's organization have a beneficial interest are not acceptable.
  - C. Use only one source of cement and aggregates for the project. Provide concrete uniform in color and appearance.
  - D. If, during the progress of the work, the materials from the sources originally accepted change in characteristics, make, at no additional cost to the Owner, new acceptance tests of materials and establish new concrete mixes with the assistance of an independent testing laboratory.
  - E. Provide all field testing and inspection services and related laboratory tests. Methods of testing shall comply with the latest applicable ASTM methods. The following items shall be tested to verify conformity with this Section.

1. Concrete placements - compressive strength (cylinders), compressive strength (cores), temperature, slump, and air content.
  2. Other materials that may require field testing.
- F. Develop concrete mixes and their testing by an independent testing laboratory engaged by and at the expense of the Contractor. Methods of testing shall comply with the latest applicable ASTM methods.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Ship and store reinforcing steel with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same designations as those shown on the submitted placement drawings. Provide reinforcing steel free from mill scale, loose rust, mud, dirt, grease, oil, ice or other foreign matter. Store off the ground, protect from moisture and keep free from rust, mud, dirt, grease, oil, ice or other injurious contaminants.
- B. Store products in conformity with the manufacturer's recommendations.
- C. Cement: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination and to prevent warehouse set.
- D. Aggregate: Arrange and use stockpiles to prevent segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding three feet in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.
- E. Sand: Arrange and use stockpiles to prevent contamination. Allow sand to drain to a uniform moisture content before using. Do not use frozen or partially frozen sand.
- F. Admixtures: Store in closed containers to prevent contamination, evaporation or damage. Provide agitating equipment to uniformly disperse ingredients in admixture solutions which tend to separate. Protect liquid admixtures from freezing and other temperature changes which could adversely affect their characteristics.
- G. Fly Ash or Ground Granulated Blast Furnace Slag: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination
- H. Sheet Curing Materials: Store in weathertight buildings or off the ground and under cover.
- I. Liquid Membrane Forming Curing Compounds: Store in closed containers.

### PART 2 PRODUCTS

#### 2.01 GENERAL

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

- B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.
- C. Materials shall comply with this Section and any applicable State or local requirements.

## 2.02 MATERIALS

- A. Cement: Domestic portland cement conforming to ASTM C150. Do not use air entraining cements. Do not use cement produced by a manufacturer that uses hazardous waste derived fuel as an energy source for its kilns. Cement brand must be approved by the Engineer and one brand shall be used throughout the work. Provide the following type(s) of cement:
  - 1. Type I or II with the addition of fly ash or ground granulated blast furnace slag resulting in C3A being below 8 percent of total cementitious content, Type II, Type II (MH) or Type III limited to 8 percent C3A.
- B. Fine Aggregate: Washed inert natural sand conforming to ASTM C33.
- C. Coarse Aggregate: Well-graded crushed stone or washed gravel conforming to ASTM C33, size 57. Limits of deleterious substances and physical property requirements as listed in ASTM C33, Table 3 for severe weathering regions.
- D. Water: Potable water free of oil, acid, alkali, salts, chlorides, (except those attributable to drinking water) organic matter, or other deleterious substances.
- E. Admixtures: Use admixtures free of chlorides and alkalis (except for those attributable to drinking water). The admixtures shall be from the same manufacturer when it is required to use more than one admixture in the same concrete mix. Use admixtures compatible with the concrete mix including other admixtures.
  - 1. Air Entraining Admixture: Conforming to ASTM C260. Proportion and mix in accordance with manufacturer's recommendations.
  - 2. Water Reducing Admixture: Conforming to ASTM C494, Type A. Proportion and mix in accordance with manufacturer's recommendations.
  - 3. Do not use admixtures causing retarded or accelerated setting of concrete without written approval from the Engineer. Use retarding or accelerating water reducing admixtures when so approved.
- F. Fly Ash: Class F fly ash complying with ASTM C618, including the requirements of Table 1 but with the Loss of Ignition (LOI) limited to 3 percent maximum and the optional physical requirements of Table 3.
- G. Sheet Curing Materials: Waterproof paper, polyethylene film or white burlap-polyethylene sheeting, all conforming to ASTM C171.
- H. Liquid Membrane-Forming Curing Compound. Compound conforming to ASTM C309, Type 1-D (clear or translucent with fugitive dye) and containing no wax, paraffin, or oil. Curing compounds shall be non-yellowing and have a unit moisture loss no greater than 0.039 gm/cm<sup>2</sup>

at 72 hours as measured by ASTM C156. Curing compound shall comply with Federal, State and local VOC limits.

- I. Deformed Concrete Reinforcing Bars: ASTM A615, Grade 60 deformed bars.
- J. Welded Steel Wire Fabric: Conforming to ASTM A185.
- K. Reinforcing Steel Accessories
  - 1. Plastic Protected Wire Bar Supports: CRSI Bar Supports, Class 1 - Maximum Protection.
  - 2. Stainless Steel Protected Wire Bar Supports: CRSI Bar Supports, Class 2 - Moderate Protection with legs made wholly from stainless steel wire.
  - 3. Precast Concrete Bar Supports: CRSI Bar Supports, Precast Concrete Bar Supports. Precast concrete blocks that have equal or greater strength than the surrounding concrete.
- L. Tie Wires for reinforcement: 16 gauge or heavier black annealed wire.

## 2.03 MIXES

- A. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce placeable, durable concrete conforming to these Specifications. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing free water to collect on the surface.
- B. Base concrete mixes on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, develop concrete mixes by laboratory tests using the materials proposed for the work.
  - 1. For concrete mixes based on standard deviation data of prior mixes, submit standard deviation data of prior mixes with essentially the same proportions of the same constituents in accordance with ACI 318 and based on the modification factors for standard deviation tests contained in ACI 318.
  - 2. For concrete mixes developed by laboratory testing, base cementitious content of the concrete on curves showing the relation between water cementitious ratio and 7, 14 and 28 day compressive strengths of concrete made using the proposed materials. Determine curves by four or more points, each representing an average value of at least three test specimens and one water-cementitious ratio at each age. Provide curves with a range of values sufficient to yield the desired data, including the compressive strengths specified, without extrapolation. The cementitious content of the concrete mixes to be used, as determined from the curve, shall correspond to the required average compressive strength in Table 5.3.2.2 of ACI 318. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content specified in Table 1.
- C. Test the fly ash and concrete mixture to provide test data confirming that the fly ash or ground granulated blast furnace slag in combination with the cement to be used meets all strength requirements and is compatible with the other concrete additives.

- D. Compression Tests: Provide testing of the proposed concrete mix or mixes to demonstrate compliance with the compression strength requirements in conformity with the provisions of ACI 318.
- E. Entrained air, as measured by ASTM C231, shall be as shown in Table 1.
- F. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1.
- G. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of the other admixture(s).

TABLE 1

| Class | Design<br>Strength<br>1 | Cement<br>2 | Fine<br>Aggregate<br>3 | Coarse<br>Aggregate<br>3 | Cementitious<br>Content<br>4 |                          |
|-------|-------------------------|-------------|------------------------|--------------------------|------------------------------|--------------------------|
| A     | 2500                    | Type II     | Sand                   | 57 (9)                   | 440                          |                          |
| B     | 3000                    | Type II     | Sand                   | 57                       | 480                          |                          |
| E2    | 4500                    | Type II     | Sand                   | 57                       | 580                          |                          |
| Class | W/C<br>Ratio<br>5       | SCM<br>6    | AE<br>Range<br>7       | WR<br>8                  | HRWR<br>9                    | Slump<br>Range<br>Inches |
| A     | 0.62 max.               | Yes         | 3.5 to 5               | Yes                      | No                           | 1-4                      |
| B     | 0.54 max.               | Yes         | 3.5 to 5               | Yes                      | No                           | 1-3                      |
| E2    | 0.42 max.               | Yes         | 3.5 to 5               | Yes                      | No                           | 3-5                      |

TABLE 1 NOTES:

1. Minimum compressive strength in psi at 28 days
2. ASTM designation in ASTM C150
3. Size Number in ASTM C33
4. Minimum cementitious content in lbs per cubic yard (where fly ash or ground granulated blast furnace slag is used cementitious content is defined as cement content plus fly ash or ground granulated blast furnace slag content)
5. W/C is Maximum Water Cementitious ratio by weight
6. Supplementary Cementitious Material (SCM) fly ash content in the range of 20-25 percent of the total cement content plus fly ash content, by weight. If ground granulated blast furnace slag is used in lieu of fly ash, the content of ground granulated blast furnace slag shall be in the range of 25-45 percent of the total cement plus ground granulated blast furnace slag content, by weight
7. AE is percent air entrainment
8. WR is water reducing admixture
9. HRWR is high-range water-reducing admixture

## 2.04 MEASURING, BATCHING, MIXING AND TRANSPORTING CONCRETE

- A. Measure, batch, mix and transport concrete in conformance with ASTM C94 and the requirements herein or as otherwise approved in writing by the Engineer.
- B. Ready-mixed concrete, whether produced by a concrete supplier or the Contractor shall conform to the requirements above. Do not hand mix.
- C. Dispense admixtures into the batch in conformity with the recommendations of the admixture manufacturer.
- D. Mix concrete until there is uniform distribution of the materials and discharge completely before the mixer is recharged. The mixer shall be rotated at a speed recommended by the mixer manufacturer and mixing shall be continued for at least 1-1/2 minutes after all the materials are in the mixer. Place concrete within 1-1/2 hours of the time at which water was first added, otherwise it will be rejected. Concrete which has been remixed or rettempered, or to which an excess amount of water has been added, will also be rejected.
- E. Furnish a delivery ticket for ready mixed concrete to the Engineer as each truck arrives. Provide a printed record of the weight of cement and each aggregate as batched individually on each ticket. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Indicate for each batch the weight of fine and coarse aggregate, cement, fly ash or ground granulated blast furnace slag, and water, moisture content of fine and coarse aggregate at time of batching, and types, brand and quantity of each admixture, the quantity of concrete delivered, the time any water is added and the amount, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of transit mix truck.
- F. Temperature and Mixing Time Control
  1. In cold weather (see Paragraph 3.07D) maintain the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms as indicated in Table 3.
  2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.
  3. In hot weather (see Paragraph 3.07E), cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. Well-crushed ice may be substituted for all or part of the mixing water.
  4. The maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed the values shown in the following TABLE 2:

TABLE 2  
AIR OR CONCRETE TEMPERATURE (WHICHEVER IS HIGHER)

|  | MAXIMUM TIME |
|--|--------------|
| (27 Degree C) 80 Degree F to 90 Degree F (32 Degree C) | 45 minutes   |
| (21 Degree C) 70 Degree F to 79 Degree F (26 Degree C) | 60 minutes   |
| (5 Degree C) 40 Degree F to 69 Degree F (20 Degree C)  | 90 minutes   |

## 2.05 FORMS

- A. Provide forms free from roughness and imperfections, watertight and braced and tied to prevent motion when concrete is placed. Wooden spreaders will not be allowed in the concrete.
- B. Wire ties will not be allowed. Metal ties or anchorages which are necessary within the forms shall be so constructed that the metal work can be removed for a depth of at least 1-1/2-in from the concrete surface without damage by spalling. Clean forms before using and treat with form release agent, or other approved material.
- C. All exposed edges of the finished concrete shall be chamfered 3/4-in.

## PART 3 EXECUTION

### 3.01 CONSTRUCTION JOINTS

- A. Locate construction joints where indicated or where approved by the Engineer.
- B. Continue all reinforcing steel through the joint.
- C. At construction joints and at concrete joints indicated to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points and side to side) of 1/4-in with chipping tools to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding. At least two hours before and again shortly before the new concrete is deposited, saturate the joints with water. After glistening water disappears, coat joints with neat cement slurry mixed to the consistency of very heavy paste. The surfaces shall receive a coating at least 1/8-in thick, scrubbed-in by means of stiff bristle brushes. Deposit new concrete before the neat cement dries.

### 3.02 REINFORCING STEEL

- A. Fabricate reinforcing steel accurately to the dimensions shown. Bend bars around a revolving collar having a diameter of not less than that recommended in ACI 318. All bars shall be bent cold.
- B. Provide tension lap splices in compliance with ACI 318. Stagger splices in adjacent bars where possible. Provide Class B tension lap splices at all locations unless otherwise indicated.
- C. Lap splices in welded wire fabric in accordance with the requirements of ACI 318 but not less than 12-in. Tie the spliced fabrics together with wire ties spaced not more than 24-in on center and lace with wire of the same diameter as the welded wire fabric. Offset splices in adjacent widths to prevent continuous splices.
- D. Use precast concrete blocks where the reinforcing steel is to be supported over soil. Use plastic protected bar supports or steel supports with plastic tips where the reinforcing steel is to be supported on forms for a concrete surface that will be exposed to weather, high humidity, or liquid. Use stainless steel supports or plastic tipped metal supports in all other locations unless otherwise noted on the Drawings or specified herein.
- E. Before placing in position, clean reinforcement of loose mill scale and rust, mud, dirt, grease, oil and other coatings, including ice that reduce or destroy bond. When there is a delay in

depositing concrete after the reinforcement is in place, bars shall be reinspected and cleaned again when necessary.

- F. Coat reinforcement which is to be exposed for a considerable length of time after being placed with a heavy coat of cement grout.
- G. Do not cover any reinforcing steel with concrete until the amount and position of the reinforcement has been checked and the Engineer has given permission to proceed.

### 3.03 INSPECTION AND COORDINATION

- A. Batching, mixing, transporting, placing and curing of concrete shall be subject to the inspection of the Engineer at all times. Advise the Engineer of readiness to proceed at least six working hours prior to each concrete placement. The Engineer will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing and the alignment, cleanliness and tightness of formwork. Do not place concrete without the inspection and acceptance of the Engineer.

### 3.04 EMBEDDED ITEMS

- A. Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, anchors, inserts and other items furnished under other Sections and required to be embedded into concrete. Set and secure such items in the locations and alignments needed so they are not displaced by concrete placement.
- B. Clean embedded items free of rust, mud, dirt, grease, oil, ice, or other contaminants which would reduce or prevent bonding with concrete.
- C. Coat or isolate all aluminum embedments to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.
- D. Do not embed piping in concrete unless shown on the Drawings.
- E. Do not embed electrical conduits in concrete unless shown on the Drawings.
- F. Fabricate piping and conduit such that the cutting, bending, or relocation of reinforcing steel is not required. Pipes and conduits embedded within a slab or wall (other than those merely passing through) shall satisfy the following, unless otherwise shown on the Drawings or approved:
  - 1. Maximum outside dimension of pipe or conduit shall not be greater than one third the overall thickness of the slab or wall.
  - 2. Spacing of pipes or conduits shall be greater than or equal to three diameters or widths on center.
- G. Close open ends of piping, conduits, and sleeves embedded in concrete with caps or plugs prior to placing concrete.
- H. Ensure all specified tests and inspections on embedded piping are completed and satisfactory before starting concrete placement. Ensure all mechanical or electrical tests and inspections are

completed and satisfactory prior to starting concrete placement. Do not place concrete until unsatisfactory items and conditions have been corrected.

- I. Position embedded anchor bolts using templates.
- J. Check location, alignment, and support of anchor bolts, piping, electrical conduits, and other items which will be fully or partially embedded in concrete before depositing concrete. Correct mislocated and misaligned items and secure items which have become loose before depositing concrete.
- K. Correct all embedded items not installed in the location or alignment needed or displaced by concrete placement at no additional cost to the Owner.

### 3.05 CONCRETE APPEARANCE

- A. Remix concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. If this does not correct the condition, the concrete shall be rejected.
- B. Provide concrete having a homogeneous structure which, when hardened, will have the specified strength, durability and appearance. Provide mixtures and workmanship such that concrete surfaces, when exposed, will require no finishing except as specified herein.

### 3.06 PLACING AND COMPACTING

- A. Do not place concrete until forms, condition of subgrade and method of placement have been approved by the Engineer. Remove all debris, foreign matter, dirt, ice and standing water from the forms before depositing concrete. Do not place concrete on frozen subgrade, snow or ice. The contact surface between concrete previously placed and new concrete shall be cleaned and brushed with cement paste. Concrete, except as indicated on the Drawings, shall not be placed in water or submerged within 24 hours after placing, nor shall running water be permitted to flow over the surface of fresh concrete within 4 days after its placing.
- B. Deposit concrete as near its final position as possible to prevent segregation due to rehandling or flowing. Pumping of concrete will be permitted when an approved design mix and aggregate sizes suitable for pumping are used. Do not deposit concrete which has partially hardened or which has been contaminated by foreign materials. If the section cannot be placed continuously, place construction joints as specified or as approved. Place concrete for walls using tremie tubes in 12-in to 24-in lifts, keeping the surface horizontal. Do not drop concrete more than 4-ft.
- C. Use high frequency mechanical vibrators to obtain proper consolidation of the concrete. Do not use vibrators to move or transport concrete in the forms. Do not over-vibrate so as to segregate. Continue vibration until the frequency returns to normal, trapped air ceases to rise and the surface appears liquefied, flattened and glistening. Use spades, rods or forks so that concrete is completely worked around reinforcement, embedded items, pipe stubs, and openings and into corners of forms.

### 3.07 CURING AND PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.

- B. Cure all concrete in conformance with ACI 301. Concrete that is to be used for the containment of water shall be water cured. Water curing shall be by ponding, by continuous sprinkling or by covering with continuously saturated burlap. Other concrete shall be cured by either water curing, sheet material curing or liquid membrane curing compound except that liquid membrane curing compound shall not be used on any concrete surface where additional concrete is to be placed or where the concrete surface is to be coated or painted.
- C. Protect finished surfaces and slabs from the direct rays of the sun to prevent checking and crazing.
- D. During cold weather concrete shall be batched, delivered, placed, cured and protected in compliance with the recommendations of ACI 306R. Do not use salt, manure or other chemicals for cold weather protection.
- E. During hot weather concrete shall be batched, delivered, placed, cured and protected in compliance with the recommendations of ACI 305R. The temperature of the concrete shall be such that it will cause no difficulties from loss of slump, flash set or cold joints. Immediately cover plastic concrete with sheet curing material during hot weather.

### 3.08 FIELD TESTS

- A. Take field control cylinder specimens during the progress of the work, in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than one set per day, nor less than one set for each 100 cu yds of concrete nor less than one set for each 5,000 sq ft of surface area for slabs or walls. Specimens shall be formed in 6-in diameter by 12-in long non-absorbent cylindrical molds.
  - 1. A "set" of test cylinders shall consist of four cylinders: one to be tested at seven days and two to be tested and their strengths averaged at 28 days. The fourth may be used for a special test at 3 days or to verify strength after 28 days if 28-day test results are low.
  - 2. When the average 28-day compressive strength of the cylinders in any set falls below the required compressive strength or below proportional minimum seven-day strengths (where proper relation between seven and 28-day strengths have been established by tests), change proportions, cementitious content, or temperature conditions to achieve the required strengths at no additional cost to the Owner.
- B. Provide four firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold ten specimens, complete with cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication until shipment to the testing lab. Protect the specimens against injury or loss through construction operations. Furnish material and labor required for the purpose of taking concrete cylinder samples. All shipping of specimens will be paid for by the Owner.
- C. Test slump immediately prior to placing the concrete. Test shall be made in accordance with ASTM C143. When concrete is pumped, slump will be determined at point of truck discharge. If the slump is outside the specified range, the concrete will be rejected.
- D. Test for air content shall be conducted on a fresh concrete sample. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with

ASTM C173. If aggregates with high absorptions are used, the latter test method shall be used. When concrete is pumped, air content will be determined at point of placement.

### 3.09 STRIPPING AND FINISHING CONCRETE

- A. Do not remove forms before the concrete has attained a strength of at least 30 percent of the specified design strength nor before reaching approximately "100 day-degrees" of moist curing (whichever is the longer). Degree-days are defined as the total number of 24-hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g., 7 days at an average 50 degrees F = 350 degree-days).
- B. Exercise care to prevent damaging edges or obliterating the lines of chamfers, rustications or corners when removing the forms or doing any other work adjacent thereto.
- C. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete, to the satisfaction of the Engineer.
- D. Immediately after removal of forms remove tie cones and metal portions of ties. Fill holes promptly upon stripping as follows: Moisten the hole with water, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.
- E. Defective concrete and honeycombed areas: Chip down square and at least 1-in deep to sound concrete with hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded in the parent concrete. If honeycomb exists around reinforcement, chip to provide a clear space at least 3/8-in wide all around the steel. For areas less than 1-1/2-in deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require build-up in successive 1-1/2-in layers on successive days, each layer being applied (with slurry, etc.) as described above.
- F. Concrete to receive dampproofing and concrete not exposed in the finished work shall have off-form finish with fins and other projections removed and tie cones and defects filled as specified above.
- G. Screed top surface of slabs to the established grades and to a true plane with a tolerance of 1/8-in when checked with a 10-ft straightedge. Pitch surface to drain unless otherwise noted on the Drawings. Finish the surface to give a smooth, hard, even surface free from high or low spots or other defects. Concrete subject to pedestrian traffic shall be given a broom finish. Failure to meet these conditions shall be cause for removal, grinding, or other correction as directed by the Engineer.

### 3.10 FAILURE TO MEET REQUIREMENTS

- A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the Engineer may require changes in proportions or materials, or both, to apply to the remainder of the work in accordance with Paragraph 1.05E. Furthermore, the Engineer may require additional curing on those portions of

the structure represented by the test specimens which fall below the values given in Table 1. The cost of such additional curing shall be at no additional cost to the Owner. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the Owner. In such cases of failure to meet strength requirements the Contractor and Owner shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in C94 is the Contractor.

- B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In cases where tests of cores fall below the values given in Table 1, the Engineer, in addition to other recourses, may require load tests on any one of the slabs in which such concrete was used. Test need not be made until concrete has aged 60 days. The Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. All coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the Owner.
- C. Should the strength of test cylinders fall below 60 percent of the required minimum 28-day strength, the concrete shall be rejected and shall be removed and replaced at no additional cost to the Owner.

### 3.11 SCHEDULE

- A. The following (Table 3) are the general applications for the various concrete design strengths to be used:

| TABLE 3 |                          |  |
|---------|--------------------------|--|
| Class   | Design Strength<br>(psi) | Description  |
| A       | 2,500                    | Concrete fill and electrical raceway encasement                  |
| B       | 3,000                    | Concrete sidewalks and pavements                                 |
| E       | 4,500                    | Pipe supports, slabs on grade, and all other structural concrete |

END OF SECTION

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SECTION 03600  
GROUT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install grout complete as shown on the Drawings and as specified herein.
- B. Perform all sampling and furnish all testing of materials and products by an independent testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor.

1.02 RELATED WORK

- A. Cast-in-place concrete and Reinforcing Steel is included in Section 03301.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of surface preparation, mixing and installation for:
  - 1. Commercially manufactured non-shrink cementitious grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to the specified ASTM standards, and Material Safety Data Sheet.
  - 2. Commercially manufactured non-shrink epoxy grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to the specified ASTM standards, and Material Safety Data Sheet.
  - 3. Cement grout. Include the type and brand of cement, the gradation of fine aggregate, product data on any proposed admixtures and the proposed grout mix.
- B. Samples
  - 1. Submit samples of commercially manufactured grout products when requested by the Engineer.
  - 2. Submit samples of aggregates proposed for use in grout mixes when requested by the Engineer.
- C. Certifications
  - 1. Certify that the Contractor is not associated with the independent testing laboratory, nor does the Contractor or its officers have a beneficial interest in the laboratory.
- D. Qualifications
  - 1. Submit documentation that grout manufacturers have a minimum of 10 years' experience in the production and use of the grouts proposed.

2. Independent Testing Laboratory
  - a. Name and address
  - b. Names and positions of principal officers and the name, position, and qualifications of the responsible registered professional engineer in charge.
  - c. Listing of technical services to be provided. Indicate external technical services to be provided by other organizations.
  - d. Names and qualifications of the supervising laboratory technicians.
  - e. Statement of conformance provided by evaluation authority defined in ASTM C1077. Provide report prepared by evaluation authority when requested by the Engineer.
  - f. Submit as required above for other organizations that will provide external technical services.

#### 1.04 REFERENCE STANDARDS

##### A. ASTM International

1. ASTM C33 - Standard Specification for Concrete Aggregates
2. ASTM C150 - Standard Specification for Portland Cement
3. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts and Monolithic Surfacing and Polymer Concretes
4. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
5. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
6. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
7. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
8. ASTM E329 - Standard specification for agencies engaged in the testing and/or inspection of materials used in construction

- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

##### A. Qualifications

1. Grout manufacturers shall have a minimum of 10 years' experience in the production and use of the type of grout proposed.
2. Independent testing laboratory shall meet the requirements of ASTM E329 and ASTM C1077 and be acceptable to the Engineer. Laboratories affiliated with the Contractor or in

which the Contractor or officers of the Contractor's organization have beneficial interest are not acceptable.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.
- B. Store materials in full compliance with the manufacturer's recommendations. Limit total storage time from date of manufacture to date of installation to six months or the manufacturer's recommended storage time, whichever is less.
- C. Remove immediately from the site material which becomes damp, contains lumps, or is hardened and replace with acceptable material at no additional cost to the Owner.
- D. Deliver non-shrink cementitious grout as a pre-portioned blend in prepackaged mixes requiring only the addition of water.
- E. Deliver non-shrink epoxy grout as a pre-proportioned, prepackaged, three component system requiring only mixing as directed by the manufacturer.

#### 1.07 DEFINITIONS

- A. Non-shrink Grout: A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state and bonds to a clean base plate.

### PART 2 PRODUCTS

#### 2.01 GENERAL

- A. The use of a manufacturer's name and product or catalog number is for the purpose of establishing the standard of quality desired.
- B. Like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

#### 2.02 MATERIALS

- A. Non-shrink Cementitious Grout
  - 1. Non-shrink cementitious grouts: Conform to ASTM C1107. Grouts shall be portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents and require only the addition of water. Non-shrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827.
    - a. General purpose non-shrink cementitious grout: Conform to the standards stated above. SikaGrout 212 by Sika Corp.; Set Grout by BASF Building Systems; NS Grout by The Euclid Chemical Co.; Five Star Grout by Five Star Products, Inc., or equal.
    - b. Flowable (Precision) non-shrink cementitious grout: Conform to the standards stated above. Masterflow 928 by BASF Building Systems; Hi-Flow Grout by The Euclid

Chemical Co.; SikaGrout 212 by Sika Corp.; Five Star Grout by Five Star Products, Inc., or equal.

B. Non-shrink Epoxy Grout

1. Non-shrink epoxy grout: Grout shall be pre-proportioned, prepackaged, three component, 100 percent solids system consisting of epoxy resin, hardener and blended aggregate. It shall have a compressive strength of 10,000 psi in 7 days when tested in conformity with ASTM D695 and have a maximum coefficient of thermal expansion of  $30 \times 10^{-6}$  in/in/degrees F when tested in conformity with ASTM C531. Masterflow 648 CP by BASF Building Systems; Five Star HP Epoxy Grout by Five Stars Products, Inc; Sikadur 42 Grout-Pak by Sika Corp.; E3-G Epoxy Grout by the Euclid Chemical Co. or equal.

C. Cement Grout

1. A mixture of one part portland cement conforming to ASTM C150, Type I, II, or III and one to two parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.

D. Water

1. Potable water free of oil, acid, alkali, salts, chlorides (except those attributable to drinking water), organic matter, or other deleterious substances.

PART 3 EXECUTION

3.01 PREPARATION

- A. Place grout where indicated or specified over existing concrete and cured concrete which has attained its specified design strength unless otherwise approved by the Engineer.
- B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, dust, grease, oil, form release agent, laitance and paints and free of all loose material or foreign matter which may affect the bond or performance of the grout.
- C. Roughen concrete surfaces by chipping, sandblasting, or other dry mechanical means to bond the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.
  1. Air compressors used to clean surfaces in contact with grout shall be the oilless type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.
- D. Remove all loose rust, oil or other deleterious substances which may affect the bond or performance of the grout from metal embedments or bottom of baseplates prior to the installation of the grout.
- E. Wash concrete surfaces clean and then keep moist for at least 24 hours prior to the placement of non-shrink cementitious or cement grout. Saturation may be achieved by covering the concrete

- F. with saturated burlap bags, use of a soaker hose, or flooding the surface. Upon completion of the 24-hour period, remove visible water from the surface prior to grouting.
- G. Non-shrink epoxy grouts do not require saturation of the concrete substrate. Do not wet concrete surfaces to receive non-shrink epoxy grout. Surfaces in contact with epoxy grout shall be completely dry before grouting.
- H. Provide forms for grout. Line or coat forms with release agents recommended by the grout manufacturer. Provide forms anchored in place and shored to resist the forces imposed by the grout and its placement.
  - 1. Forms for all grout other than concrete grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.
- I. Level and align the structural or equipment bearing plates in accordance with the structural requirements or the recommendations of the equipment manufacturer, as applicable.
- J. Support equipment during alignment and installation of grout by shims, wedges, blocks or other approved means. The shims, wedges and blocking devices shall be prevented from bonding to the grout by bond breaking coatings and removed after grouting unless otherwise approved by the Engineer. Grout voids created by the removal of shims, wedges and blocks.

### 3.02 INSTALLATION - GENERAL

- A. Mix, apply and cure products in strict compliance with the manufacturer's recommendations and these specifications.
- B. Provide staffing and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.
- C. Maintain temperatures of the base plate, supporting concrete, and grout between 40 and 90 degrees F during grouting and for at least 24 hours after placement, until grout compressive strength reaches 1000 psi or as recommended by the grout manufacturer, whichever is longer. Do not allow differential heating or cooling of baseplates and grout during the curing period.
- D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 40 to 90 degrees F range.
- E. Install grout to preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or partial contraction joint.
- F. Reflect all existing underlying expansion, partial contraction and construction joints through the grout.

### 3.03 INSTALLATION - NON-SHRINK CEMENTITIOUS GROUTS AND CEMENT GROUTS

- A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel or admixtures without prior approval by the Engineer.

- B. Do not mix by hand. Mix in a mortar mixer with moving blades. Pre-wet the mixer and empty excess water. Add pre-measured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.
- C. Placements greater than 3-in in depth shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added.
- D. Provide forms as specified in Paragraph 3.01H. Place grout into the designated areas and prevent segregation and entrapment of air. Do not vibrate grout to release air or to consolidate the material. Fill all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes and vent holes as necessary.
- E. Place grout rapidly and continuously to avoid cold joints. Do not place grout in layers. Do not add additional water to the mix (retemper) after initial stiffening.
- F. Just before the grout reaches its final set, cut back the grout to the substrate at a 45-degree angle from the lower edge of bearing plate unless otherwise ordered and approved by the Engineer. Finish this surface with a wood float or brush finish.
- G. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement, until grout compressive strength reaches 1000 psi or as recommended by the manufacturer, whichever is longer. Saturate the grout surface by use of saturated burlap bags, soaker hoses or ponding. Provide sunshades. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

#### 3.04 INSTALLATION – NON-SHRINK EPOXY GROUTS

- A. Mix in accordance with manufacturer's recommendations. Mix full batches only, to maintain proper proportions of resin, hardener and aggregate. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not overmix. Do not entrain air bubbles by mixing too quickly.
- B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90 degrees F.
- C. Place grout rapidly and continuously to avoid cold joints. Place grout in lifts in accordance with manufacturer's recommendations.
- D. Provide forms as specified in Paragraph 3.01H. Place grout into the designated areas and prevent entrapment of air. Fill all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes and vent holes as necessary.
- E. Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.
- F. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.

G. Epoxy grouts are self-curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placement, until grout compressive strength reaches 1000 psi or as recommended by the manufacturer, whichever is longer.

H. Provide grout control joints as indicated on the Drawings.

### 3.05 SCHEDULE

A. The following list indicates where the particular types of grout are to be used:

1. General purpose non-shrink cementitious grout: Use at all locations where non-shrink grout is indicated on the Drawings, except for base plates greater in area than 3-ft wide by 3-ft long.
2. Flowable (precision) non-shrink cementitious grout: Use under all base plates greater in area than 3-ft wide by 3-ft long. Use at all locations indicated on the Drawings to receive flowable (precision) non-shrink grout. Flowable (precision), non-shrink, cementitious grout may be substituted for general purpose non-shrink cementitious grout.
3. Non-shrink epoxy grout: Use at all locations specifically indicated on the Drawings to receive non-shrink epoxy grout.
4. Cement grout: Use where indicated on the Drawings.

END OF SECTION

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SECTION 05500  
MISCELLANEOUS METAL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all miscellaneous metal complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Concrete joint accessories are included in Section 03250.
- B. Equipment anchor bolts are included in the respective Sections of Divisions 11, 13, 14 and 15.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:
  - 1. Shop drawings, showing sizes of members, method of assembly, anchorage and connection to other members.
- B. Samples
  - 1. Submit 6-in by 6-in samples of metal grating, illustrating surface finish, color, texture and jointing details.
  - 2. Submit 12-in long samples of guardrail and handrail. Submit 1 samples of elbow, tee, wall bracket, escutcheon, end stop, rail joint connections.
  - 3. Submit samples as requested by the Engineer during the course of construction.
- C. Design Data
  - 1. Submit calculations or test data demonstrating that the railings will resist the loads specified in the Florida Building Code and OSHA at the post spacing provided. Calculations shall be signed and sealed by a professional engineer registered in the State of Florida.
  - 2. Submit calculations demonstrating that all anchors have been designed in accordance with the building code. All anchors into concrete shall be designed in accordance with ACI 318.
  - 3. Submit manufacturer's load and deflection tables for grating.
- D. Certificates
  - 1. Submit certification that the railing system is in compliance with OSHA requirements and the Florida Building Code.
  - 2. Certify that welders have been qualified under AWS, within the previous 12 months, to perform the welds required under this Section.

## 1.04 REFERENCE STANDARDS

### A. Aluminum Association (AA)

1. AA M31C22A41
  - a. M31: Mechanical Finish, Fine Satin.
  - b. C22: Finish, Medium Matte.
  - c. A41: Clear Anodic Coating, Class I.

### B. American Society for Testing and Materials (ASTM)

1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A48 - Standard Specification for Gray Iron Castings.
3. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
4. ASTM A108 - Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.
5. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
6. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
7. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Plate, Sheet, and Strip Pressure Vessels.
8. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
9. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 Psi Tensile Strength.
10. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
11. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
12. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
13. ASTM A536 – Standard Specification for Ductile Iron Castings.
14. ASTM A570 - Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
15. ASTM A1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

16. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
17. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
18. ASTM B429 – Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
19. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
20. ASTM F2329 – Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon Screws, Washers, Nuts, and Special Threaded Fasteners.

C. American Institute of Steel Construction (AISC)

1. Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design.

D. American Welding Society (AWS)

1. AWS D1.1 – Structural Welding Code - Steel.
2. AWS D1.2 – Structural Welding Code - Aluminum.
3. AWS D1.6 – Structural Welding Code - Stainless Steel.

E. Federal Specifications

1. FS-FF-B-575C - Bolts, Hexagonal and Square.

F. Occupational Safety and Health Administration (OSHA)

- G. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. The work of this Section shall be completely coordinated with the work of other Sections. Verify, at the site, both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.
- B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.
- C. All welding shall be performed by qualified welders and shall conform to the applicable AWS welding code. Welding of steel shall conform to AWS D1.1 and welding of aluminum shall conform to AWS D1.2 and welding of stainless steel shall conform to AWS D1.6.

- A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.
- B. Store materials on skids and not on the ground and block up so that they will not become bent or otherwise damaged. Handle materials with cranes or derricks. Do not dump material off cars or trucks nor handle in any other way that will cause damage.
- C. Repair items that have become damage or corroded to the satisfaction of the Engineer prior to incorporating them into the work.

A. Field measurements shall be taken at the site, prior to fabrication of items, to verify or supplement indicated dimensions and to ensure proper fitting of all items.

## 2.01 GENERAL

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.

A. Unless otherwise noted, materials for miscellaneous metals shall conform to the following standards:

- |    |   |   |
|----|---|---|
| 1. | Structural Steel<br>Other shapes; plates; rods and bars: ASTM A36 | Wide flange shapes: ASTM A992   |
| 2. | Structural Steel Tubing   | ASTM A500, Grade B  |
| 3. | Welded and Seamless Steel Pipe                                    | ASTM A501 or ASTM A53, Type E or S, Grade B Schedule 40. Use standard malleable iron fittings, galvanized for exterior work |
| 4. | Steel Sheets  | ASTM A1008  |
| 5. | Gray Iron Castings  | ASTM A48, Class 35  |
| 6. | Ductile Iron Castings   | ASTM A536, Grade 65-45-12   |
| 7. | Aluminum Extruded Pipe  | ASTM B429, Alloy 6063 T6 and Alloy 6061 T6 as indicated   |
| 8. | Aluminum Extruded Shapes  | ASTM B221, Alloy 6061 T6  |

- |   |  |
|---|--|
| 9. Aluminum Sheet and Plate                               | ASTM B209, Alloy 6061 T6   |
| 10. Stainless Steel Plates, Sheets, and Structural Shapes |  |
| a. Exterior, Submerged or Industrial Use                  | ASTM A240, Type 316 (Type 316L for welded)                               |
| b. Interior and Architectural Use                         | ASTM A240, Type 304  |
| 11. Stainless Steel Bolts, Nuts, and Washers              | ASTM A276, Type 316  |
| 12. Carbon Steel Bolts and Studs                          | ASTM A307, Grade A (hot dip galvanized nuts and washers where noted)     |
| 13. High Strength Steel Bolts, Nuts and washers           | ASTM A325 (mechanically galvanized per ASTM B695, Class 50, where noted) |
| a. Elevated Temperature Exposure                          | Type I   |
| b. General Application                                    | Type I or Type II  |
| 14. Galvanizing   | ASTM A123, Zn w/0.05 percent minimum Ni                                  |
| 15. Galvanizing, hardware                                 | ASTM A153, Zn w/0.05 percent minimum Ni                                  |
| 16. Galvanizing, anchor bolts                             | ASTM F2329, Zn w/0.05 percent minimum Ni                                 |
| 17. Welding electrodes, steel                             | AWS A5.1 E70xx   |

## 2.03 ANCHORS, BOLTS AND FASTENING DEVICES

- A. Unless otherwise noted, anchor bolts shall be ASTM F1554, Grade 36. Provide standard headed bolts with heavy hex nuts and Grade A washers. Where galvanized anchor bolts are shown or specified, provide standard headed bolts with heavy hex nuts and Grade A washers, all galvanized in accordance with ASTM F2329.
- B. Unless otherwise noted, bolts for the connection of carbon steel or iron shall be steel machine bolts; bolts for the connection of galvanized steel or iron shall be galvanized steel or stainless steel machine bolts; and bolts for the connection of aluminum or stainless steel shall be stainless steel machine bolts.
- C. All anchors into concrete shall be designed in accordance with ACI 318 Appendix D.
- D. Adhesive anchor system, for fastening to solid concrete substrate, shall be a system manufactured for the installation of post installed studs including anchoring hardware and chemical dispenser. Injection adhesive shall be a two-component epoxy system including a hardener and a resin, furnished in pre-measured side-by-side cartridges which keep the two components separate. Side-by-side cartridges shall be designed to accept a static mixing nozzle which thoroughly blends the two components and allows injection directly into the drilled hole. Provide zinc plated carbon steel or Type 316 stainless steel stud assemblies as indicated on the Drawings consisting of an all-thread anchor rod with nut and washer. Adhesive anchor system shall be Hilti RE 500 SD; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5; or

equal. Unless otherwise noted, anchorage designs shown on the Drawings are based on Hilti RE 500 SD.

- E. Compound masonry expansion anchors shall be lead expansion sleeve type anchors complete with nuts and washers. Anchors shall be precision die-cast zinc alloy with a minimum of two lead alloy expansion sleeves. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least 1-in behind the concrete reinforcing steel. Expansion anchors shall be Star Expansion Industries, Star Slugin or equal.
- F. Adhesive anchors, for fastening to hollow concrete block or brick, or hollow-core precast concrete planks shall be a three-part stud, screen tube and chemical dispenser anchoring system. Adhesive cartridges shall contain pre-measured amounts of resin and hardener which are mixed and deposited in a screen tube by a dispenser. Provide zinc plated carbon steel or Type 316 stainless steel stud assemblies as indicated on the Drawings consisting of an all-thread anchor rod with nut and washer. Anchors shall be Hilti HIT HY-20 System; Rawlplug Company Chem-Fast; ITW Ramset Redhead Ceramic 6 Epcon System, or equal.
- G. Automatic end welded headed anchor studs shall be flux ended studs made from cold drawn steel, ASTM A108 Grades C-1010 through C-1020. Headed anchor studs shall be Nelson, H4L Headed Concrete Anchors or equal.
- H. Machine bolts and nuts shall conform to Federal Specification FF-B-575C. Bolts and nuts shall be hexagon type. Bolts, nuts, screws, washers and related appurtenances shall be Type 316 stainless steel.
- I. Toggle bolts shall be Hilti, Toggler Bolt or equal.

## 2.04 METAL GRATING

- A. Grating shall have rectangular, 3/16-in thick, bearing bars spaced 1-3/16-in on center with cross bars spaced at 4-in on center. All grating panels shall be banded with a bar the same size as the bearing bars.
  - 1. Grating shall be of the same depth shown on the Drawings, not exceed the fabricator's maximum recommended span, and meet or exceed the following load and deflection criteria for the maximum span length at the opening being covered by the grating.
    - a. The grating shall produce a deflection of 1/360 of the span or less under a uniform live load of 100 lbs/sq ft on the maximum span.
    - b. The grating shall produce a deflection of 1/360 of the span or less under a concentrated live load of 300 lbs applied at the mid-point of the maximum span.
  - 2. Openings 2-in or greater in diameter/dimension and grating edges shall be banded with a bar of the same depth and thickness as the bearing bars. Cut bearing bars or cross bars shall be welded to the banding bar.
  - 3. Provide trench grating with symmetrical cross bar arrangement.
  - 4. Grating clamps, nuts, bolts, washers and other fastening devices for grating and grating supports shall be Type 316 stainless steel. Anchor blocks, when used, shall be of the same

material as the grating. All grating shall be anchored to the supporting system using saddle clips.

- B. Aluminum grating material shall be aluminum alloy 6063-T6 with a mill finish. Cross bars shall be attached to the bearing bars with interlocked swaged joints. The grating shall be Type BS by IKG Borden, Houston, TX; Type 19 SG-4 by Ohio Gratings, Inc., Canton, OH; Type 19S4 by Seidelhuber Metal Products, San Carlos, CA or equal.
- C. Steel grating material shall conform to ASTM A570, Grade 36 or ASTM A36, galvanized. Cross bars shall be attached to the bearing bars by welding or with interlocked swaged joints. Grating with cross bars pressed into notches in the top of the bearing bars will not be acceptable. Grating shall be hot-dipped galvanized finish complying with the requirements of ASTM A123; however, the average minimum weight of the zinc coating shall not be less than 2 oz/sq ft.
- D. Metal frames and supports for grating shall be of the same material as the grating unless otherwise shown on the Drawings. Where aluminum supports are used, they shall be fabricated from aluminum alloy 6061-T6.

## 2.05 RAILINGS

- A. Handrail and railing systems shall comply with the requirements of OSHA and the Florida Building Code.
- B. Aluminum railing and handrail shall be a welded or mechanically fastened, seamless, extruded aluminum pipe system. Rails shall be 6063-T6 alloy. Posts shall be 6061-T6 alloy. Splice and reinforcing sleeves, brackets, end caps, toeboards, etc., shall be aluminum alloy 6063-T6 or 6061-T6. Cast fittings shall be aluminum alloy No. 214. Railing system fastening hardware shall be Type 316 stainless steel. Aluminum shall have a mill finish.
- C. Railings shall be 2 rail system, as shown on the Drawings, fabricated with 1-1/2-in nominal diameter pipe. Posts shall be Schedule 80 pipe, minimum and rails and handrail shall be Schedule 40 pipe, minimum. Posts and top rails shall be continuous. Spacing of posts shall not exceed 5-ft on center and shall be uniformly spaced except as otherwise shown on the Drawings. Posts will be required on each side of structure expansion joints. All railing posts shall be vertical.
- D. Welds shall be circumferential welds ground smooth and even to produce a railing that is neat in appearance and structurally sound. Welding methods shall be in conformity with AWS standards for the materials being joined. For welding aluminum, use a weld filler alloy that is compatible with the alloys to be joined, that will not discolor the pieces to be joined and that will not be discolored by anodizing. All rails to post connections shall be coped and fastened by continuous welds. There shall be no burrs, sharp edges or protrusions on any weld on any part of the handrail system. After fabrication, the welds and surrounding area shall be cleaned and hand buffed to blend with the adjacent finish. All mechanical fasteners shall be unobtrusively located in countersunk holes with the top flush with the surface of the rail. Bends in the railing shall be as indicated by the Drawings. No distortion of the circular railing shape will be allowed. Bends and terminal sections shall be made without the use of fittings. Corner bends shall have a 3-in centerline radius.

- E. Railing shall be assembled in sections as long as practical but shall not be greater than 24-ft in length. A field splice shall be used when an assembled section is to be attached to another section.
  - 1. Field splices shall use internal splice sleeves located within 8-in of railing posts. The sleeve shall be welded to the rail on one side and fastened with a set screw to the rail on other side. The field splice shall be detailed to take the differential expansion between the railing system and the supporting structure.
- F. The bases or supports for railing posts and handrail shall be the types indicated on the Drawings.
  - 1. Stainless steel and aluminum railing posts, which may collect condensation, shall have a 3/16-in drain hole drilled immediately above the concrete encased area, the base flange, or supporting socket on the side away from the walking area. The bottom of the rail post between the drain hole and the bottom of the post shall be filled with an inert material such as a compressed closed cell neoprene rod.
  - 2. Where handrail is to be fastened to walls, the rails shall be provided with screwed wall flanges fastened to the walls with three 3/8-in stainless steel flat head machine screws. The horizontal projection of the handrail support off the wall shall provide 2-1/2-in minimum clearance below the bottom of the handrail.
- G. Safety gates, for railing openings, shall be fabricated of matching pipe and rail material and configuration. The gates shall be self-closing gates with approved stop, latch and stainless steel closure spring and hinges.
- H. Barrier chains, for railing openings, shall be fabricated of stainless steel chains. Chain shall be 1/4-in stainless steel links, with eleven links per foot as manufactured by Eastern Chain Works, Inc., NY; Lawrence Metal Products, Inc. or equal. Chains shall be fastened to the handrail posts at the elevation of each rail. One end of each chain shall be connected to one post with a 1/4-in diameter stainless steel eye bolt and the other end shall be connected to the other post by means of a heavy chromium plated bronze swivel eye slide harness snap and a similar eye bolt.
- I. Toeboards shall be provided on all railing adjacent to a drop in elevation of 3-ft or more. Toeboards are not required on the inclined portion of stairway railings or where concrete or steel curbs, 4-in or more in height, are present. Toeboards shall be 4-in high channels or extruded proprietary sections of the same material as the railing. The channels shall have a minimum thickness of 1/8-in and have flanges of not less than 3/4-in nor more than 1-1/2-in in width. Toeboards shall be positioned with a maximum clearance of 1/4-in from the floor and fastened to railing posts with 1/4-in stainless steel U-bolts, with J-bolts at corner posts and with clip angles and two 1/4-in stainless steel expansion bolts at walls.
- J. All railings shall be properly protected by paper, or by an approved coating or by both against scratching, splashes or mortar, paint, or other defacements during transportation and erection and until adjacent work by other trades has been completed. After protective materials are removed, the surfaces shall be made clean and free from stains, marks, or defects of any kind.

## 2.06 LADDERS

- A. Ladders, ladder accessories and ladder clearances shall conform to the requirements of OSHA.

- B. Aluminum ladders shall be fabricated with Schedule 80, 1-1/2-in I.D. continuous extruded aluminum pipe side rails spaced a minimum 18-in apart. Rungs shall be fabricated from extruded aluminum shapes, alloy 6063-T5/T6, with a serrated tread, number A5680 by Washington Aluminum Company or equal spaced 12-in on center. Wall support brackets shall be aluminum 6061-T6 spaced 5-ft on center with Type 316 stainless steel fasteners. Where possible, the side rails shall be fastened to the floor with 1/2-in diameter Type 316 stainless steel expansion bolts.
- C. Ladder cages shall be of aluminum construction by Aluminex, Inc. Model LC-100 or equal.
- D. Provide a rigid fall prevention system at each ladder more than 20 feet high and as indicated on the Drawings.
  - 1. The system shall consist of an aluminum or stainless steel vertical rigid rail, rail extension, stainless steel mounting hardware and fasteners, two non-corrosive metal sliding fall prevention devices, two stainless steel connecting straps, two full body harnesses with “D” rings, accessories and all other materials required for the complete installation and operation of the fall prevention system in accordance with the manufacturer’s recommendations.
  - 2. Provide 36-in minimum height permanent aluminum or stainless steel rail extension compatible with the sliding fall prevention device to ensure worker is attached to the fall prevention system while mounting and dismounting from a platform or landing. Ladder extension may be removable at manholes, hatches, and roof scuttles. Provide stainless steel hardware and fasteners, accessories, and all other materials required for the complete installation to ladders in accordance with the manufacturer’s recommendations.
  - 3. Provide alignment between successive pieces of rail. Provide allowance for expansion and contraction on long runs.
  - 4. In addition to the “D” ring used for attachment to the sliding fall prevention device, the harness shall have at least two “D” rings for the attachment of safety straps and lanyards.
  - 5. The fall prevention system shall be attached to ladders installed under this contract. The sliding fall prevention device shall move freely up and down the rail with the worker in the normal climbing position. The fall prevention system shall stop the fall of a worker independently from offset ladders, platforms or safety cages.
  - 6. Conform to OSHA Regulation 1910.27 for fall prevention system. Rope and cable systems will not be allowed.
  - 7. The fall prevention system shall be Saf-T-Climb by North Safety Products; TS Fall Prevention System by TS Products, Inc.; Glideloc System by Rose Manufacturing Company, or equal.
- E. Ladder safety post extensions shall be provided on all fixed ladders 20 feet or less in height located below hatches and roof scuttles and as indicated on the Drawings. The aluminum telescoping tubular safety post extension shall lock in its vertical position and extend a minimum of 36-in above the opening and shall be secured to the ladder rungs with stainless steel fasteners and brackets. The ladder post extension shall be Ladder UP Safety Post, Model

LU-4 by Bilco Co.; Series L1E Safety Extension by Halliday Products; Pull-up Bar by Access Manufacturing, or equal.

- F. Ladder shields shall be "Ladder Gate" by Siebe Norton, Inc., Cerritos, CA or equal. The bottom of the ladder shield shall be 7-ft above finish grade.
- G. Manhole rungs for cast-in-place concrete work shall be 12-3/4-in wide with a drop front design and a serrated step surface and comply with the requirements of OSHA. Type 316 stainless steel.
- H. Ship ladders shall be of all aluminum construction. Treads shall have abrasive nosing as manufactured by Reliance Steel Products Co.; IKG Industries or equal.

## 2.07 ACCESS HATCHES

- A. Access hatches shall have single or double leaf doors as indicated by the Drawings. The doors shall be 1/4-in aluminum diamond pattern plate with welded stiffeners, as necessary, to withstand a live load of 300 lbs/sq ft with a maximum deflection of 1/150th of the span or AASHTO H20 wheel load if indicated on the plans. Hatches shall have a 1/4-in aluminum channel frame with a perimeter anchor flange or strap anchors for concrete embedment around the perimeter. Unless otherwise noted on the Drawings, use pivot torsion bars for counterbalance or spring operators for easy operation along with automatic door hold open. Hardware shall be durable and corrosion resistant with Type 316 stainless steel hardware used throughout. Provide removable lock handle. Finish shall be the factory mill finish for aluminum doors and frames with bituminous coating on the exterior of the frames in contact with concrete. Hatches shall be watertight and have a 1-1/2-in drainage coupling to the channel frame. Access hatches shall be Types as indicated on the Drawings by Bilco Company, New Haven, CT or equal.
- B. Prefabricated roof scuttles shall be single or double leaf type of the sizes shown on the Drawings or specified. Cover and curb shall be 14-gauge paint bond galvanized steel with a welded 3-in beaded flange. The cover shall have at least 1-in of insulation covered on the inside with a steel liner panel. Curb shall be at least 12-in in height with a flange having holes for bolts to firmly secure scuttle in place. Provide rigid insulation on the exterior of the curb at least 1-in in thickness. The insulation shall be fully covered by metal. The cover and curb perimeters shall be provided with a positive seal and entire scuttle shall be watertight. Supply spring operators for easy opening along with automatic cover hold open. Hardware shall be Type 316 stainless steel. Roof scuttles shall be the Types as indicated on the Drawings by Bilco Company, New Haven, CT or equal.

## 2.08 MISCELLANEOUS ALUMINUM

- A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical.

Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Welding shall be on the unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Provide holes for temporary field connections and for attachment of the work of other trades.

- C. Miscellaneous aluminum items shall include: beams, angles, closure angles, grates, hatches, floor plates, stop plates, stair nosings and any other miscellaneous aluminum called for on the Drawings and not otherwise specified.
- D. Angle frames for hatches, beams, grates, etc., shall be complete with welded strap anchors attached.
- E. Aluminum diamond plate and floor plate shall have a minimum thickness of 3/8-in. Frames and supports shall be of aluminum construction. Fastening devices and hardware shall be Type 316 stainless steel. Plates shall have a mill finish.
- F. Stair treads for aluminum stairs shall have abrasive non-slip nosing as approved.
- G. Aluminum nosing at concrete stairs shall be Wooster Products, Inc.; Alumogrit Treads, Type 116; similar by Barry Pattern and Foundry Co.; Andco or equal. Furnish with wing type anchors and flat head stainless steel machine screws, 12-in on center. Nosing shall also be used at concrete ladder openings. Nosing shall a single piece for each step extending to within 3-in at each side of stair or full ladder width. Set nosing flush with stair tread finish at concrete stairs. Furnish treads with heavy duty protective tape cover.
- H. Aluminum as specified on the design drawings shall be given an anodic oxide treatment in accordance with the AA M31C22A41. Other aluminum items shall have a cleaned and degreased mill finish.

## 2.09 MISCELLANEOUS STEEL

- A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous steel items shall include: beams, angles, lintels, metal stairs, support brackets, base plates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, hold-down straps and lugs, door frames, splice plates, subframing at roof openings and any other miscellaneous steel called for on the Drawings and not otherwise specified.

- D. Structural steel angle and channel door frames shall be galvanized. Frames shall be fabricated with not less than three anchors on each jamb.
- E. Steel pipe pieces for sleeves, lifting attachments and other functions shall be Schedule 40 pipe unless otherwise shown on the Drawings. Wall and floor sleeves, of steel pipe, shall have welded circumferential steel waterstops at mid-length.
- F. Lintels, relief angles or other steel supporting masonry or embedded in masonry shall be galvanized.
- G. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust and foreign matter and shall be given one shop coat of primer compatible with the finish coat after fabrication but before shipment. Paint shall be omitted within 3-in of proposed field welds. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces.
- H. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Coating shall be not less than 2 oz/sq ft of surface.

#### 2.10 MISCELLANEOUS STAINLESS STEEL

- A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous stainless steel items shall include: beams, angles, bar racks and any other miscellaneous stainless steel called for on the Drawings and not otherwise specified.

#### 2.11 CASTINGS

- A. Casting shall be of good quality, strong, tough, even-grained, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Castings shall be thoroughly cleaned and will be subjected to a hammer inspection in the field by the Engineer. All matching surfaces shall be machined to a true plane surface to allow contact surfaces to seat at all points without rocking. Allowances shall be made in the patterns so that the thickness specified shall not be reduced in obtaining finished surfaces. Castings will not be acceptable if the actual weight is less than 95 percent of the theoretical weight computed from dimensions. The Construction Contractor shall provide facilities for weighing castings in the presence of the Engineer.
- B. Frames, covers, cast grates and trench drains for structures shall be gray iron castings except as otherwise specified or indicated on the Drawings. Sizes shall be as shown on the Drawings.

Covers shall have letters "WATER," "SANITARY SEWER," or "DRAIN," as applicable, embossed on top.

- C. Frames and covers for installation in slabs shall be heavy duty, R-6099 Series as manufactured by Neenah Foundry Co., or equal.
- D. Electrical and telephone manhole and handhole frames and covers for structures shall be ductile iron castings. The covers shall be watertight. Covers shall have the word "ELECTRIC," "HIGH VOLTAGE," "LOW VOLTAGE," "SIGNAL," "TELEPHONE," as applicable, embossed on or cast into the top in letters 2-in high. The clear opening shall be 36-in unless otherwise indicated on the Drawings.
- E. Trench drains shall be of the length shown on the Drawings and shall be heavy duty, R-4990 Series with a "Type A" cover as manufactured by Neenah Foundry Co. or equal.

## 2.12 OZONE OFFGAS RELEASE VALVES STAIR AND PLATFORM

- A. Platform and stairs shall be located to provide access to the ozone offgas air release valves as shown in the drawings. The height of the platform shall be approximately 5-feet above the existing top of slab. The exact height of the platform shall be field verified and coordinated with Engineer and Owner. Stair and platform assembly shall be PerfectaStep by SafeRack or equal. All products shall be OSHA-compliant. The steps and platform shall be aluminum with no-slip treading. Stairs and platform shall be provided with powder coated aluminum safety rails

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install all items except those to be embedded in concrete or other masonry which shall be installed under Division 3 and Division 4 respectively. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted.
- B. Abrasions in the shop primer shall be touched up immediately after erection. Areas left unprimed for welding shall be painted with primer after welding.
- C. Zinc coating which has been burned by welding, abraded, or otherwise damaged shall be cleaned and repaired after installation. The damage area shall be thoroughly cleaned by wire brushing and all traces of welding flux and loose or cracked zinc coating removed prior to painting. The cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Military Specifications MIL-P-15145. The paint shall be properly compounded with a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.
- D. Specialty products shall be installed in accordance with the manufacturer's recommendations.
- E. Expansion bolts shall be checked for tightness a minimum of 24 hours after initial installation.
- F. Install adhesive anchor system in strict compliance with the manufacturer's recommendations, including drill bit diameter, surface preparation, temperature, injection and installation of bolts.

Use oil free compressed air to blast out loose particles and dust from the drilled holes. Bolts must be clean and free of dirt, oil, grease, ice or other material which would reduce bond.

- G. Headed anchor studs shall be welded in accordance with manufacturer's recommendations.
- H. All railings shall be erected to line and plumb.
- I. All steel surfaces that come into contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.
- J. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
- K. Where aluminum contacts masonry or concrete, apply a heavy coat of approved alkali resistant paint to the masonry or concrete.
- L. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.
- M. Between aluminum gratings, aluminum stair treads, or aluminum handrail brackets and steel supports, insert 1/4-in thick neoprene isolator pads, 85 plus or minus 5 Shore A durometer, sized for full width and length of bracket or support.
- N. Ozone offgas release valves stair and platform shall be installed in accordance with manufacturer's written instructions.

END OF SECTION

SECTION 09901  
SURFACE PREPARATION AND SHOP PRIME PAINTING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required for the surface preparation and application of shop primers on ferrous metals, excluding stainless steels, as specified herein.

1.02 RELATED WORK

- A. Finish painting is included in Section 09902.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings, manufacturer's specifications and data on the proposed primers and detailed surface preparation, application procedures and dry mil thicknesses.
- B. Submit representative physical samples of the proposed primers, if required by the Engineer.

1.04 REFERENCE STANDARDS

- A. The Society for Protective Coatings (SSPC)
  - 1. SSPC-SP 6/NACE No. 3 - Joint Surface Preparation Standard SSPC-SP 6/NACE No. 3: Commercial Blast Cleaning.
  - 2. SSPC-SP 10/NACE No. 2 - Joint Surface Preparation Standard SSPC-SP 10/NACE No. 2: Near-White Blast Cleaning.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Submerged Surfaces - Shop primer for ferrous metals which will be in contact with water being treated, either submerged or which are subject to splash action or which are specified to be considered submerged service shall be shop primed with the following:
  - 1. Shop Prime Coat: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer)
    - a. TNEMEC: Series 1 Omnithane.
    - b. Carboline: Carboguard 561.
    - c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.
    - d. PPG PMC Durathane MCZ 97-679 Series or PPG PMC Amerlock 400.
    - e. Or equal.

B. Non-Submerged Surfaces: Shop primer for ferrous metals which will not be in contact with water being treated, not submerged and not subject to splash action shall be shop primed with the following:

1. Shop Prime Coat: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer)
  - a. TNEMEC: Series 1 Omnithane.
  - b. Carboline: Carboguard 561.
  - c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.
  - d. PPG PMC Durathane MCZ 97-679 Series or PPG PMC Amercoat 68HS.
  - e. Or equal.

C. Submerged Surfaces:

1. Shop Prime Coat for Ductile Iron Pipe: (Epoxy, Polyamidoamine Shop Primer)
  - a. TNEMEC: Series N140 Pota-Pox-Plus.
  - b. Carboline: Carboguard 561.
  - c. Sherwin-Williams Company (The): Macropoxy 846 NSF Winter Grade Epoxy Mill White.
  - d. PPG PMC Aquapon HB Potable Water Epoxy Coating 95-132 Series or PPG PMC Amerlock 2 Epoxy.
  - e. Or equal.
2. Shop Prime Coat for Ferrous Metal Surfaces: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer)
  - a. TNEMEC: Series 1 Omnithane.
  - b. Carboline: Carboguard 561.
  - c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.
  - d. PPG PMC Durathane MCZ 97-679 Series.
  - e. Or equal.

D. Non-Primed Surfaces - Gears, bearings surfaces and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust-resistant coating. This coating shall be maintained as necessary to prevent corrosion during all periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.

E. Compatibility of Coating Systems - Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with their corresponding primers and finish coats specified in Section 09902 for use in the field and which are recommended for use together.

## PART 3 EXECUTION

### 3.01 APPLICATION

A. Surface Preparation and Priming

1. Non-submerged components scheduled for priming, as defined above, shall be blast cleaned in accordance with SSPC-SP 6/NACE No. 3, immediately prior to priming. Submerged components scheduled for priming, as defined above, shall be blast cleaned in accordance with SSPC-SP 10/NACE No. 2, immediately prior to priming. Consult manufacturer regarding required surface profiles.

2. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.
3. Shop prime in accordance with approved manufacturer's recommendations.

B. Non-Primed Surfaces

1. Apply approved coating per manufacturer's recommendations.

3.02 FABRICATED ITEMS

- A. All items to be shop primed shall be blast cleaned as specified for applicable service prior to priming. If, in the opinion of the Engineer, any prime coating that has been improperly applied or if material contrary to this Section has been used, that coating shall be removed by abrasive blasting to white metal and reprimed in accordance with this Section.
- B. All shop prime coats shall be of the correct materials and applied in accordance with this Section. Remove prime coats not in accordance with this Section by blast cleaning and apply the specified prime coat at no additional cost to the Owner.
- C. Shop primed surfaces shall be cleaned thoroughly and damaged or bare spots prepared as approved and retouched with the specified primer before the application of successive paint coats in the field.
- D. Shop finish coats, if proposed and allowed, shall be equal in appearance and protection quality to a field applied finish coat. If, in the opinion of the Engineer, a shop finish coat system does not give the appearance and protection quality of other work of similar nature, prepare the surfaces and apply the coat or coats of paint as directed by the Engineer to accomplish the desired appearance and protection quality. Submit to the Engineer substantial evidence that the standard finish is compatible with the specified finish coat.
- E. Properly protect the shop prime and finish coats against damage from weather or any other cause.
- F. Wherever fabricated equipment is required to be blast cleaned, protect all motors, drives, bearings, gears, etc., from the entry of grit. Equipment found to contain grit shall be promptly and thoroughly cleaned.

END OF SECTION

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SECTION 09902  
PAINTING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all painting complete as shown on the Drawings and as specified herein.
- B. It is the intent of this Section to paint all exposed structural and miscellaneous steel; chemical tanks and systems; mechanical and electrical equipment; sluice gates, operators and posts; conveying systems, pipe, fittings and valves; electrical conduit and appurtenances; all as specified in the attached painting schedules and all other work obviously required to be painted unless otherwise specified. Minor items not mentioned in the schedule of work shall be included in the work of this Section where they come within the general intent of this Section as stated herein.
- C. Paint items so noted in Paragraph 1.01B and in accordance with the Paint Color Schedule. Provide vinyl film letters and numbers for markings as specified. Items noted in Paint Color Schedule as having factory finish and other factory finished items obviously are not field painted. The Contractor is responsible for having damaged factory finish painted items repaired or, if so ordered, for replacing items. The various Sections are responsible, as stated in each, for preparation and field touch-up of abrasions, welds and damaged primed areas of primed or galvanized components after erection.
- D. The following items will not be painted:
  - 1. Concrete except where specified above and scheduled to be painted and seamless flooring.
  - 2. Finish hardware.
  - 3. Non-ferrous metals and stainless steel, unless specifically noted otherwise.
  - 4. Factory pre-finished architectural components.
  - 5. Packing glands and other adjustable parts and name plates of mechanical equipment.
  - 6. Parts of structures not exposed to sight, unless specifically noted otherwise.
  - 7. Plumbing fixtures.
  - 8. Mechanical, HVAC, Plumbing and Electrical equipment which has been finished painted in the factory as specified in Divisions 11, 13 and 15.

1.02 RELATED WORK

- A. Valve identification is included in Division 15.
- B. Shop priming and surface preparation of equipment and piping (except copper piping) are specified in Section 09901 and included in the respective Section with the item to be primed.

- C. Shop priming of metal substrates with primers is included in Division 5.

#### 1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01300.
- B. Product Data: For each type of product indicated.
- C. Samples: Submit the following for each type of coating system and in each color and gloss of finish coat indicated.
  - 1. Color cards for initial color selections.
  - 2. Three sets of 8-in by 8-in samples, on 1/4-in hardboard, of all colors required for all types of paint. Resubmit until approved.
- D. Product List: For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.

#### 1.04 REFERENCE STANDARDS

- A. Steel Structures Painting Council (SSPC)
  - 1. SSPC SP-1 - Surface Preparation Specification No. 1 Solvent Cleaning.
  - 2. SSPC SP-2 - Surface Preparation Specification No. 2 Hand Tool Cleaning.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste from storage areas daily.

#### 1.06 PROJECT CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

#### 1.07 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Manufacturers: Provide products by one of the following:

1. Tnemec, Inc. (TN).
2. The Sherwin Williams Company (SW).
3. PPG Architectural Finishes, Inc. (PPG).
4. PPG Architectural Finishes, Inc. Ameron (AME).
5. Or equal.

### 2.02 MATERIALS

A. Material Compatibility:

1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. Provide products of same manufacturer for each coat in a coating system.

B. All painting materials shall be delivered to the work site in unbroken packages, bearing the manufacturer's brand and name. They shall be used without adulteration and mixed, thinned and applied in strict accordance with manufacturer's directions for the applicable materials and surface and with the Engineer's approval before using.

C. Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with the finish paints to be used. Refer to Section 09901 for special primers.

D. Work areas will be designated by the Engineer for storage and mixing of all painting materials. Materials shall be in full compliance with the requirements of pertinent codes and fire regulations. Proper containers outside of the buildings shall be provided and used for painting wastes and no plumbing fixture shall be used for this purpose.

E. Colors: As selected by Engineer from manufacturer's full range to match existing color scheme.

### 2.03 COLOR CODING FOR PIPES AND EQUIPMENT

A. The color code establishes, defines and assigns a definite color for each process system. All elements which are an integral part of the system, that is originating from the equipment and/or supplying the equipment, shall be painted between and up to but not including the fixed flanges nor the flexible conduit connections on the equipment. Valves and fittings shall be painted in the color of the main body of the pipe.

- B. All pipes and equipment shall be painted with final coat color selected by the Engineer and shall be treated as an integral part of the Contract.
- C. All hanger saddles and pipe support floor stands shall be painted the same color and with the same paint as the pipe it supports. Hanger rods and hanger rod connections to building structure shall be painted to match the color of the wall or ceiling to which it is attached.

## 2.04 LETTERING OF TITLES

- A. The name of the materials in each pipeline and alongside this an arrow indicating the direction of flow of fluids, shall be indicated on each pipe system. Titles shall not be located more than 26 linear feet apart and shall also appear directly adjacent to each side of any wall the pipeline breaches, adjacent to each side of the valve regulator, flowcheck, strainer cleanout and all pieces of equipment.
- B. Titles shall identify the contents by complete name at least once in each space through which it passes and thereafter by generally recognized abbreviations, letters or numerals as approved. Identification title locations shall be determined by the Engineer but in general they shall be placed where the view is unobstructed and on the two lower quarters of pipe or covering where they are overhead. Title should be clearly visible from operating positions especially those adjacent to control valves.
- C. Numbers and letters shall be die-cut from 3.5 mil vinyl film and pre-spaced on carrier tape. Adhesive and finish surface shall be protected with one piece removable liners. Color shall be white or black as approved depending on substrate color.
- D. Letter size shall be as indicated in the following table:

| OUTSIDE DIAMETER OF<br>PIPE OR COVERING | SIZE OF LEGEND LETTERS |
|---|------------------------|
| 3/4-in to 1-1/4-in                      | 1/2-in                 |
| 1-1/2-in to 2-in                        | 3/4-in                 |
| 2-1/2-in to 6-in                        | 1-1/2-in               |
| 8-in to 10-in                           | 2-1/2-in               |
| Over 10-in                              | 3-in                   |

- E. The system for preparation and application of letters shall be Type B a.s.i/2 by ASI Sign Systems; Architectural Graphics Inc. or equal. Letter type shall be Optima Bold, upper case. Grid 2 spacing shall be employed. Arrow shall match as approved, letter type and size. The instructions of the manufacturer shall be followed in respect to storage, surface preparation and applications of letters.

## 2.05 TITLES FOR EQUIPMENT

- A. Titles shall be provided in vinyl film as specified above on all equipment using 1-in high Optima Bold upper case, Grid 2 spacing, white or black in color as approved depending on substrate. Use titles shown on mechanical drawings for bidding purposes. Titles shall be mounted at eye level on machines where possible or at the upper broadest vertical surface of low equipment. Where more than one piece of the equipment item to be titled exists, the items shall be numbered consecutively as indicated on the mechanical drawings or as directed by the

Engineer; for example, Pump No. 1, Pump No. 2, etc. Titles shall be composed in more than one line if required and justified on the left-hand side as approved.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
  - 1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
    - a. Concrete: 12 percent.
  - 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  - 3. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
  - 4. Coating application indicates acceptance of surfaces and conditions.

### 3.02 PREPARATION

- A. All surfaces to be painted shall be prepared as specified herein and shall be dry and clean before painting. Special care shall be given to thoroughly clean interior concrete surfaces to receive polyamide cured epoxy paint of all marks before application of finish.
- B. All metal welds, blisters, etc., shall be ground and sanded smooth. All pits and dents shall be filled, and all imperfections shall be corrected so as to provide a smooth surface for painting. All rust, loose scale, oil, tar and asphalt bearing coatings, grease and dirt shall be removed by use of approved solvents, wire brushing, grinding or sanding.
- C. Concrete surfaces shall have been finished as specified in Section 03350. Report unsatisfactory surfaces to the Engineer. Concrete shall be left for one-month minimum before painting and shall be free of dust, oil, curing compounds and other foreign matter.
- D. All PVC pipe and other plastic matrix surfaces to be painted shall be sanded to an approved profile and cleaned of residue before painting.
- E. Galvanized, aluminum, and copper surfaces shall have all oxidation and foreign material removed before painting by SSPC SP-1, using an approved V.O.C. compliant method. Galvanized and, when ordered, the other metal surfaces specified above shall be hand tool cleaned to SSPC SP-2 standards to provide a uniform 1 mil surface profile.
- F. Existing Surfaces to be Repainted
  - 1. Existing masonry, steel and other previously field painted surfaces so noted or as provided in Paragraph 1.01B shall be repainted.

2. Preparation shall be in general as specified above for new surfaces except that all loose paint shall be removed, and all edges of existing paint shall be feathered to ensure a smooth surface.
3. Paint removal, capture of its residue, and its disposal shall be handled in accordance with all laws and regulations concerning disposal of hazardous materials.
4. Primer (spot) and paint used for a particular surface shall, in general, be as scheduled for that type of new surface. Provide a CDM Smith approved organic zinc-rich (min. 83% zinc in dried film) primer as specified. Confirm with the paint manufacturer that the paint proposed for a particular repaint condition will be compatible with the existing painted surface. Perform adhesion and compatibility tests on existing substrates as ordered and required. Repainted areas shall be covered by the same guaranty specified for remainder of Project.

### 3.03 WORKMANSHIP

#### A. General

1. At the request of the Engineer, sample areas of the finished work prepared in strict accordance with this Section shall be furnished and all painting shall be equal in quality to the approved sample areas. Finished areas shall be adequate for the purpose of determining the quality of workmanship. Experimentation with factory or paint manufacturer's warehouse mixed colors shall be furnished to the satisfaction of the Engineer where standard chart colors are not satisfactory.
2. Protection of furniture and other movable objects, equipment, fittings and accessories shall be provided throughout the painting operation. Canopies of lighting fixtures shall be loosened and removed from contact with surface, covered and protected and reset upon completion. Remove all electric plates, surface hardware, etc, before painting, protect and replace when completed. Mask all machinery name plates and all machined parts not receiving a paint finish. Dripped or spattered paint shall be promptly removed. Lay drop cloths in all areas where painting is being done to adequately protect flooring and other work from all damage during the operation and until the finished job is accepted.
3. On metal surfaces apply each coat of paint at the rate specified by the manufacturer to achieve the minimum dry mil thickness required. If material has thickened or must be diluted for application by spray gun, the coating shall be built up to the same film thickness achieved with undiluted material. One gallon of paint as originally furnished by the manufacturer shall not cover a greater area when applied by spray gun than when applied unthinned by brush. Deficiencies in film thickness shall be corrected by the application of an additional coat(s). On masonry, application rates will vary according to surface texture; however, in no case shall the manufacturer's stated coverage rate be exceeded. On porous surfaces, it shall be the painter's responsibility to achieve a protective and decorative finish either by decreasing the coverage rate or by applying additional coats of paint.

#### B. Field Priming

1. Steel members, metal castings, mechanical and electrical equipment and other metals which are shop primed before delivery at the site will not require a prime coat on the job. All piping and other bare metals to be painted shall receive one coat of primer before

exposure to the weather, and this prime coat shall be the first coat as specified in the painting schedule. Surface preparation of bare metal shall be the responsibility of the Contractor.

2. Equipment which is specified to receive a baked-on enamel finish or other factory finish shall not be field painted unless the finish has been damaged in transit or during installation. Surfaces that have been shop painted and have been damaged, or where the shop coat or coats of paint have deteriorated, shall be properly cleaned and retouched before any successive painting is done on them in the field. All such field painting shall match as nearly as possible the original finish. Preparation and painting shall be provided by the Contractor.
3. Equipment shipped with a protective shop painting coat or coats shall be touched up to the satisfaction of the Engineer with primers as recommended by the manufacturer of the finish paint. Preparation and painting shall be provided by the Contractor.

#### C. Field Painting

1. All painting at the site shall be under the strict inspection of the Engineer. Only skilled painters and, where dictated by special conditions or systems and so ordered, specialist painters shall be used on the work.
2. All paint shall be at room temperature before applying, and no painting shall be done when the temperature is below 60 degrees F, in dust-laden air, when rain or snow is falling, or until all traces of moisture have completely disappeared from the surface to be painted.
3. Successive coats of paint shall be different shades (from paint manufacturer's stock or shop mixed paint) of the required colors so as to make each coat easily distinguishable from each other with the final undercoat the approximate shade of the finished coat to ensure no show-through as approved.
4. Finish surfaces shall not show brush marks or other irregularities. Undercoats shall be thoroughly and uniformly sanded with the type paper appropriate for the undercoats to remove defects and provide a smooth even surface. Top and bottom edges of doors shall be painted.
5. Painting shall be continuous and shall be accomplished in an orderly manner so as to facilitate inspection. Materials subject to weather shall be primed coated as quickly as possible. Surfaces of exposed members that will be inaccessible after erection shall be cleaned and painted before erection.
6. All painting shall be performed by approved methods with number of coats modified as required to obtain the total dry film thickness specified. Spray painting shall be performed specifically by methods submitted and as approved by the Engineer.
7. All surfaces to be painted as well as the atmosphere in which painting is to be done shall be kept warm and dry by heating and ventilation, if necessary, until each coat of paint has hardened. Any defective paint shall be scraped off and repainted in accordance with the Engineer's directions.

8. Before final acceptance of the work, all damaged surfaces of paint shall be cleaned and repainted as directed by the Engineer.
9. Only the aluminum work noted on the Drawings or in the Painting Schedule shall be field painted.

### 3.04 FIELD QUALITY CONTROL

- A. Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coatings are being applied:
  1. Owner will engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
  2. Testing agency will perform tests for compliance with specified requirements.
  3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

### 3.05 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Engineer, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

### 3.06 PAINTING SCHEDULE

- A. All colors will be selected by the Engineer.
- B. The following types of paints by PPG Protective & Marine Coatings, (PPG PMC); Tnemec Co. (TN) and The Sherwin Williams Company (SW) have been used as a basis for the paint schedule:
  1. Epoxy:
    - a. TN: Hi-build Epoxoline II (Series N69).
    - b. SW: Macropoxy 646.
    - c. PPG PMC: Pitt-Guard 97-145 Series Epoxy Mastic.
    - d. AME: Amerlock 2/400 Series Epoxy.

- e. Or equal.
- 2. Waterborne Cementitious Acrylic:
  - a. TN: Envirofil (No. 130-6602 off-white color).
  - b. SW: Cement-Plex 875.
  - c. PPG: Cementitious Waterproofing Block Filler 95-217 Series.
  - d. AME: Amerlock 400 BF Epoxy Block Filler.
  - e. Or equal.
- 3. High-Build Acrylic Polyurethane Enamel:
  - a. TN: Endura-Shield III - semi-gloss (Series V73).
  - b. SW: Acrolon 218 HS.
  - c. PPG: Pitthane HB Semigloss Urethane 95-8800 Series.
  - d. AME: Amercoat 450H SG Polyurethane.
  - e. Or equal.
- 4. High Heat Silicone Aluminum (to 600 degrees F):
  - a. TN: Silicone Aluminum (No. 39-661).
  - b. SW: Kem Hi-Temp No.850.
  - c. PPG: Speedhide 6-220 Series Silicone Aluminum Coating.
  - d. AME: Amercoat 878 Silicone Aluminum Coating.
  - e. Or equal.
- 5. Tie Coat, Low VOC, Epoxy:
  - a. TN: FC Typoxy (Series V27).
  - b. SW: Macropoxy HS.
  - c. PPG: Pitt-Guard Epoxy Mastic 95-245 Series.
  - d. AME: Amercoat 385 Multi-purpose Epoxy.
  - e. Or equal.
- 6. Acrylic Latex Emulsion, Eggshell Finish:
  - a. TN: Tneme-Cryl (Series 6).
  - b. SW: DTM Primer Finish.
  - c. PPG: Pitt-tech Plus 90-1110 Series Satin DTM Acrylic.
  - d. AME: Amercoat 220 Waterborne Acrylic.
  - e. Or equal.
- 7. Vinyl Acrylic Surface Sealer:
  - a. TN: PVA Sealer (No. 51-792).
  - b. SW: Prep-Rite 200 Primer.
  - c. PPG: Speedhide 6-2 Vinyl Acrylic Drywall Primer.
  - d. AME: Amercoat 148 Acrylic Primer.
  - e. Or equal.
- C. The following surfaces shall have the types of paint scheduled below applied at the dry film thickness (DFT) in mils per coat noted:
  - 1. Exterior non-submerged ferrous metals (except first coat-hollow metal-pressed metal work).
    - a. First Coat: On properly prepared unprimed metal or for touch-up.
      - 1) TN: No. N69 (white in color) (3.0-4.0 DFT).

- 2) SW: Macropoxy 646 (5.0-10.0 DFT).
    - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
    - 4) AME: Amerlock 2/400 Series Epoxy.
    - 5) Or equal.
  - b. Second Coat:
    - 1) TN: Series N69 (4.0 DFT).
    - 2) SW: Acrolon 218 HS (3.0-6.0 DFT).
    - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
    - 4) AME: Amerlock 2/400 Series Epoxy.
    - 5) Or equal.
  - c. Third Coat:
    - 1) TN: Series V73 (3.0 DFT).
    - 2) SW: Acrolon 218 HS (3.0-6.0 DFT).
    - 3) PPG: Pitthane HB Semigloss Urethane 95-8800 Series.
    - 4) AME: Amercoat 450H SG Polyurethane.
    - 5) Or equal.
2. Interior non-submerged ferrous metals (except first coat of previously painted metal work), on properly prepared unprimed metal or for touch-up.
  - a. First Coat:
    - 1) TN: No. N69 (white in color) (3.0-4.0 DFT).
    - 2) SW: Macropoxy 646 (5.0-10.0 DFT).
    - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
    - 4) AME: Amerlock 2/400 Series Epoxy.
    - 5) Or equal.
  - b. Second and Third Coats:
    - 1) TN: Series N69 (3.0-4.0 DFT).
    - 2) SW: Macropoxy 646 (5.0-10.0 DFT).
    - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
    - 4) PPG: Amerlock 2/400 Series Epoxy.
    - 5) Or equal.
3. Submerged ferrous metals and ferrous metals subject to submersion or splashing. Surface shall be lightly sanded or abraded before application of first field coat.
  - a. First and Second Coats:
    - 1) TN: Series N69. (3.0-4.0 DFT)
    - 2) SW: Macropoxy 646 (5.0-10.0 DFT)
    - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
    - 4) PPG: Amerlock 2/400 Series Epoxy.
4. Plastic piping and, where scheduled to be painted, plastic components
  - a. First and Second Coats:
    - 1) TN: Series N69 (3.0 DFT).
    - 2) SW: Macropoxy 646 (5.0-10.0 DFT).
    - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
    - 4) AME: Amerlock 2/400 Series Epoxy.
    - 5) Or equal.
5. Pipe insulation: (Plastic or metal sheathed insulation-paint as scheduled for appropriate substrate)
  - a. First Coat:

- 1) TN: No. 51-792 (Vinyl-Acrylic Sealer - 1.0 DFT).
    - 2) SW: Prep-Rite 200 (1.1 DFT), Macropoxy 646 (5.0-10.0 DFT).
    - 3) PPG: Speedhide 6-2 Vinyl Acrylic Drywall Primer.
    - 4) AME: Amercoat 148 Acrylic Primer.
    - 5) Or equal.
  - b. Second and Third Coats:
    - 1) TN: Series N69 (3.0 DFT).
    - 2) SW: Prep-Rite 200 (1.1 DFT), Macropoxy 646 (5.0-10.0 DFT).
    - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
    - 4) AME: Amerlock 2/400 Series Epoxy.
    - 5) Or equal.
6. Aluminum designated to be painted. (Mechanically abrade surfaces to a uniform profile of 1 to 2 mils and clean completely.)
  - a. First and Second Coats: (Interior)
    - 1) TN: Series N69 (3.0 DFT).
    - 2) SW: Macropoxy 646 (5.0-10.0 DFT).
    - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
    - 4) AME: Amerlock 2/400 Series Epoxy.
    - 5) Or equal.
  - b. First Coat: (Exterior)
    - 1) TN: Series N69 (4.0 DFT), 1 coat Series V73 (3.0 DFT).
    - 2) SW: Macropoxy 646 (5.0-10.0 DFT), Acrolon 218 HS (3.0-6.0 DFT).
    - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
    - 4) AME: Amerlock 2/400 Series Epoxy.
    - 5) Or equal.
7. Hot Ferrous Metal Surfaces:
  - a. First and Second Coats:
    - 1) TN: No product.
    - 2) SW: Heat-Flex Hi-Temp 1000 Aluminum, B59-820 Series, Aluminum.
    - 3) PPG: Speedhide 6-220 Series Silicone Aluminum Coating.
    - 4) AME: Amercoat 878 Silicone Aluminum Coating.
8. Previously Painted Metal Surfaces:
  - a. First coat on substrates prepared as approved and replacing first coat of above-specified systems. Complete painting with remainder of specified system for each type of substrate.
  - b. First Coat:
    - 1) TN: FC Typoxy, Series V27.
    - 2) SW: Macropoxy 646, B58 Series.
    - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
    - 4) AME: Amerlock 2/400 Series Epoxy.
9. Exterior galvanized steel surfaces. (Mechanically abrade surfaces to a uniform profile of 1 to 2 mils and clean completely.)
  - a. First Coat:
    - 1) TN: Series V27 (3.0 to 4.0 DFT).
    - 2) SW: Macropoxy 646 (5.0-10.0 DFT).
    - 3) PPG: Pitt-Guard Epoxy Mastic 95-245 Series.
    - 4) AME: Amercoat 385 Multi-purpose Epoxy.

- 5) Or equal.
- b. Second Coat:
  - 1) TN: Series V73 (2.5 to 3.5 DFT).
  - 2) SW: Acrolon 218 HS (3.0-6.0 DFT).
  - 3) PPG: Pitthane HB Semigloss Urethane 95-8800 Series.
  - 4) AME: Amercoat 450H SG Polyurethane.
  - 5) Or equal.

END OF SECTION

SECTION 11214  
VERTICAL TURBINE WELL PUMP

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required, install, complete and ready for operation and field test, one (1) vertical turbine well pump for JEA Greenland Water Treatment Plant backup Well No. 3 as shown on the Drawings and as specified herein.
- B. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, factory testing, delivery and complete installation and field testing of all materials, equipment and appurtenances for the complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.
- C. The work under this Section shall include supervisory services during installation and field testing of the unit and instructing the regular operating personnel in the proper care, operation and maintenance of the equipment.
- D. System curves developed are based on backup Well No. 3 specific capacity of 28.6 gpm/ft. The specific capacity of backup Well No. 3 shall be verified during well drawdown testing.
- E. The pump manufacturer (Manufacturer) shall coordinate the design of the pump and motor with the variable frequency drives, and provide the variable frequency drives as specified in Sections 16150 and 16370.

1.02 RELATED WORK

- A. Concrete work and the installation of anchor bolts are included in Division 3; however, anchor bolts for these units as recommended by the pump manufacturer (Manufacturer) shall be furnished by the Contractor under this Section.
- B. Instrumentation and control work, except as specified herein, is included in Division 13. Instrumentation and controls provided in this section shall adhere to Instrumentation and Control Specifications Sections in Division 13.
- C. Valves, mechanical piping and appurtenances and pipe hangers and supports are included in Division 15.
- D. Electrical work except as hereinafter specified is included in Division 16.

1.03 REFERENCE STANDARDS

- A. Design, manufacturing and assembly of elements of the equipment specified herein shall be in accordance with the following, where applicable:
  - 1. American Concrete Institute (ACI).
  - 2. American Gear Manufacturers Association (AGMA).

3. American Institute of Steel Construction (AISC).
4. American Iron and Steel Institute (AISI).
5. American Society of Mechanical Engineers (ASME).
6. American National Standards Institute (ANSI).
7. American Petroleum Institute (API).
8. American Society for Testing Materials (ASTM).
9. American Water Works Association (AWWA).
10. American Welding Society (AWS).
11. American Bearing Manufacturers Association (ABMA).
12. Hydraulic Institute (HI) Standards.
13. Institute of Electrical and Electronics Engineers (IEEE).
14. International Organization for Standardization (ISO).
15. National Electrical Code (NEC).
16. National Electrical Manufacturers Association (NEMA).
17. National Sanitation Foundation (NSF).
18. Occupational Safety and Health Administration (OSHA).
19. The Society for Protective Coatings (SSPC).
20. Underwriters Laboratories (UL).

- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.04 SYSTEM DESCRIPTION

- A. The vertical turbine well pump will pump raw water from the Upper Floridan aquifer to the Greenland Water Treatment Plant through the new and existing Raw Water Transmission System. The equipment to be furnished under this section shall include one (1) open line-shaft vertical turbine raw water pump, motor, variable frequency drive, and accessories, all as specified herein and as shown on the Drawings. Refer to Division 13 for system description and control narratives. Contractor shall coordinate and be fully responsible for proper operation and compatibility between items in this scope of work and items listed in Division 16 and Division 13.

## 1.05 QUALIFICATIONS

- A. To assure unity of responsibility, the motors, column, line shafting and supporting wellhead flange for the pump shall be furnished and coordinated by the Manufacturer. The Contractor and Manufacturer shall assume responsibility for the satisfactory installation and operation of the entire pumping system including pumps, motors, variable frequency drives and well head flange as specified. Variable frequency drives are covered in Section 16370.
- B. The equipment covered by this Section is intended to be standard pumping equipment of proven ability as manufactured by companies having extensive experience in the production of such equipment similar to the applications stated in Articles 1.04, 2.02 and 2.03. Units specified herein shall be furnished by a single manufacturer. The equipment provided shall be designed, constructed and installed to operate satisfactorily when installed as shown on the Drawings or as approved by the Engineer.
- C. Pump shall be manufactured in accordance with the Hydraulic Institute Standards, except where otherwise specified.
- D. The Manufacturer shall be fully responsible for the design, arrangement, and operation of all connected rotating components of the assembled pumping unit mounted on a fabricated steel baseplate to ensure that neither harmful nor damaging vibrations occur at any speed within the specified operating range.
- E. The Manufacturer or its representative shall have an authorized warranty center within a 3-day shipping radius of the job site, fully staffed with factory trained mechanics, and equipped with a stock of strategic spare parts for the model of pump furnished under this contract. The service facility and strategic spare parts shall be established prior to delivery of equipment for this project.
- F. All equipment furnished under this Specification shall be new and unused, shall be the standard product of manufacturers having a successful record of manufacturing and servicing similar equipment and systems to that specified herein for a minimum of five years.
- G. The pumping equipment shall be furnished complete with accessories required and shall meet the detailed requirements of the Specifications.
- H. The Manufacturer shall be certified to the ISO 9001 standard for design and manufacture of vertical turbine pumps.
- I. Welding of pressure-containing fabrications shall be by welders qualified to ASME Code Section 9 or AWS D1.1 Structural Welding Code – Steel.
- J. Prior to manufacture, a submittal must be forwarded to the Engineer indicating that the required vibration analyses outlined herein have been performed and that the specified limitations will be met. For the dynamic vibration analysis described, maximum operating speeds will be in accordance with the operating speeds required to satisfy the conditions of operation specified in Article 2.02. The dynamic vibration analysis required by the following paragraphs shall be performed by Mechanical Solutions Inc. (MSI) of Whippany, NJ, or Engineering Dynamics Inc. (EDI) of San Antonio, TX, or approved equal or alternatively by the Manufacturer if Manufacturer can demonstrate successful vibration analysis experience in at least ten projects similar in scope, with the same proposed personnel involved. This vibration analysis approach

will be evaluated by the Engineer, based upon the information provided and in accordance with the specified requirements.

1. Structural dynamic analysis of the combined pump/motor system including the nearby foundation and the piping out to the first pipe restraint or expansion joint. Analysis shall not simply assume the foundation is rigid rather it shall incorporate foundation design shown on the Drawings. The structural dynamic analysis shall predict that no first or second bending mode frequencies will exist within 25 percent above maximum operating speed.
2. A lateral rotordynamic analysis of the pump rotating system (i.e., motor rotor, line shafting, couplings, bowl shafting and impellers, etc.) shall identify and predict that the first lateral critical speed shall have a separation margin of at least 25 percent above the maximum pump speed. If a design modification (i.e., such as changing the bearing span or shaft diameter) cannot resolve a separation margin deficiency or is not practical, a forced damped response analysis shall be performed to demonstrate that the pump will function properly over the speed range.
3. A torsional rotordynamic analysis of the complete rotating system (pump, motor, intermediate shafting, and coupling) shall identify and predict that no torsional natural frequencies occur within a separation margin extending from 25 percent below to 25 percent above the specified pump operating speed range. Additionally, no natural frequencies shall be +/- 10% of 2x times running speed, line frequency, 2x line frequency, and vane pass frequency. If a design modification (i.e., such as a shaft diameter change or different coupling arrangement) cannot resolve a separation margin deficiency or is not practical, a forced damped response analysis shall be performed to show that infinite life will be achieved with a safety factor of at least two.
4. Campbell diagrams shall be submitted, documenting the structural lateral, rotating component lateral, and torsional analysis results, graphically demonstrating the separation margins specified above.
5. Maximum vibration velocity in inches per second RMS, measured in the field, shall conform to the requirements of ANSI/HI 9.6.4. In addition, for operating motor full load speeds less than or equal to 600 rpm, field vibration displacement in mils peak-to-peak shall conform to the requirements of ANSI/HI 9.6.4.

#### 1.06 SUBMITTALS

- A. Submit, in accordance with Section 01300, copies of all materials required to establish compliance with the specifications. In the event that it is not practical to conform to certain details of the specifications because of different manufacturing techniques, describe completely all nonconforming aspects. Submittals shall include the following:
  1. Certified dimensional drawings showing all important details of pump construction and auxiliary apparatus.
  2. Baseplate and pump support design details showing anchor bolt locations and sizing information.

3. Literature and drawings describing the equipment in sufficient detail, including materials of construction, to indicate full conformance with the detail specifications.
4. Schematic electrical wiring diagram and other data as required for complete pump installation.
5. The total weight of the equipment including the weight of the single largest item.
6. A complete materials table for all equipment establishing compliance with these specifications.
7. A list of the Manufacturer's recommended spare parts with the Manufacturer's current price for each item. Include gaskets, packing, etc. on the list. List all bearings by the bearing manufacturer's numbers only.
8. All information required by Division 1.
9. A statement and supporting data indicating motor bearing life meets or exceeds specified value.
10. Complete data on motors and variable speed frequency drives in accordance with Section 16150 and Section 16370.
11. Compliance with noise levels as specified in Division 16 – Electrical.
12. Complete description of surface preparation and shop painting for pumps and motors.
13. Critical speed analyses report submittal including backup documentation and a statement of guarantee that the critical speed analyses as required in Paragraph 1.05 J of this Section have been completed and that the specified limitations will be met.

B. Design Data:

1. Data on the characteristics and performance of the pump. Data shall include guaranteed performance curves to ANSI/HI 14.6 acceptance grade 1U for all specified points, based on actual factory tests of similar units, which show that they meet the specified requirements for head, flow rate, efficiency, guaranteed maximum net positive suction head required (NPSH3), submergence and horsepower. Curves shall be submitted on 8-1/2-inch by 11-inch sheets, at as large a scale as is practical. Curves shall be plotted from zero flow at shut off head to pump flow rate at minimum specified total head (TH). The POR and AOR (refer to ANSI/HI 9.6.3) shall be clearly shown on the curves. This information shall be prepared specifically for the pump proposed. Catalog sheets showing a family of curves will not be acceptable.

C. Test Reports:

1. Certified motor test data as described in Section 16150.
2. Tabulated data for the drive motors including rated horsepower, full load rpm, power factor and efficiency curves at 1/2, 3/4 and full load, service factor and kW input, including when the pump is at its design point. Submit a certified statement from the motor manufacturer

that the motors are capable of continuous operation on the power supply from the variable frequency drives to be furnished without affecting their design life for bearings or windings.

3. Description of proposed pump factory test procedures and equipment.
4. Factory and field performance test data as specified in PART 2 and PART 3.
5. A schedule of the date of factory testing and delivery of the equipment to the job site.

D. Instructions, Certifications, and Reports:

1. Manufacturer's Installation Instructions.
2. Manufacturer's certification of installation meeting Manufacturer's installation, operation and maintenance manuals and as specified in PART 3.
3. Manufacturer's field report as specified in PART 3.
4. Submit warranty information to demonstrate conformance to Article 1.10.
5. Identify the entity and experience of the individual who will inspect the installation in accordance with Article 1.07.
6. Welder certifications.

E. Project Record Documents, reference Section 01720.

F. Six-month follow up vibration testing report as specified in Article 3.02.

1.07 MANUFACTURER SERVICES INCLUDING OPERATING INSTRUCTIONS

A. Operating and Maintenance Manual:

1. Operating and maintenance manual shall be furnished by the Manufacturer to the Engineer as provided for in Section 01730. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, description, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include trouble shooting data, full preventative maintenance schedules, and complete spare parts lists with ordering information.

B. Installation Inspection and Startup:

1. The Contractor shall include in his bid price the services of a Manufacturer's factory representative who has complete knowledge of proper operation and maintenance shall be provided to instruct representatives of the Owner and the Engineer on proper operation and maintenance. This work may be conducted in conjunction with the inspection of the installation and start-up. If there are difficulties in operation of the equipment because of the Manufacturer's design or fabrication, additional service shall be provided at no additional cost to the Owner. The listed service requirements are exclusive of travel time, and shall not limit or relieve the Contractor of the obligation to provide sufficient service

necessary to place the equipment in satisfactory and functioning condition. VFD training shall be as specified in Division 16. Also refer to requirements in PART 3 of this Section.

2. Installation inspection: Complete review of installation in accordance with Section 01465. Provide written certification that the installation is complete and operable in all respects, and that no conditions exist which may affect the warranty. Qualified supervisory services, including Manufacturers' Factory representatives, shall be provided to ensure that the installation is done in a manner fully approved by the Manufacturer. The Manufacturer's factory representative shall specifically supervise the installation and alignment of the pump with the motor, the grouting, and the alignment of the connecting piping and the installation of the field installed packing. If there are difficulties in the start-up or operation of the equipment due to the Manufacturer's design or fabrication, additional service shall be provided at no additional cost to the Owner. Services of the Manufacturer's factory representative and training shall be provided when the well pump is started.
  - a. Minimum time on-site shall be one 8-hour day.
3. Start-Up: Provide written report, summarizing test procedures, tested and measured variables (flow rates, total heads, shaft-speed, vibration measurements, alignment check, etc.):
  - a. Minimum time on-site shall be one 8-hour day.

C. Training:

1. Field instruction on operation and maintenance of the equipment, including start-up, shut-down troubleshooting, lubrication, maintenance and safety.
  - a. Training can occur the same day as start-up if timing allows.
2. The Manufacturer shall provide detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.

- D. The Contractor alone shall be responsible for requesting these services, and shall coordinate these requests with all other relevant trades, to ensure the effectiveness of the Manufacturers' service. In the event that the lack of coordination by the Contractor results in the need to recall the Manufacturer's factory representative, the lost time shall not be counted against the above days.

1.08 PRODUCT HANDLING

- A. Delivery, storage and handling of equipment shall be in accordance with Section 01600 and as specified herein.
- B. All equipment and parts must be properly protected against any damage during shipment. Store the equipment in accordance with Manufacturer's recommendations.
- C. All completely assembled units shall be off loaded by the use of a primary and "tail" crane system. Additionally, when lifting the units from a horizontal position to a vertical position, the use of a primary and "tail" crane system shall be used.
- D. Long Term Storage:

1. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of fabrication, including storage in accordance with Manufacturer's requirements, until the unit and equipment are ready for operation.
  2. If long-term storage is required on-site, Contractor shall follow Manufacturer's detailed recommendations for long term storage.
  3. If the pump is delivered and stored on-site in a horizontal position and left for an extended period of time, the rubber line-shaft bearings may become deformed and the shaft may take on a permanent "sag". The Contractor shall be responsible for rotating the shafting, in accordance with the pump Manufacturers requirements, so that damage does not occur.
- E. Factory assembled parts and components less than 25 feet in length shall not be dismantled for shipment unless permission is received in writing from the Engineer.
- F. For units greater than 25 feet in length that are shipped unassembled, all connecting parts shall be "match-marked" by the Manufacturer to ensure correct assembly on-site by the Contractor.
- G. The finished surfaces of all exposed flanges shall be protected by wooden or equivalent blank flanges, strongly built and securely bolted thereto.
- H. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- I. No shipment shall be made until approved by the Engineer in writing.
- J. For protection of bearings during shipment and installation, the bearing shall be properly processed. Anti-friction bearings, if pre-lubricated, shall be protected in accordance with the bearing manufacturer's recommendations against formation of rust during a long period of storage while awaiting completion of installation and start-up of the machine in which they are used. Anti-friction bearings which are not pre-lubricated shall be properly treated in accordance with the bearing manufacturer's recommendation against formation of rust during a long period of storage while waiting completion of installation and start-up by the application of an appropriate rust preventative treatment.

#### 1.09 WARRANTY

- A. All equipment supplied under this Section of the Specifications shall be warranted for a period of 12 months from successful startup and acceptance by Owner.
- B. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced in the machine(s) and the unit(s) restored to service at no expense to the Owner.
- C. The Manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.
- D. Refer to Section 01740 for additional warranty requirements.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. The pumping units shall all be supplied by one manufacturer and shall be complete including pump, motor, variable frequency drive, bowl, column, line-shaft, discharge head and appurtenances such as, but not limited to, couplings, guards and gauges. The pump shall conform to AWWA E-103, Horizontal and Vertical Line-Shaft Pumps Standard and ANSI/NSF 61 and ANSI/NSF 61 Annex G and ANSI/NSF 372 where not in conflict with the requirements specified herein. Ample room shall be provided for inspection, repairs and adjustments.
- B. Discharge head lifting lugs or eye bolts shall be provided by the Manufacturer.
- C. The pump, motor, and variable frequency drive shall be designed and built for 24-hour continuous service at any and all points within the required range of operation, without overheating, excessive vibration or strain.
- D. The top column section of the vertical turbine well pump shall be fabricated to include a flange for mounting of the pump to the casing. The mounting flange shall be bolted to the top column section, designed to support the weight of the complete pump and motor assembly. The flange shall be epoxy coated with the column as specified in paragraph 2.08.B. The wellhead flange shall be designed to mount on the top of the well casing flange as shown on the Drawings.
- E. Each major piece of equipment shall be furnished with a stainless steel nameplate (with embossed data) securely mounted to the body of the equipment. At a minimum, the nameplate for the pumps shall include the Manufacturer's name and model number, serial number, rated flow rate, head, and speed. At a minimum, nameplate for motors shall include the manufacturer's name and model number, serial number, horsepower, speed, input voltage, amps, number of cycles, and power and service factors. Nameplate information for the variable frequency drive shall include the manufacturer's name and serial number, input speed, voltage, current and frequency and horsepower at full load. Furnish one nameplate for pump discharge head and one for the pump bowl assembly.
- F. The pump and its driving equipment shall be designed and constructed to prevent reverse rotation using a non-reverse ratchet installed in the electric motor. As an alternate, the pump and motor shall be designed and constructed to successfully withstand a maximum turbinning speed of the unit resulting from backflow through the pump. Manufacturer shall determine maximum potential reverse rotational speed for design.
- G. The maximum sound pressure level from one pump/motor when operating on utility power measured 3 feet from the equipment and 5 feet above the floor shall be 85 dBA throughout the VFD range.
- H. The nameplate ratings of the motor and VFD shall not be exceeded, nor shall the design service factor be reduced when the pump is operating at any point on its performance curve within the specified operating range at maximum speed.
- I. Mechanical equipment, including electric motors shall be supplied and installed in accordance with applicable OSHA regulations. The Contractor's attention is drawn to the requirement for guards on all rotation assemblies.

## 2.02 CONDITIONS OF OPERATION

- A. The pump shall be Model 15EHL 2 Stage by Flowserve; Model H14LC 2 Stage by National Pump Co.; Model J12XHC 3 Stage by National Pump Co.; 14MD 2 Stage by Peerless; or pre-approved equal from Goulds and American Marsh.

- B. Design Information:

| Design Information                       | Well No. 3     |
|--|----------------|
| Approx. Grade Elevation (ft NGVD)        | 29.2           |
| Well Casing Flange (ft NGVD)             | 31.00          |
| Casing nominal diameter (in)             | 20             |
| Open Hole nominal I.D (in)               | 18             |
| Open Hole-Top Elevation (ft BLS)         | 360            |
| Open Hole-bottom Elevation (ft BLS)      | 700            |
| Well Depth (ft BLS)                      | 700            |
| Water Temperature (°F)                   | 72°F           |
| Water pH                                 | 7.8-8.2        |
| Static Water Level (ft ALS) <sup>1</sup> | 5.1 (artesian) |
| Drawdown (ft) <sup>1</sup>               | 70             |
| Specific Capacity (gpm/ft)               | 28.6           |
| Pump Suction Elevation (ft. BLS)         | 80             |

MSL = mean sea level

ALS = above land surface

BLS = below land surface

1) Drawdown will need to be verified during well testing.

- C. The pump shall be designed for the conditions of service tabulated as follows and shall operate within the system head curve envelope as appended. All pumps shall have a continuously rising (from runout toward shutoff) head-flow rate performance curve for stable pump operation within the AOR.
- D. The pumps shall operate throughout the specified operating range, within the vibration limitations specified in Paragraph 1.05 J.5 above.

TABLE 11214-1  
PUMPING UNIT DESIGN REQUIREMENTS

| Item Description   | Design Conditions |
|--|-------------------|
| Service  | Raw Water         |
| Number of Pumps (operating/standby)  | (1/0)             |
| Maximum Motor Full Load Speed (FLS) (rpm)  | 1,800             |
| Maximum Allowable Motor Horsepower (non-overloading throughout operating range) (HP) | 125               |
| Motor Design Voltage/Phase/Frequency   | 460/3/60          |
| Maximum Anticipated Pumped Fluid Temperature (degrees F.)                            | 72                |

| Item Description   | Design Conditions |
|--|-------------------|
| Minimum Pump Discharge Nozzle Size (inches)                                    | 12                |
| Minimum Pump Column Diameter (inches)  | 10                |
| Pump Shut-Off Head at Motor FLS Acceptable Range (minimum/maximum) (feet)      | 245/250           |
| Flow Rate at Secondary Operation Point (gpm)                                   | 3,000             |
| Minimum TH at Secondary Operation Point (feet)                                 | 78                |
| Minimum Bowl Efficiency at Secondary Operation Point (%)                       | 62                |
| Maximum NPSH3 at Secondary Operation Point (feet)                              | 31                |
| Intermediate (Design) Point Flow Rate (gpm)                                    | 2,000             |
| Minimum TH at Intermediate (Design) Point (feet)                               | 156               |
| Minimum Bowl Efficiency at Intermediate (Design) Point (%)                     | 76.7              |
| Maximum NPSH3 at Intermediate (Design) Point (feet)                            | 22.6              |
| Best Efficiency Point (BEP) Flow Rate Acceptable Range (minimum/maximum) (gpm) | 2,000/2,500       |
| Minimum Bowl Efficiency at BEP (%)   | 75                |
| Primary Operating Point TH (feet)  | 195               |
| Minimum Flow Rate at Primary Operating Point (gpm)                             | 1,000             |
| Minimum Bowl Efficiency at Primary Operating Point (%)                         | 52                |
| Maximum NPSH3 at Primary Operating Point (feet)                                | 19                |
| Minimum Submergence Above Pump Suction Bell (feet)                             | 2.5               |

## 2.03 PUMP CONSTRUCTION

- A. Vertical turbine line-shaft pump shall be product lubricated with open line-shaft bearings as specified below, completely equipped with motor support and discharge head and shall conform to AWWA E-103, Horizontal and Vertical Line-Shaft Pumps, and ANSI/NSF 61 and ANSI/NSF 61 Annex G and ANSI/NSF 372 where not in conflict with the specific requirements contained herein. All pump assemblies shall be evaluated by the Manufacturer for galvanic corrosion potential and zinc anode protection systems provided where required.
- B. Pump bowl, including suction bell, shall be ASTM A48 Class 30 cast iron, flanged and bolted construction with Vesconite HiLube Thermoplastic bearings in the suction and discharge case and Vesconite HiLube Thermoplastic bearings in the intermediate bowls. All bowl hardware shall be Type 304 stainless steel. The bowl shall be provided with a 420 stainless steel wearing rings.
- C. Impeller shall be CF8M cast stainless steel; enclosed type; two-plane dynamic balance in accordance with ISO 1940-1 quality grade G2.5. Impeller design shall include adequate material so as to provide for the future addition of wear rings to restore impeller efficiency.
- D. Impeller shafts and couplings shall be 17-4 PH stainless steel and shall be field replaceable. Collets and locknuts shall be Type 316 stainless steel.
- E. Line-shafts and couplings shall be 17-4 PH stainless steel and shall be field replaceable. Maximum shaft lengths shall be 10-ft and shall be verified with vibration analysis as specified in Paragraph 1.05J above and clearance limitations. Material for vibration isolation devices shall

be consistent with materials used on other wetted components. Material selected should give consideration to potential for damage by sulfides. Minimum diameter for the line-shaft shall be 1.5 inch.

- F. Discharge columns shall be ASTM A53 Grade B steel schedule 40 pipe, flanged construction in lengths not exceeding 10-ft. All flange hardware shall be Type 316 stainless steel with monel nuts. The minimum wall thickness on all columns with nominal diameters 12-in and above shall be 0.375-in.
- G. Pump Discharge Head for Flange Mounted Pumps:
1. The discharge head shall be fabricated ASTM A53 carbon steel with 150 lb ASME B16.5 or B16.47 flanged connections. The long radius 90-degree elbow type discharge head design shall have a 12-in discharge flange. The base of the discharge head shall be machined to match the drilling of the pump adaptor flange complete with all Type 316 stainless steel bolts and washers and monel nuts. Manufacturer may submit a variation for the pump adaptor flange on the condition that the pump Manufacturer submits the modified pump adaptor design to the Engineer for approval and incorporate the revised design into the required vibration analysis described in paragraph 1.05J. The pump shall be equipped with a 1-inch tapped vent in the pump baseplate with a 1-inch 316 stainless steel nipple, 316 stainless steel ball valve, and J-tube for the removal of air from the casing. A casing adapter flange shall be bolted to the casing flange at the location shown on the Drawings and as specified below. The casing adapter flange and the pump adapter flange shall be welded to the pump column.
  2. Motor mounting flange for the vertical driving motor shall be of standard NEMA dimensions for commercially available motors.
  3. The top of the discharge head shall have a registered fit for mounting the driving motor.
  4. The discharge head shall include a stuffing box and have large openings for pump adjustment and seal maintenance. Provide suitably sized drain connection and pre-lubricating water connection (if required by application), a design that ensures continuous positive stuffing box bushing lubrication and a 1/4-in tap for the suction and discharge pressure gauges, each complete with 1/4-in brass pipe nipples and stainless steel ball valves. Stuffing box must be located and accessible above pump baseplate.
- H. Stuffing box/seal box sealed with packing: The discharge head shall be fitted with a packed type stuffing box arranged for fresh water flush of stuffing box. Stuffing box shall be supplied complete with bronze split gland, packing, stainless steel studs and nuts and bronze lantern ring. Any small diameter drain piping shall be secured to the pump column and be armored to prevent damage during installation and removal.
- I. The construction of the pumps, position and number of column pipe flanges shall be such that the pumps can be readily installed and removed for repairs within the crane vertical lift limitations using normal methods of operation and handling without undue difficulties.
- J. The Contractor shall furnish one pump blind flange that is normally uninstalled but, when a pump has been removed for maintenance, the pump blind flange can be bolted to the open well casing flange to protect against accidents and for general safety. The pump blind flange

designed for maximum internal pressure, with holes drilled to match the top of the wellhead flange bolts and be fitted with a large lifting eye(s) in the middle to allow lifting by a crane.

#### 2.04 MOTOR TO PUMP COUPLING

- A. Pump shafting shall be directly connected to the motor by means of an adjustment nut on top of the motor, suitably sized to transmit the required driving torque, axial thrust and be easily accessible for impeller adjustment, packing or mechanical seal replacement.

#### 2.05 MOTORS

- A. The pump shall be driven by means of a 460 Volt, 3-ph, 60 Hz squirrel cage induction motor that meets or exceeds requirements of NEMA MG1 for NEMA Premium Efficient motors. The motor shall be suitable for driving the pump continuously over the entire pumping range without overload. Motor horsepower shall be as specified in Paragraph 2.02.A above. The motor shall be furnished with thrust bearing having ample capacity to carry the full weight of all rotating parts and hydraulic forces developed by continuous pump operation. The pump motor shall be furnished by the pump manufacturer. Motors shall meet all requirements of Section 16150.
- B. Motor shall be vertical, hollow shaft with a WP-1 enclosure. Motor shall be provided with a 1.15 service factor, Class F vacuum/pressure impregnated insulation with Class B temperature rise, and copper windings.
- C. Bearings shall be anti-friction, oil-lubricated or grease lubricated with external reservoirs. Bearings shall have a minimum of L-10 life of 50,000 hours.
- D. The electric motor shall be furnished with a non-reversing ratchet to prevent rotation in the reverse direction and a steady bushing to prevent excess shaft movement during variable speed operation.
- E. The electric motor shall be equipped with normally closed motor winding thermostat, and 120-volt space heaters. Provide wiring diagrams and space heater wattage rating with the pump and motor submittals.
- F. All materials, design, construction and nomenclature for the motor, shall be in accordance with the NEMA standards for the class of installation and enclosure employed.

#### 2.06 VARIABLE FREQUENCY DRIVES

- A. The speed control for variable speed pump shall be Variable Frequency Drive, as specified in Section 16370, suitable for installation as shown on the Drawings.
- B. The Variable Frequency Drive shall be supplied by the Manufacturer and shall be completely coordinated with the pump and pump driving motor and shall include all internal auxiliaries required to meet the functional specifications.
- C. The Variable Frequency Drive shall conform to all requirements stipulated in this section and Division 16, Electrical, and shall be designed for a speed range of 50% to 100% of full load motor speed. The VFD design shall incorporate the necessary components to accommodate receiving vibration data from the pump motor.

- D. The Variable Frequency Drive shall be compatible with the motor provided by the Manufacturer.

## 2.07 PRESSURE GAUGES

- A. The pump shall be equipped with a discharge pressure gauge. Pressure gauges shall be Ashcroft Type 1279 Duragauge XLL with plus performance options and 316 stainless steel rack and pinion movement or equal. Gauges shall be calibrated from 0 to 60 psig for discharge service. Gauges shall be 4-1/2-in diameter furnished with 1/4-in inlet. All fittings and cocks shall be Type 316 stainless steel. Diaphragm seals shall be Type 316 stainless steel suitable for use with pressure gauges. All gauges and diaphragms shall be furnished by the Contractor.

## 2.08 CONE STRAINER

- A. A 316 stainless steel cone strainer shall be provided. It shall be threaded-to-bowl type; clip-on type shall not be acceptable. It shall have a net inlet area equal to at least three times the impeller inlet area. The maximum opening shall not be more than 75% of the maximum opening of the water passage through the bowl or impeller.

## 2.09 SHOP PAINTING

- A. Each piece of equipment in the pumping system including pump, support system, motor and associated equipment shall be prepared, shop-primed and finished-coated in accordance with the Manufacturer's standard practice prior to shipment. Colors shall be Manufacturer's standard. Coating for Variable Frequency Drives shall be as specified in Section 16150. Adequate supply of touch-up paints shall be supplied by the Contractor.
- B. All exterior wetted surfaces of pump columns, interior and exterior wetted surfaces of discharge heads, and the interior and exterior of the bowl assemblies shall be cleaned of all rust and mill scale, grease, dirt, other foreign matter and supplied with Manufacturer's standard epoxy coatings.
- C. All coatings on wetted surfaces shall be epoxy type and shall comply with AWWA E-103 and ANSI/NSF 61 and ANSI/NSF 61 Annex G and ANSI/NSF 372 for use with drinking water systems. Surface preparation shall conform to the coating manufacturer's recommendations.
- D. All nameplates shall be properly protected during painting.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Take all necessary measurements in the field to determine the exact dimensions for all work and the required sizes of all equipment under this Contract. All pertinent data and dimensions shall be verified.
- B. Installation shall be in strict accordance with the Manufacturer's instructions and recommendations in the locations shown on the Contract Documents and pump shop drawings. Refer to Article 1.07 for additional requirements. The Contractor shall furnish all required oil and grease for initial operation, if required, in accordance with the Manufacturer's

recommendations. Anchor bolts shall be set in accordance with the Manufacturer's recommendations and setting plans.

- C. If the Contractor does not provide qualified installation staff on the job during the pump installation, the Engineer may direct the Contractor to provide the services of a Manufacturer's factory representative to give the necessary instructions to ensure a proper installation.
- D. Refer to Article 2.01 for additional installation requirements. Connection of piping to pumps shall be done in the presence of the Engineer. All piping connections to the pump shall be done without bending and/or twisting the piping to mate with the pump flange connections.
- E. A certificate from the Manufacturer shall be submitted stating that the installation of their equipment is satisfactory, that the equipment is ready for operation, and that the Owner's operating personnel have been suitably instructed in the operation, lubrication, and care of each unit.

### 3.02 INSPECTION AND TESTING

#### A. General:

- 1. The Engineer shall have the right to inspect any equipment to be furnished under this Section prior to their shipment from place of manufacture.
- 2. The Engineer shall be notified in writing no fewer than ten working days prior to initial shipment, so that arrangements can be made for inspection by the Engineer.
- 3. Field tests shall not be conducted until such time that the pumping system, including controls, is complete and ready for testing.

#### B. Factory Pump Testing:

- 1. The pump shall be factory tested as described in ANSI/HI 14.6, American National Standard for Rotodynamic Pumps for Hydraulic Performance Acceptance Tests, as specified herein.
- 2. The Manufacturer shall perform hydrostatic test on the pressure-containing parts in accordance with ANSI/HI 14.6. Test shall be conducted on the pump prior to shipment.
- 3. Cast surfaces of all components shall be examined by visual inspection per MSS SP-55.
- 4. Factory pump tests shall be the basis of acceptance of the hydraulic performance of the pumps. The Manufacturer shall factory test all pumps prior to shipment in accordance with the Hydraulic Institute standards. Flow rate, total head, efficiency and input KW shall be tested and recorded for at least five points on the pump performance curve. Test shall be performed to demonstrate that the pumps meet ANSI/HI 14.6, acceptance grade 1U for the rated point. Any additional specified points shall be tested to acceptance grade 1E. The points shall include the points specified in Article 2.02. If any pump tested fails to meet any specification requirement it will be modified until it meets all specification requirements. If any pump tested fails to meet the flow rate, head or efficiency requirements for any of the conditions listed in Article 2.02 of this specification and all

reasonable attempts to correct the inefficiency are unsuccessful, the pump shall be replaced with a unit that meets the specified requirements.

5. Certified pump performance curves shall be submitted, including total head, flow rate, bowl efficiency and total brake horsepower for the pump supplied. Test data shall be submitted for approval by the Engineer prior to shipment.
  6. If the Manufacturer does not have historical test records for NPSH3 at the specified design pump speed, one pump shall be tested to demonstrate NPSH3 versus flow rate.
  7. All meters, gauges, and other test instruments shall be calibrated within the manufacturer's established time period prior to the scheduled test and certified calibration data shall be provided. If the Manufacturer has no ISO standard calibration period, Hydraulic Institute Standards shall govern.
  8. In lieu of testing with all job equipment, job pump bowls may be tested with a laboratory column pipe and discharge head similar in size to that furnished for final installation.
  9. The pumps shall be tested at 100 percent of the design speed. Reduced speed curves will be determined using affinity laws.
  10. The pump shall be tested through the specified range of flow, and head/flow rate/efficiency curves plotted at maximum output speed. During the test, the pump shall be run at each head condition for sufficient time to accurately determine flow rate, head, power input, and efficiency. In addition, during the tests, the overall efficiency shall be determined at each test point. The pump under test shall be modified until the specified conditions are met or replaced with a pump that will meet the specified conditions.
- C. Pump motor tests, including physical testing after manufacture and before shipment to determine actual motor reed critical frequency of each motor, in two perpendicular planes denoted relative to the conduit box, at the motor manufacturer's facility and variable frequency drive tests as specified in Section 16150 shall be submitted for approval by the Engineer prior to shipment.
- D. Field Testing:
1. In the presence of the Engineer, necessary tests shall be performed to indicate that the pump, variable frequency drive and motor generally conform to the operating conditions specified. The factory testing specified above will be the basis of performance acceptance. A 7-day operating period of the pump will be required before acceptance. If a pump performance does not generally agree with the factory test results, corrective measures shall be taken, or the pump shall be removed and replaced with a pump that satisfies the conditions specified. Provide, calibrate and install all temporary gauges and meters, make necessary tapped holes in the pipes, and install all temporary piping and wiring required for the field acceptance tests. Written test procedures shall be submitted to the Engineer for approval no fewer than 30 days prior to testing.
  2. After installation and as soon as conditions permit full speed operation, the Contractor shall retain the services of a fully experienced independent mechanical vibration testing and analysis firm, either Mechanical Solutions Inc. (MSI) Whippany, NJ, or Engineering Dynamics Inc. (EDI) San Antonio, TX or pre-approved equal, to perform a detailed

vibration signature analysis of each unit(s) in accordance with ANSI/HI 9.6.4, including both "Bump Tests" and X-Y vibration profiles, to (a) prove compliance with the specified vibration limitations and (b) prove there are no field installed resonant conditions due to misalignment, the foundation, or the connecting piping and its supports, when operating at any speed within the specified operating range. Testing shall occur at the design full speed, design minimum speed, and at a maximum of 3 Hz increments between minimum and full speed. A written report shall be submitted including a detailed schematic drawing of the units indicating thereon where and in which direction the vibration readings were taken and recorded showing (a) peak-to-peak displacement, in mils, (b) frequency spectrum, (c) peak velocity level, in inches per second, (d) velocity level, in inches per second RMS. The report shall contain a complete analysis of their findings, describing any problem encountered, if any, probable cause and specific recommendations for any required corrective action.

- a. If required, take corrective action and the units shall be retested to ensure full compliance with this Section. All costs associated with the field tests or any required corrective action shall be borne by the Contractor.
3. Motor tests:
    - a. Prior to any pump mechanical test, the Contractor shall megger each motor winding before energizing the motor, and, if insulation resistance is found to be low, shall notify the Engineer and shall not energize the motor.
    - b. Prior to any pump mechanical test, the Contractor shall check all motors for correct clearances and alignment and for correct lubrication in accordance with the motor manufacturer's instructions. The Contractor shall check direction of rotation of all motors prior to any pump mechanical test and reverse connections, if necessary.
    - c. The Contractor shall meet all the testing requirements of Section 16150.
  4. If required, take corrective action and have the units retested to ensure full compliance with the specified requirements. All costs associated with the field tests or any required corrective action shall be borne by the Contractor.

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SECTION 11216  
HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, and incidentals required to completely install, put in operation and field test one (1) horizontally mounted, axial split-case, single stage, double suction, single or double volute, variable speed driven, centrifugal pump and motor as shown on the Drawings, Contract Documents, and as specified herein.
- B. This specification is intended to give a description of what is required, but does not cover all details, which will vary in accordance with the requirements of the Manufacturer. In addition to the services required of the Manufacturer, Contractor shall provide all necessary supervisory services during installation and field testing of each unit and instructing the regular operating personnel in the proper care, operation and maintenance of the equipment.
- C. This pump is designed to pump potable water into the potable water distribution system for the Greenland WTP service area. All internal components shall be compatible for use in potable water distribution systems and shall be NSF61 approved.
- D. The Contractor shall provide a Peerless pump model, to match the existing Peerless Pump.
- E. The Contractor shall provide a motor to match the existing high service pump motors as manufactured by Reliance/Baldor.

1.02 RELATED WORK

- A. Construction sequence is included in Section 01014.
- B. Concrete work and the installation of anchor bolts are included in Division 3; however, anchor bolts for these units as recommended by the Manufacturer shall be furnished by the Contractor under this section.
- C. Field painting is included in Division 9.
- D. Valves and appurtenances, mechanical piping, piping accessories, pipe hangers and supports are included in Division 15.
- E. Instrumentation and control work, except as specified herein, is included in Division 13. Instrumentation and controls provided in this section shall adhere to Instrumentation and Control Specifications sections in Division 13.
- F. Electrical work except as hereinafter specified is included in Division 16.

1.03 SUBMITTALS

- A. With the exception of shop drawing submittals specifically assigned to the Manufacturer, Contractor shall submit, in accordance with Section 01300, shop drawings and product data. Submittals shall include the following:

1. Certified dimensional drawings of each item of equipment and auxiliary apparatus to be furnished.
2. Certified foundation, pump support and anchor bolt plans and details.
3. Schematic electrical wiring diagram and other data as required for complete pump installation.
4. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the detail specifications.
5. Total weight of pumping unit.

B. Design Data

1. Contractor shall note that the following design information shall be provided by the Supplier and provided to the Contractor by Owner: Manufacturer's certified rating curves, to satisfy the specified design conditions, showing pump characteristics of discharge, head, brake horsepower, efficiency and guaranteed net positive suction head required, 3% (NPSH3). Curves shall show the full recommended range of performance and include shut-off head. This information shall be prepared specifically for the pump proposed. Catalog sheets showing a family of curves will not be acceptable.

C. Test Reports

1. Contractor shall note that the following test reports and information shall be provided by the Manufacturer and provided to the Contractor by Owner:
2. Certified motor test data as described in Section 16150.
3. Tabulated data for the drive motors including rated Hp, full load rpm, power factor and efficiency curves at 1/2, 3/4 and full load, service factor and kW input, including when the pump is at its design point. Submit a certified statement from the motor manufacturer that the motors are capable of continuous operation on the power supply without affecting their design life for bearings or windings.
4. A schedule of the date of shop testing and delivery of the equipment to the job site.
5. Description of pump factory test procedures and equipment.
6. A statement that the pump will function properly as installed with respect to the suction piping layout as shown on the Drawings.

D. Operation and Maintenance Data

1. Contractor shall note that the following design information shall be provided by the Manufacturer and provided to the Contractor by Owner: complete operating and maintenance instructions shall be furnished for all equipment included under this section as provided in Section 01730. The maintenance instructions shall include troubleshooting data and full preventative maintenance schedules and complete spare parts lists with ordering information.

#### 1.04 REFERENCE STANDARDS

- A. Design, manufacture and assembly of elements of the equipment specified herein shall be in accordance with, but not limited to, published standards of the following, as applicable:
  - 1. American Gear Manufacturers Association (AGMA)
  - 2. American Institute of Steel Construction (AISC)
  - 3. American Iron and Steel Institute (AISI)
  - 4. American Society of Mechanical Engineers (ASME)
  - 5. American National Standards Institute (ANSI)
  - 6. American Society for Testing Materials (ASTM)
  - 7. American Welding Society (AWS)
  - 8. American Bearing Manufacturers Association (ABMA)
  - 9. Hydraulic Institute (HI)
  - 10. Institute of Electrical and Electronics Engineers (IEEE)
  - 11. National Electrical Code (NEC)
  - 12. National Electrical Manufacturers Association (NEMA)
  - 13. Occupational Safety and Health Administration (OSHA)
  - 14. The Society for Protective Coatings (SSPC)
  - 15. Underwriters Laboratories (UL)
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

- A. To assure unity of responsibility, the motors, and base plates shall be furnished and coordinated by the Manufacturer. The Contractor and Manufacturer shall assume responsibility for the satisfactory installation and operation of the entire pumping system including pumps, motors, base plates and controls as specified.
- B. The equipment supplied by the Manufacturer under this Section shall be standard pumping equipment of proven ability as manufactured by concerns having extensive experience in the production of such equipment similar to the applications stated in paragraphs 1.01 and paragraph 1.06. Units specified herein shall be furnished by a single manufacturer. The equipment furnished shall be designed, constructed and installed to operate satisfactorily when installed as shown on the Drawings.

- C. Pump supplied by Manufacturer shall be manufactured in accordance with the Hydraulic Institute Standards, except where otherwise specified herein.
- D. The Manufacturer shall be fully responsible for the design, arrangement and operation of all connected rotating components, of the assembled pumping unit mounted on a fabricated steel base plate, to ensure that neither harmful nor damaging vibrations occur at any speed within the specified operating range. The pump shall be provided with base plate so the discharge centerline elevation of all pumps is the same.
- E. Maximum vibration velocity in inches per second RMS, measured in the field, shall be less than the requirements of ANSI/HI 9.6.4-latest edition. In addition, for pump operating speeds less than or equal to 600 rpm, field vibration displacement shall be measured in mils peak-to-peak and shall be less than the requirements of ANSI/HI 9.6.4-latest edition.

#### 1.06 SYSTEM DESCRIPTION

- A. The Manufacturer-furnished pump shall be horizontal axial split-case, single stage centrifugal pumps with single or double volute enclosed type impeller with stable constantly rising curve to shut-off head, renewable casing rings, flexible coupling and extended rigid structural steel base plate under each pump and driving motor. The pump shall be provided with base plate so the discharge centerline elevation of all pumps are the same.
- B. Pump provided shall be one (1) variable frequency drive (VFD) High Service Pump as described herein.
- C. The pump shall be capable of operating over the range of system curves provided at the end of this Section.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the unit and equipment are ready for operation.
- B. All equipment and parts must be properly protected against any damage during a prolonged period at the site. Store all equipment in accordance with the manufacturer's instructions.
- C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.
- D. The finished surfaces of all exposed flanges shall be protected by wooden or equivalent blank flanges, strongly built and securely bolted thereto.
- E. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- F. No shipment shall be made until approved by the Engineer in writing.
- G. For protection of bearings during shipment and installation, the bearing shall be properly processed. Anti-friction bearings, if pre-lubricated, shall be protected in accordance with the bearing manufacturer's recommendations against formation of rust during a long period of storage while awaiting completion of installation and start-up of the machine in which they are

used. Anti-friction bearings which are not pre-lubricated shall be properly treated in accordance with the bearing manufacturer's recommendation against formation of rust during a long period of storage, while waiting completion of installation and start-up, by the application of Exxon, Rust-Ban No. 392 or equal treatment.

#### 1.08 WARRANTY

- A. The equipment shall be warranted for a period of one year from date of substantial completion as defined under the General Conditions, Division 0, to be free from defects in workmanship, design or material. If the equipment should fail during the warranty period due to a defective part(s), it shall be replaced in the machine and the unit(s) restored to service at no additional cost to the Owner.

#### PART 2 PRODUCTS

The following information in Part 2 is provided to the Contractor to assist in their preparation of their bid. The specific pump and motor to be furnished by the Manufacturer shall be made known to the Contractor as soon as an agreement is reached with the selected Manufacturer. Owner will supply all necessary information including shop drawing submittals to Contractor as available. The Contractor is still responsible for field painting requirements in paragraph 2.08.

#### 2.01 GENERAL

- A. The pumping units shall all be supplied by one manufacturer and shall be complete including pumps, motors and appurtenances such as, but not limited to, couplings, guards and gauges.
- B. The pump, motor, drive and controls shall be designed and built for 24-hour continuous service at any and all points within the required range of operation, without overheating, without cavitation and without excessive vibration or strain. All parts shall be so designed and proportioned as to have liberal strength, stability and stiffness and to be especially constructed to meet the specified requirement. Ample room and facilities shall be provided for inspection, repairs, and adjustment.
- C. All necessary anchor bolts, nuts, and washers shall be furnished and shall be Type 316 stainless steel, and furnished by Contractor.
- D. Each major piece of equipment shall be furnished with a stainless steel nameplate (with embossed data) securely mounted to the body of the equipment. As a minimum, the nameplate for the pumps shall include the manufacturer's name and model number, serial number, rated flow capacity, head, speed and all other pertinent data. As a minimum, nameplates for motors shall include the manufacturer's name and model number, serial number, horsepower, speed, input voltage, amps, number of cycles and power and service factors. Nameplate information shall include the manufacturer's name and serial number, input speed, voltage, current and frequency and horsepower at full load.
- E. Refer to Section 01170 for noise limitations for the equipment.
- F. The pump shall conform to AWWA E-103, Horizontal and Vertical Line-Shaft Pumps Standard and ANSI/NSF 61 Annex G and/or ANSI/NSF 372 where not in conflict with the requirements specified herein.
- G. Coordinate the required reducer size with the selected pump manufacturer.

## 2.02 CONDITIONS OF SERVICE

- A. The pump to be provided shall be a horizontal split case centrifugal pump by Peerless, model 6AE16
- B. The pump shall be designed for the conditions of service tabulated as follows and shall operate within the system head curves as appended.

| Item Description   | High Service Pump Design Conditions |
|--|-------------------------------------|
| Service  | Finished Water                      |
| Number of Pumps (operating/standby)  | (1/1)                               |
| Maximum Motor Full Load Speed (FLS) (rpm)                                      | 1785                                |
| Minimum Allowable Motor (non-overloading throughout operating range) (HP)      | 125                                 |
| Motor Design Voltage/Phase/Frequency   | 460V/3PH/60Hz                       |
| Maximum Anticipated Pump Fluid Temperature (degrees F.)                        | 80                                  |
| Minimum Pump Discharge Nozzle Size (inches)                                    | 6                                   |
| Minimum Suction Nozzle Size (inches)   | 8                                   |
| Pump Shut-Off Head at Motor FLS Acceptable Range (minimum/maximum) (feet)      | 275/285                             |
| Flow Rate at Secondary Operation Point (gpm)                                   | 1,500                               |
| Minimum TH at Secondary Operation Point (feet)                                 | 238                                 |
| Minimum Efficiency at Secondary Operation Point (%)                            | 79                                  |
| Maximum NPSH3 at Secondary Operation Point (feet)                              | 10                                  |
| Intermediate (Design) Point Flow Rate (gpm)                                    | 2,000                               |
| Minimum TH at Intermediate (Design) Point (feet)                               | 185                                 |
| Minimum Efficiency at Intermediate (Design) Point (%)                          | 78                                  |
| Maximum NPSH3 at Intermediate (Design) Point (feet)                            | 14                                  |
| Best Efficiency Point (BEP) Flow Rate Acceptable Range (minimum/maximum) (gpm) | 1,700/2,200                         |
| Minimum Efficiency at BEP (%)  | 80                                  |
| Primary Operating Point TH (run-out) (feet)                                    | 150                                 |
| Minimum Flow Rate at Primary Operating Point (run-out) TH (gpm)                | 2,325                               |
| Minimum Overall Efficiency at Primary Operating (run-out) TH (%)               | 70                                  |
| Maximum NPSH3 at Primary Operating Point (run-out) (feet)                      | 21                                  |
| Pump Model Used for Design   | Peerless Model -6A E16              |

- C. Where TH is referred to in conjunction with the specific discharge requirements, it shall be understood to consist of the sum of the pressure head plus the velocity head, in feet, at the discharge nozzle of the pump minus the pressure head and the velocity head at the suction nozzle of the pump. The efficiency of the pump shall be understood to be based upon TH as just defined.
- D. The top half of each case at the topmost part shall have a bossed pipe tap opening for mounting priming air chamber. Pipe taps shall not be less than ½-inch NPT.
- E. The pump shall operate throughout the entire operating range, within the vibration limits specified in paragraph 1.05F above.
- F. Flow separation at the inlet of impeller shall not be permitted when it could result in damage to the impeller. Obvious, excessive hydraulic noise that is characteristic of flow separation shall be deemed as evidence that flow separation is occurring at the level that will cause damage.

## 2.03 PUMP CONSTRUCTION

- A. Casings shall be of cast iron conforming to ASTM A48, Class 30 of sufficient thickness and suitably ribbed to withstand all stresses and strains of service at full operating pressure. Casings shall be of the double or single volute type split on the horizontal center line with the side suction and discharge nozzle cast integrally with the lower half. Removal of the upper half of the casing must allow the rotating element to be removed without disconnecting the suction and discharge flanges. Lifting eyes shall be cast into the upper casing. Flange and casings shall be designed for a working pressure of 175 psi. The casing shall be provided with tapped and plugged (removable) vent, drain and gauge connections. Suction and discharge connections shall be 125 lbs ANSI Standard flat-face flanges positioned as indicated on the Drawings.
- B. Impellers shall be of the enclosed double suction type of nickel aluminum bronze or cast CF8M stainless steel. Impellers shall be cast in one piece and shall be statically and dynamically balanced. Rotation of the impeller shall correspond to the pump discharge orientation as indicated on the Drawings. The impeller shall be keyed to the shaft and firmly held in place. The arrangement shall be such that the impeller cannot be loosened by torque from either forward or reverse rotation.
- C. Wearing Rings
  - 1. The pump shall be provided with removable ASTM A276 type 440A stainless steel wearing rings for the casing with the wearing surfaces parallel to the axis of rotation.
  - 2. Wearing rings shall be securely fastened to prevent any relative motion and designed for easy replacement.
- D. Pump Stuffing Boxes and Seals:
  - 1. The pump stuffing box shall be designed to accommodate mechanical seals. The boxes shall be satisfactory for 30 feet of positive head and 15 feet of negative head and shall be designed for external water flushing from the pump volute.
  - 2. The pump shall be equipped with a John Crane, Type 5611, self-aligning, single inside mounted mechanical seal equipped with silicon carbide rotating seal face and carbon stationary seal face. All metal parts, including gland, and drive collar shall be constructed

of 316 stainless steel. Springs shall be Hastaloy C, or Eligiloy. Elastomers shall be EPDM. The gland shall be drilled and tapped for venting back to suction or to supply seal cooling water from the volute (API Plan 11).

3. Drip pockets shall be provided in the bearing brackets under the packing glands to catch any water dripping from pump stuffing boxes. These drip pockets shall be furnished with tapped drain connections.
- E. The pump bearings shall be of the heavy duty single row inboard and double row outboard anti-friction type arranged for grease lubrication complete with pressure device designed in accordance with ABMA Standards for a minimum L-10 life of 50,000 hours, without the addition of external cooling. Removable bearing housings shall be bolted and doweled to bearing brackets that are cast integral with the pump lower half casing.
- F. The pump shaft shall be of high-grade 416 series, stainless steel. Shaft shall be of sufficient size to transmit the full driver horsepower with a liberal safety factor, accurately machined over the entire length and free from harmful and damaging vibrations.
- G. The pump and its driving equipment shall be designed and constructed to successfully withstand a maximum turbinizing speed of the unit resulting from backflow through the pump of 125 percent of the design operating speed or the runaway speed that would occur at an applied head of 270-ft, whichever is higher respectively.

#### 2.04 PUMP DRIVE SYSTEM

- A. Pump shall be driven by a horizontal premium efficiency inverter duty TEFC motor. Motor horsepower shall be as specified in Paragraph 2.02. The pump motor shall be furnished by the pump manufacturer. Motor shall meet all requirements of Section 16150.
- B. The pump motor shall be suitable for driving the pump continuously over the entire pumping range. The pump motor shall be furnished by the pump manufacturer. The motor shall be constructed and guaranteed to withstand runaway reverse speed equal to 125 percent of synchronous speed or the runaway speed that would occur at an applied head of 275-ft, whichever is higher respectively.
- C. The motor shall be built in accordance with latest NEMA, IEEE, ANSI and ABMA standards where applicable. Motor shall conform to all requirements stipulated in PART 1 - GENERAL of this Section of the specifications and with the specifications for motors included in Section 16150.
- D. Bearings shall be anti-friction, grease lubricated type. Bearings shall have an ABMA L-10 life of 50,000 hours.
- E. Motor noise level shall not exceed 85 dBA measured 3 feet from the unit under free field conditions.
- F. Provide motor winding thermostats and motor space heaters per Section 16150.
- G. Motor shall have stainless steel hardware, fasteners, drains and breathers.
- H. Motor shall be provided with the manufacturer's routine motor tests and certified reports.

- I. The pump shall be directly connected to its driver by means of a KTR Rotex 75 all metal flexible coupling, suitably sized to transmit the required driving torque and to accommodate unavoidable shaft misalignment.

## 2.05 VARIABLE FREQUENCY DRIVES

- A. The VFD will be supplied by the VFD Manufacturer specified in Section 16370 and shall be completely coordinated with the pump and pump driving motors by the Contractor.
- B. The speed control for the variable speed pump will be VFD, as specified in Section 16370, suitable for installation as shown on the drawings.
- C. The VFD will conform to all requirements stipulated in this section and Section 16370 - Electrical, and will be designed for a speed range of 65% to 100% of full load motor speed.
- D. The VFD will be compatible with the motor provided.
- E. VFD manufacturer shall provide all I/O signals and controls as described on the electrical elementary drawings and P&IDs.

## 2.06 BASE PLATES

- A. The pump and driving motor shall be mounted on an extended fabricated steel drip-rim base plate, with provision to collect leakage and shall be of sufficient size and rigidity to support the unit and prevent harmful or damaging vibration. A minimum 1/2-in drain tap and copper pipe nipple shall be provided. The steel base shall be anchored to the level surface of a concrete pad with suitably sized Type 316 stainless steel anchor bolts. Baseplate shall also include grout holes.

## 2.07 SHOP TESTING

- A. The Engineer shall have the right to inspect any equipment to be furnished under this section, prior to shipment from point of manufacture.
- B. The pump being furnished in this section shall be factory tested in accordance with the latest edition of the Hydraulic Institute Standards. Certified copies of the Hydrostatic Test Report shall be supplied prior to conducting a pump performance test. Notification of such test and a list of test equipment and procedures shall be furnished to the Engineer at least ten working days before the schedule test date.
  1. The Manufacturer shall factory test the pump prior to shipment in accordance with the Hydraulic Institute standards, latest version. Flow rate, TH and Input KW shall be tested and recorded for at least five points on the pump performance curve. Test shall be performed to demonstrate that the pumps meet ANSI/HI 14.6-latest edition, American National Standard for Rotodynamic Pumps for Hydraulic Performance Acceptance Tests, acceptance grade 1U for all specified points. The five points shall include the points specified herein.
  2. All gauges and other test instruments shall be calibrated within 30 days of the scheduled test and certified calibration data shall be provided. All Venturi flow meters shall be calibrated within two years of the scheduled test and certified calibration data shall be provided.

- C. Pump motor tests as specified in Division 16 shall be submitted for approval by Engineer prior to shipping.

## 2.08 SURFACE PREPARATION AND SHOP PRIMING

- A. The pumping unit, including pump, motor and base plate shall be prepared and shop-primed as specified in Section 09901. The shop primer shall be compatible with the finish paint. Field painting is included in Section 09902.
- B. All coatings shall be NSF61 approved.

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Coordinate with Supplier and other trades, equipment and systems to the fullest extent possible.
- B. In coordination with Manufacturer Take all necessary measurements in the field to determine the exact dimensions for all work and the required sizes of all equipment under this contract. All pertinent data and dimensions shall be verified.

### 3.02 INSTALLATION

- A. Installation shall be in strict accordance with the Supplier's instructions and recommendations in the locations shown on the Drawings. Anchor bolts shall be set in accordance with the Suppliers' recommendations and setting plans.
- B. Qualified supervisory services, including Manufacturer's engineering representatives, shall be provided to ensure that the work is done in a manner fully approved by the Manufacturer. The Manufacturer's representatives shall specifically supervise the installation and alignment of the pump with the driver, the grouting, and the alignment of the connecting piping. If there are difficulties in the start-up or operation of the equipment due to the Manufacturer's design or fabrication, additional service by the Manufacturer shall be provided at no cost to the Owner. Services of the Manufacturer's representatives and training shall be provided when the first pump is started, with follow-up visits upon start-up of each subsequent pump.
- C. Connection of piping to pump shall be done in presence of the Engineer. All piping connections to the pump shall be done without bending and/or twisting the piping to mate with the pump flange connections.
- D. A certificate from Manufacturer to the Contractor and Owner shall be submitted stating that the installation of their equipment is satisfactory, that the equipment is ready for operation and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit. Contractor shall also provide a certificate to Owner and Engineer that the high service pumping system is ready for operation

### 3.03 FIELD TESTS

- A. In the presence of the Engineer, Contractor, assisted by Manufacturer, shall perform necessary tests to indicate that the pump and motor generally conform to the operating conditions specified. The factory testing specified above will be the basis of performance acceptance. A 7 day operating period of the pump will be required before acceptance. Facility acceptance is

included in Section 01465. If a pump performance does not generally agree with the factory test results, corrective measures shall be taken or the pump shall be removed and replaced with a pump that satisfies the conditions specified. Provide, calibrate and install all temporary gauges and meters, make necessary tapped holes in the pipes, and install all temporary piping and wiring required for the field acceptance tests. Written test procedures shall be submitted to the Engineer for approval no fewer than 30 days prior to testing.

- B. After installation of the pump and as soon as conditions permit full speed operation, the Contractor shall retain the services of a qualified independent mechanical testing firm to perform a detailed vibration signature analysis of the unit(s), including both "Bump Tests" and X-Y vibration profiles, to (a) prove compliance with the specified vibration limitations and (b) prove there are no field installed resonant conditions due to misalignment, the foundation, or the connecting piping and its supports, when operating at any speed within the specified operating range. A written report shall be submitted including a sketch of the units indicating thereon where and in which direction the vibration readings were taken and recorded showing (a) peak to peak displacement, in mils, (b) frequency, (c) velocity level, in inches per second RMS. The report shall contain a complete analysis of their findings, describing any problem encountered, if any, probable cause and specific recommendations for any required corrective action.
- C. If required, take corrective action and the units shall be retested to ensure full compliance with this Section. All costs associated with the field tests or any required corrective action shall be borne by the Contractor.

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SECTION 13205  
WIRE WRAPPED PRESTRESSED CONCRETE TANKS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, and incidentals required to design, construct, test, and disinfect one 80-ft diameter (inside) AWWA D-110 Type II circular wire wrapped prestressed concrete ground storage tank (Ground Storage Tank No. 2) equipped with a 10,000-gpm capacity tray aerator and interior and exterior coatings. Also included are all cast-in-place concrete slabs, sumps and platforms in the tanks, base slab, and walls of tanks; including the guardrail, handrail, toe board, manways, ventilation fans and intake hoods all as shown on the Drawings and as specified herein.
- B. Coordinate the design and construction of the tank bottom slab, foundation, sump and equipment supports with the equipment supplier including all associated pipe connections.
- C. Furnish and install all piping and fittings to the limits as shown on the Drawings and as specified herein and in other Sections.
- D. Geotechnical information to be used in the design of the prestressed tank can be found in the Final Report of Geotechnical Exploration for JEA Greenland Water Treatment Plant Expansion performed by Meskel & Associates Engineering dated August 2019.

1.02 RELATED WORK

- A. Excavation, dewatering, and backfill are included in Division 2.
- B. Concrete is included in Division 3.
- C. Waterproofing, dampproofing and caulking are included in Division 7.
- D. Miscellaneous Metals are included in Section 05500.
- E. Level transmitters and appurtenances are included in Division 13.
- F. Pipe, valves, and fittings are included in Division 15.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data, showing materials of construction and details of installation for:
  - 1. Product Data: Manufacturer's information, specifications, and installation instructions for the tank appurtenances. This submittal will be reviewed for operational requirements only. Appurtenances shall include the following:
    - a. Inlet, outlet, overflow, and drain pipes
    - b. Walkways, hatches, and railings
    - c. Supports
    - d. Wall Manways
    - e. Liquid Level Indicators

- f. 7-level tray aerator
  - g. Vents and fan hoods
  - h. Interior and exterior coatings
- 2. Shop Drawings: Detailed erection shop drawings and construction procedures stamped by a professional engineer licensed in the State of Florida. Provide complete details for the foundation, floor slab, walls, roof construction, piping, and all other details and accessories necessary to build the tanks. The submittal will be reviewed for operational requirements only and will be used in the field by the Owner's representative during construction.

B. Design Data

- 1. Upon the completion of the construction of the tank(s), submit the design calculations of the "as-built tank(s)" stamped by a professional engineer licensed in the State of Florida for the project records only. The calculations will not be reviewed by the Engineer. Calculations submitted prior to tank construction will be not be reviewed and will be returned for re-submittal upon completion of construction.

C. Certification

- 1. The tank manufacturer shall be responsible for the design and construction of the prestressed concrete tank(s) and all interior and exterior tank coatings. The tank manufacturer shall submit written certification prepared, sealed, and signed by a professional engineer licensed in the State of Florida that the design, details, and construction conform to the requirements of AWWA D110, this Section, and applicable city and state building codes. Submit certification on Form 13205-A included at the end of this Section.

D. Statement of Qualification

- 1. Submit experience record in the design and construction of wire-wrapped prestressed concrete tanks as specified herein.
- 2. Submit experience record in shotcrete work of each nozzleman and foreman to be employed on the project as specified herein.

1.04 REFERENCE STANDARDS AND DOCUMENTS

A. ASTM International

- 1. ASTM A366 - Standard Specification for Commercial Steel, Sheet, Carbon, Cold-Rolled.
- 2. ASTM A416 - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
- 3. ASTM A475- Standard Specification for Zinc-Coated Steel Wire Strand.
- 4. ASTM A603- Standard Specification for Zinc-Coated Steel Structural Wire Rope.
- 5. ASTM A615/A615M – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

6. ASTM A653/653M – Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by Hot Dip Process.
7. ASTM A722 - Standard Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete.
8. ASTM A821 - Standard Specifications for Steel Wire, Hard Drawn for Prestressing Concrete Tanks.
9. ASTM A882/A882M-04 – Standard Specification for Filled Epoxy-Coated Seven-Wire Prestressing Strand.
10. ASTM A884/A884M – Standard Specification for Epoxy Coated Steel Wire and Welded Wire Reinforcement.
11. ASTM A1064/A1064M – Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
12. ASTM C31/C31M – Standard Practice for Making and Curing Concrete Test Specimens in the Field.
13. ASTM C33/C33M – Standard Specification for Concrete Aggregates.
14. ASTM C39/C39M – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
15. ASTM C143/C143M – Standard Test Method for Slump of Hydraulic-Cement.
16. ASTM C172/C172M – Standard Practice for Sampling Freshly Mixed Concrete.
17. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
18. ASTM D1056 - Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
19. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Filler for Concrete Paving and Structural Construction.
20. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.
21. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
22. ASTM E1745 - Standard Specifications for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.

B. American Concrete Institute (ACI)

1. ACI 318 - Building Code Requirements for Structural Concrete.

2. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures.
3. ACI 506R - Guide to Shotcrete
- C. American Water Works Association (AWWA)
- D. AWWA C652 - Disinfection of Water-Storage Facilities
- E. AWWA D110 - Wire- and Strand- Wound Circular-Prestressed Concrete Water Tanks.
- F. U.S. Army Corps of Engineers Spec. CRD-C572 - Specification for PVC Waterstop.
- G. State of Florida Building Code, 2017 edition
- H. Occupational Safety and Health Administration (OSHA)
- I. Concrete Reinforcing Steel Institute (CRSI) – Code of Standard Practice
- J. Dynamic Pressure on Fluid Containers of Nuclear Reactors and Earthquakes – Publication TID-7024
- K. ASCE Standard 7 – Minimum Design Loads for Buildings and Other Structures.
- L. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

- A. The Ground Storage Tank No. 2 shall be a wire wrapped prestressed concrete tank with a Type II core wall as manufactured by Crom Corp. Gainesville, FL or Precon Corp. Newberry, FL. No alternates will be allowed.
- B. The Contractor is responsible for providing and installing the stairs to access the ground storage tanks and shall coordinate location, height and any other parameter required with the prestressed concrete tank supplier.
- C. The tank contractor is responsible for providing and installing all interior and exterior tank coatings. Subcontracting of this work is not allowed.
- D. The tank design and construction shall be performed by an established manufacturer of recognized ability, having at least 20 years of experience in the design and construction of AWWA D110 Type II wire wrapped circular prestressed concrete tanks as specified herein. The design and construction of all aspects of the floor slab, walls, prestressing, shotcrete and roof of the wire wound circular prestressed concrete tank shall be performed by the tank manufacturer and shall not be subcontracted or otherwise assigned.
- E. All excavation, backfill, grading, underslab piping, concrete grout topping and concrete encasement work shall be performed by the general contractor under the supervision and responsibility of the tank manufacturer, including the base slab and foundation. The manufacturer shall have designed and constructed at least 10 wire wrapped prestressed concrete tanks conforming to AWWA D110 with Type II core wall(s) that have been put into service

within the last 10 years. The tanks shall have a diameter and capacity of not less than 75 percent nor more than 150 percent of the diameter and capacity of the proposed tank.

- F. Foreman supervising the placing of the shotcrete shall have a minimum of 3 years' experience as a nozzleman. Each shotcrete nozzleman shall have a minimum of 2 years' experience on similar applications and shall be able to demonstrate by tests, if required, his/her ability to satisfactorily gun shotcrete of the required quality.
- G. The tank and equipment shall be designed for a highly corrosive environment with elevated levels of hydrogen sulfide and reduced sulfur.

## 1.06 DESIGN CRITERIA

### A. Tank Construction

- 1. Inside diameter: 80 feet
- 2. Tank wall height: 30.33 feet
- 3. Water elevation levels
  - a. Maximum water elevation level: 63.16 feet
  - b. Minimum water elevation level: 33.83 feet

Top of wall elevations for new tank shall match existing tank. Coordinate field-verified elevation with access stairway and platform

- 4. Floor – Non-prestressed cast-in-place reinforced concrete
  - a. The minimum thickness of the floor slab is 4-in. The floor system shall have a thickened edge for the exterior wall footing. Slabs greater than 8-in shall have top and bottom reinforcement in each direction. The transition from the bottom of the footings and pipe encasements to the underside of the floor slab shall not be steeper than 2 horizontal to 1 vertical. The pipe encasements shall not be less than 6-in for pipes less than 12-in. diameter and not less than 12-in for pipes greater than or equal to 12-in. All pipe encasements shall be flared at tank wall as shown in drawings. The clearance in all directions shall not be less than 12 inches. Pipe encasements shall be shown on the drawings.
  - b. Concrete membrane floors shall be a minimum of 4 inches thick and have a minimum thickness of 8 inches of concrete over all pipe encasements and around sumps.
  - c. A minimum percentage of 0.60% reinforcing steel shall be used in the membrane floor. The minimum percentage shall apply to all thickened sections and shall extend a minimum of 2 ft into the adjacent membrane floor.
- 5. Hydrostatic Floor/Wall Joint - Fixed, rotating, or translating
- 6. Wall - Type II Shotcrete core wall with galvanized metal diaphragm
- 7. Horizontal prestressing shall be continuous. Discontinuous prestressing tendons or strands will not be allowed.
- 8. Roof - Concrete dome. Roof shall be a cast-in-place concrete dome with a minimum thickness of 3 inches.

9. The wire-wound, prestressed concrete tank core wall shall be designed as a thin shell cylindrical element using shotcrete and an embedded, mechanically bonded, galvanized steel shell diaphragm.
10. The design of the core wall shall take into account appropriate edge restraint. To compensate for bending moments, shrinkage, differential drying, and temperature stresses, the following minimum reinforcing steel shall be incorporated into the design:
  - a. The top 2 ft of core wall shall have not less than 1% circumferential reinforcing.
  - b. The bottom 3 ft of core wall shall have not less than 1% circumferential reinforcing.
  - c. Inside Face:
    - 1) The inside face of the core wall shall utilize the diaphragm as effective reinforcing.
    - 2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.
11. Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.
  - a. Outside Face:
    - 1) Vertical reinforcing steel in the outside face of the core wall shall be: minimum of #4 bars at 12" center to center.
    - 2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.
12. The minimum core wall thickness shall be 3½ inches.
13. Reinforcing steel used in the core wall shall be designed using a maximum allowable design tensile stress,  $f_s$ , of 18,000 psi.
14. Allowable compressive stress in the core wall due to initial prestressing force,  $f_{gi}$ , shall be:
  - a. 1250 psi + 75t psi/in. with 0.5  $f'_{gi}$  maximum or less (where  $f'_{gi}$  is defined as compressive strength at time initial prestressing force is applied and  $t$  is the thickness of the core wall in inches).
  - b. Maximum of 2000 psi.
15. Allowable compressive stress in the core wall due to final prestressing force,  $f_g$ , shall be:
  - a. 1250 psi + 75t psi/in. with 0.45  $f'_g$  maximum (where  $f'_g$  is defined as compressive strength required for final prestressing force and  $t$  is the thickness of the core wall in inches).
  - b. Maximum of 1800 psi.
16. The dome shall be designed as a free-span, spherical thin shell with one-tenth rise in accordance with the following:
  - a. Typical Dome Design: The typical dome thickness and steel reinforcement shall meet the requirements of ANSI/AWWA D110.
  - b. In all cases, the thickness of the dome shall be no less than 3".
  - c. Dome Edge Design: The dome edge and upper wall shall be designed to resist the moments, thrusts, and shears that occur in this region due to dome and wall prestressing and loading conditions. The design of the edge region shall conform to the following:
    - 1) Dome Edge Thickness:

- (a) A determination of the buckle diameter shall be made, as defined by:

$$d_b = 2.5 \cdot \sqrt{r_d \cdot t_d} \text{ rounded up to the next foot}$$

Where:  $d_b$  = buckle diameter in feet

$r_d$  = dome radius in feet

$t_d$  = typical dome thickness in feet

- (b) Dome edge thickening shall begin at a radial location on the dome, defined as  $s_2$  which is at least one buckle diameter away from the tank wall.
- (c) A springline haunch shall be provided, which extends radially from the inside face of the tank wall to radial location  $s_1$  which is defined as:

$$s_1 = 0.6 \cdot \sqrt{1.5 \cdot r_d \cdot t_d} \text{ rounded up to the next foot}$$

Where:  $s_1$  = distance from inside face of wall to haunch in feet

$s_2$  = distance from inside face of wall to typical dome thickness in feet.

This springline haunch shall begin at the inside face of the tank wall with a springline thickness as required by paragraph (f) below and shall end at radial location  $s_1$  with the following thickness:

$$t_{d1} = 1.33 \cdot t_d$$

Where:  $t_{d1}$  = minimum thickness at  $s_1$  in feet

$t_d$  = typical dome thickness in feet at one buckle diameter from tank wall

- (d) Beginning at  $s_1$  and continuing to  $s_2$  the dome shell shall have a uniform straight line taper.
- (e) Parameters (b), (c), and (d) above are not required for domes where the calculated typical dome thickness is less than 75% of the actual typical dome thickness.
- (f) Sufficient concrete thickness at the springline of the dome shall be provided so that no more than 2 ft of the springline haunch is considered in calculating the effective dome edge ring cross sectional area. Compressive stress in this area shall not exceed 1000 psi when subjected to initial prestressing, offset by dead load only.
- 2) Dome Edge Steel Reinforcement:
- (a) Throughout the dome edge, the percentage of steel reinforcement, both radially and circumferentially, shall be no less than 0.25% of the gross cross sectional area of concrete.
- (b) Along the dome edge, steel reinforcement shall be distributed between the upper and lower layers unless finite element analysis calculations indicate

that tensile stress does not exist in the concrete along the bottom face of the dome edge. In that case, only top bars are required radially and circumferentially. In addition, radial and circumferential reinforcing bars will not be required along the bottom face of the dome edge where the calculated typical dome thickness is less than 75% of the actual typical dome thickness.

- (c) Where reinforcing bars are required in the bottom layer, they shall be placed near the tank wall to insure adequate development at the intersection between dome and wall.
  - (d) In all cases, the percentage of circumferential steel reinforcement in the effective dome ring shall be no less than one percent of the gross cross sectional area of concrete. The effective dome ring is defined as  $\frac{1}{4}$  of the haunch length not to exceed 2 ft'.
  - (e) Where bottom dome edge steel reinforcement is required, vertical steel reinforcement along the inside face of the tank wall shall be no less than 0.5% of the cross sectional area of wall shotcrete.
- B. Design Loads: The tank manufacturer shall use the following minimum loading in the design of the tank and tank appurtenances:
- 1. Unit Weights:
    - a. Concrete and Shotcrete - 150 pcf
    - b. Soil - 120 pcf
    - c. Water – 62.5 pcf
    - d. Steel – 490 pcf
  - 2. Live Load:
    - a. Floor - 62.4 psf times the height of water to overflow plus 6-in
    - b. Buoyant forces shall be offset with dead weight when the tank is fully drained. Note tank is placed above high water elevation and flood zones.
    - c. Roof – 12 psf horizontal projection to tank roof
  - 3. Wind Load:
    - a. Shall be calculated using ASCE 7-10 based on an ultimate wind load of 138 mph ( $V_{ASD} = 107$  mph)
    - b. Building Category III
    - c. Exposure C
  - 4. Earth Pressure:
    - a. Equivalent fluid pressure above groundwater level - 60 pcf
    - b. Equivalent fluid pressure below groundwater level - 90 pcf
    - c. Live Load surcharge equivalent to 2-ft earth
  - 5. Allowable Bearing Pressure: 2,500 psf
  - 6. Seismic design shall comply with the Florida Building Code

## 1.07 DELIVERY, STORAGE AND HANDLING

- A. Delivery, storage and handling of all items shall be specified in Section 01600.

## 1.08 WARRANTY

- A. The tank manufacturer shall warranty the tank structure against any defective materials or workmanship for a period of 5 years from the date of tank acceptance. If any materials or workmanship prove to be defective within that period, they shall be replaced or repaired by the tank manufacturer at no additional cost to the Owner.
- B. If any leakage or other defects appear within warranty period, the tank manufacturer shall promptly repair the tank at its own expense upon written notification by Owner that such defects have been found. This warranty shall not apply to any accessory, equipment, or other products that are not a structural part of the tank manufacturer by a company other than the tank construction company. Leakage is liquid appearing on the exterior of the tank, the source of which is from inside the tank.
- C. All interior and exterior coating shall be included in the scope of the tank manufacturer and shall not be subcontracted. The tank manufacturer shall provide a warranty for the workmanship and materials on all interior and exterior coatings for a 10-year period from the date of acceptance of the work.
- D. A coating system failure is defined as either (1) delamination of the coating, (2) a breach of the coating exposing the substrate below, or (3) chipping and peeling of the coating system not caused by physical damage or abrasion to the tank. Changes in color shall not be deemed a coating failure.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Materials shall be new, be of domestic manufacture, and shall conform to the material specified in AWWA D110 and the following material standards.

### 2.02 GROUND STORAGE TANK MATERIALS

- A. Concrete and reinforcing steel for the tank core wall and roof dome shall conform to the requirements of AWWA D110. Concrete and reinforcing steel for all other structural elements shall conform to the requirements of DIV 3. Admixtures causing accelerated or retarded set of the concrete shall not be used unless approved in writing by the Engineer.
  - 1. Concrete Strength: Minimum concrete strength at 28 days.
    - a. Pipe Encasement  $f'c = 3000$  psi
    - b. Footing and floors  $f'c = 4000$  psi
    - c. Shotcrete composite walls  $f'c = 4000$  psi
    - d. Dome  $f'c = 4000$  psi
- B. Prestressed Wire
  - 1. Unless otherwise approved in writing by the Engineer, prestressed wire shall conform to ASTM A821, having a minimum ultimate strength of 231,000 psi.
- C. Moisture Barrier

1. The moisture barrier shall be polyethylene Class A conforming to ASTM E1745. The thickness shall not be less than 6 mil.
- D. The "eye lid" ventilators shall be precast concrete located on the dome near the edge. The ventilator(s) shall be provided with a 24 mesh stainless steel fail safe pop out insect screen in case of blocked up screens.
- E. Wall Manways. The wall manways shall be a watertight elliptical shape made of Type 316 stainless steel construction. The manway shall have clear opening minimum dimension of 36-in vertical by 60-in horizontal. The manway cover plate with a stainless steel hinge shall be mounted on the inside. A gasket shall be provided between manway cover and the wall sleeve and attached to the manway cover.
- F. Liquid Level Indicator. The liquid level indicator shall have a half travel gauge with an interior float. The glass shall be fiberglass with 4-in black numbers on a white board. The level indicator shall be a red fiberglass target. The zero mark shall be set even with the top of the tank wall. The interior float shall be fiberglass or PVC and shall be guided vertically true. The liquid level indicator shall be placed in a location visible from the operator building.

## 2.03 PERFORMANCE

- A. Performance of the materials used in the tank construction shall conform to the minimum requirements of this specification.
- B. Substitutions to the materials in this specification may only be made if submitted in writing and approved by the engineer.

## 2.04 CONCRETE

- A. Concrete shall conform to ACI 301/301M.
- B. All concrete shall utilize Type I/II Portland cement.
- C. A maximum of 25% of cementitious material may be fly ash.
- D. Admixtures other than air-entraining and water reducing admixtures will not be permitted unless approved by the engineer.
- E. Coarse and fine aggregate shall meet the requirements of ASTM C33/C33M. Concrete mixes

| Mix   | Compressive Strength (psi) | Minimum Cement Content (lbs) | Maximum Aggregate Size (in) | Maximum W/C Ratio | Air Content (%) | Slump (in) |
|-------|----------------------------|------------------------------|-----------------------------|-------------------|-----------------|------------|
| Floor | 4000                       | 560                          | 1"                          | 0.45              | N/A             | 4"+/-1"    |
| Dome  | 4000                       | 600                          | ½                           | 0.45              | 5% ± 1.5%       | 4"+/-1"    |

used in the construction of the tank shall conform to the following:

## 2.05 SHOTCRETE

- A. Shotcrete shall conform to the requirements of ACI 506.2 except as modified herein.

- B. All shotcrete mixes shall utilize Type I/II cement.
- C. A maximum of 25% of cementitious material may be fly ash.
- D. All shotcrete in contact with diaphragm or prestressing wire shall be proportioned to consist of not more than three parts sand to one part Portland cement by weight. All other shotcrete shall be proportioned to consist of not more than four parts sand to one part Portland cement by weight.
- E. Admixtures will not contain more than trace amounts of chlorides, fluorides, sulfides or nitrates.
- F. Fine aggregate shall meet the requirements of ASTM C33/C33M.
- G. Shotcrete mixes used in the tank construction shall conform to the following:

| Mix       | Compressive Strength (psi) | Maximum W/C Ratio | Air Content (%) | Slump (in) | Fiber Reinforcement (lbs/cyd) |
|-----------|----------------------------|-------------------|-----------------|------------|-------------------------------|
| Core Wall | 4000                       | 0.42              | 4 – 7           | 4"±1"      | -                             |
| Covercoat | 4000                       | 0.42              | 4 – 7           | 4"±1"      | -                             |

#### 2.06 PRESTRESSED REINFORCEMENT

- A. The prestressing wire shall conform to the requirements of ASTM A821/A821M, Type B.
- B. The prestressing wire size shall be 0.162" (8 gauge), 0.192" (6 gauge) or larger, but no larger than 0.250".
- C. The ultimate tensile strength,  $f_u$  shall be, 231,000 psi or greater for 8-gauge wire, 222,000 psi or greater for 6 gauge.
- D. Splices for horizontal prestressed reinforcement shall be ferrous material compatible with the prestressing reinforcement and shall develop the full strength of the wire.

#### 2.07 NON-PRESTRESSED REINFORCEMENT

- A. Non-prestressed mild reinforcing steel shall be new billet steel meeting the requirements of ASTM A615/A615M with a minimum yield strength,  $f_y$ , of 60,000 psi.
- B. Welded wire reinforcing shall be plain wire conforming to the requirements of ASTM A1064/A1064M with a minimum yield strength,  $f_y$ , of 65,000 psi.

#### 2.08 GALVANIZED STEEL DIAPHRAGM

- A. The galvanized steel used in the construction of the core wall shall be 26 gauge with a minimum thickness of 0.017 in. conforming to the requirements of ASTM A653/A653M. Weight of zinc coating shall be not less than G90 of Table 1 of ASTM A653/A653M.
- B. The diaphragm shall be formed with re-entrant angles and erected so that a mechanical key is created between the shotcrete and diaphragm.

- C. The diaphragm shall be continuous to within 3 in. of the top and bottom of the wall. Horizontal joints or splices will not be permitted.
- D. All vertical joints in the diaphragm shall be rolled seamed, crimped and sealed watertight using epoxy injection.
- E. In all tanks designed to use a waterstop at the floor/wall joint, the steel shell diaphragm shall be epoxy bonded to the waterstop.

## 2.09 PVC WATERSTOPS, BEARING PADS AND SPONGE FILLER

- A. Plastic waterstops shall be extruded from an elastomeric plastic material of which the base resin is virgin polyvinyl chloride.
- B. The profile and size of the waterstop shall be suitable for the hydrostatic pressure and movements to which it is exposed.
- C. Bearing pads used in floor/wall joints shall consist of neoprene, natural rubber or polyvinyl chloride.
- D. Sponge filler at the floor/wall joint shall be closed-cell neoprene.

## 2.10 EPOXY

- A. Epoxy Sealants:
  - 1. Epoxy shall conform to the requirements of ASTM C881/C881M.
  - 2. Epoxy used for sealing the diaphragm shall be Type III, Grade 1, and shall be 100% solids, moisture insensitive, low modulus epoxy.
  - 3. Epoxy used for placing the waterstop shall be Type II, Grade 2, and shall be 100% solids, moisture insensitive, low exotherm epoxy.
  - 4. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77°F.
  - 5. The epoxy sealants used in the tank construction shall be suitable for bonding to concrete, shotcrete, PVC and steel.
- B. Bonding Epoxy:
  - 1. Epoxy resins used for enhancing the bond between fresh concrete and hardened concrete shall conform to the requirements of ASTM C881/C881M.
  - 2. Epoxy resins shall be a two-component, 100% solids, moisture-insensitive epoxy and shall be Type II, Grade 2.

## 2.11 SEISMIC RESTRAINT CABLES

- A. When required by design, seismic restraint cables shall be ½-inch diameter, 7-wire strand conforming to ASTM A416/A416M.

- B. The strand shall be galvanized in accordance with ASTM A475, or ASTM A603, with a minimum weight per unit of coated wire surface, Class A.
- C. The minimum yield strength of the seven-wire strand shall be 270,000 psi.

## 2.12 TANK ACCESSORIES

- A. Minimum of two, 3' 0" x 5' 0" rectangular Type 316 stainless steel wall manholes for access to the interior of the tank. The cover shall also be of Type 316 stainless steel and hinged. The wall manhole shall be designed to resist hydraulic loading without excessive deflection.
- B. Aluminum handrail shall be fabricated from 6061-T6 aluminum and shall conform with all applicable OSHA standards. Aluminum accessories shall have an anodized finish.
- C. Interior ladder shall be fabricated from NSF approved fiberglass shall conform with all applicable OSHA standards. The ladder shall have a safety climbing device manufactured from Type 316 stainless steel as required to meet applicable OSHA standards.
- D. Roof hatch cover and liquid level indicator shall be fabricated from fiberglass.
- E. Through-wall pipe sleeves shall be Type 316 stainless steel sleeves with neoprene modular seal units.
- F. Baffle Curtains of the dimensions and locations shown on the construction drawings. All associated hardware, cables, and fasteners shall be Stainless Steel Type 316 except NSF approved fiberglass framing angles.
- G. Fiberglass Natural Draft Aerator – One 10,000-gpm fiberglass perforated tray natural draft aerator suitable for contact with potable water shall be provided at the apex of the dome. The tray aerator shall be constructed to the dimensions shown on the drawings. All fasteners shall be of 316 stainless steel. A watertight circular fiberglass catch basin and roof, roof support columns, and screen shall be provided for the aerator housing. A minimum of six 20-inch diameter downcomers shall be provided. Downcomers shall be located at the low point next to the aerator housing to ensure complete drainage inside aerator housing. Ponding of water shall not be acceptable. Tray aerator shall be provided by the tank manufacturer.
- H. Accessory hardware, unless otherwise noted, shall be Type 316 stainless steel conforming to ASTM F593.
- I. Appurtenances
  - 1. Settlement Monument
    - a. Provide settlement monuments centered on the perimeter top of wall of the tank (four) at 90-deg increments to survey and monitor total, differential, and angular settlement for compliance with ACI 372R and settlement estimates.
- J. Internal fiberglass flanged flare for 16-inch DIP overflow pipe, 23½ inches in diameter at flare.
- K. Fiberglass dome overflow eyelids with 24/24 stainless-steel screens

- L. Reservoir sample lines shall be 3/4-inch schedule 40 pipe, Type 316 stainless steel. The reservoir sample lines shall be configured and constructed to the dimensions shown on the drawings.

## 2.13 COATINGS

- A. The tank manufacturer shall be responsible for the paint and coatings. The tank construction company shall apply and have system responsibility for all interior and exterior coatings and shall not subcontract the work.
- B. All coatings shall be applied a minimum of 28 days after final application of concrete and shotcrete.
- C. Application procedures for coatings shall meet the requirements of Section 2.06 and the manufacturer's recommendations.
- D. The interior coating systems shall be designed for a corrosive hydrogen sulfide environment resulting in a pH of 3.0 or greater.
- E. Tank manufacturer shall issue a 10-year warranty on internal and external coating system directly to the Owner from date of substantial completion. The coating manufacturer shall provide a letter to the Owner documenting that coatings were applied in accordance to the coating manufacturer's recommendations.

## 2.14 CONCRETE AND SHOTCRETE TESTING

- A. Compression Tests
  - 1. Compression tests specimens shall be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. At least one set of test specimens shall be made for each 50 yards of concrete/shotcrete placed. Each set of test specimens shall be a minimum of 5 cylinders.
  - 2. Compression test specimens for concrete/shotcrete shall conform to ASTM C172/C172M for sampling and ASTM C31/C31M for making and curing test cylinders. Test specimens shall be 6-inch diameter by 12-inch high or 4-inch diameter by 8-inch high cylinders.
  - 3. Compression test shall be performed in accordance with ASTM C39/C39M. Two test cylinders will be tested at 7 days and two at 28 days. The remaining cylinder will be held to verify test results, if needed.
- B. Air Content Tests (concrete only):
  - 1. Air content tests shall conform to ASTM C231/C231M (Pressure Method for Air Content).
  - 2. Tests for air content shall be made prior to concrete placement and whenever compression test specimens are made.
- C. Slump Tests (concrete only):
  - 1. Slump tests shall be made in accordance with ASTM C143/C143M.

2. Slump tests shall be made whenever compression test specimens are made.

D. Hydrostatic Testing the Completed Tank(s)

1. After the tank(s) have been completed, but before any backfill is placed, the tank(s) shall be filled slowly in the presence of the Engineer. Careful observation for leaks shall be made and any leaks that occur shall be immediately repaired.
2. The tank(s) shall be kept full of water until the Engineer is satisfied that all defects have been discovered and repaired. There shall be no flowing water allowed through the walls or floor slab. Damp spots that glisten on the surface of the tank(s) and spots where moisture can be picked up on a dry hand will not be allowed. Damp spots on the top of footing projections that are not from flowing water shall not be considered to be leakage.
3. All water for the first test will be furnished by the Owner. However, Contractor shall be responsible for supplying the water to the tank at means acceptable to the Owner. If additional piping, valves, or pumps are needed Contractor shall supply and install for testing.

2.15 GROUND STORAGE TANK BAFFLES

- A. The baffles shall be suitable for installation in the ground storage tank as shown on the Contract Drawings and shall conform to the dimensions and clearances shown. All material must be NSF 61 approved.
- B. The baffles shall include custom fabricated reinforced geomembrane curtain material, anchor bolts and all necessary appurtenances. Each baffle shall be tested to withstand chlorine, extreme temperatures, abrasion and hydraulic shock, and shall have a prudent safety factor for all stresses that may occur during fabrication, erection, intermittent, or continuous 24-hour per day operation. Baffles shall be provided by the ground storage tank contractor.
- C. All submerged materials, except anchors and hardware, shall be non-corroding plastics. Anchor bolts and hardware shall be manufactured from 316 Stainless Steel.
- D. The manufacturer shall provide written certification to the Engineer that all equipment furnished complies with all applicable requirements of these specifications and has been in use in similar applications for a minimum of 5 years.
- E. Materials
  1. Baffle/curtain shall be NSF 61 certified.
  2. Baffle/curtain material shall be 30 mil minimum polyester liner. Liner material shall be 8130 XR-3 PW as manufactured by Seaman Corporation, or approved equal.
  3. Baffle/curtain shall have 3/8-inch, polypro rope in the top, bottom and sides for supporting ballast. The top edge shall have double 2 x 2 1/4 inch stainless steel angles bolted on each side of the reinforced hem with lifted points adequate to permanently suspend the curtain, spaced 6 feet on center. The fiberglass angle needs to be anchored every 3 feet on bottom and sides.

4. The baffle/curtain shall be supported by 5/8-inch 316 stainless steel weg-it eyebolts or 316 stainless steel embedded anchor cast into the roof, side and bottom slab at 6 feet on center, supplied and installed by the Contractor.
  5. The baffle/curtain shall be attached to the sides and bottom anchorage with a 2 x 2 x 1/4-inch fiberglass angle or a 2 x 2 x 3/16-inch stainless steel angle bolted to the side and bottom at 6'-0" centers. Curtain hem shall be doubled at both sides and bottom connections; bottom hem shall have an additional layer of material.
- F. Baffles shall be installed in accordance with the manufacturer's recommendations as approved by the Engineer.

## 2.16 VENTILATION FANS

### A. General:

1. Provide two ventilation fans rated at 9,000 cfm at 0.75" SP to be installed on the Ground Storage Tank No. 2 as shown on the Contract Drawings.
2. Tank manufacturer shall be responsible for coordination with the fan supplier, including but not limited to: dimensions and connection, additional weight, air flow, and potential pressure impacts.
3. Equipment shall be designed for corrosive environment, specifically exposure to hydrogen sulfide and reduced sulfur components.
4. Ventilation fans shall be direct driven.

### B. Fan Housing:

1. Fan housing shall be arranged for vertical upblast exhaust construction.
2. Fan housing shall be minimum 0.125-inch aluminum continuous welded seam construction.
3. Inlet and outlet flanges shall be continuously welded to fan casing constructed of heavy gauge aluminum angle rings.
4. Concentricity of fan casing shall be ensured through use of welding jigs and fixtures.
5. Guide vanes shall be integrally welded with the outer housing providing a substantial weldment.
6. Fan shall have a welded aluminum stack cap with 316 SS hardware and Owner approved mechanically fastened insect gasketing.
7. Fan shall be designed with a self-supported swing-out maintenance accessibility of motor & propeller utilizing triple post aluminum pipe supports, stainless steel De-Sta-Co door hardware, gasketed door, 316 SS door shaft with pillow block style flanged bearings, and aluminum sloped roller entry ramp with SS wheel.

8. Fan curb cap shall be welded 0.125-inch aluminum with support gussets and 4-inch overlap on curb.

C. Fan Propeller:

1. Propeller shall be vane axial style with heavy blade construction.
2. The propeller shall be of sand cast 535 aluminum alloy, solid one-piece construction and dynamically and statically balanced.
3. The propeller shall be secured to motor shaft with taper-lock bushing.
4. Fabricated aluminum shield shall be installed behind propeller hub to direct airflow around motor.
5. The propeller assembly shall be statically and dynamically balanced in accordance with ISO 1940-1973, "Balance Quality Grade Of G2.5". In addition, the fan assembly shall be balanced after final assembly, in the fan casing, in accordance with ISO 1972.

D. Finish:

1. The units, after fabrication, shall be cleaned and aluminum welds shall be brushed with non-ferrous wire cleaning brush.
2. Fans shall be mill finished.

E. Accessories:

1. Provide NEMA 4X Non-Fused Disconnect, Mounted and Wired To Motor Junction Box When Specified On Scheduled
2. Provide 316 SST Extended Lube Lines
3. Provide 316 SST Nameplates and Assembly Hardware

F. Motors and Drives:

1. Fan motors shall be UL listed suitable for severe mill and chemical duty, TEFC, premium efficient with IEEE-841 rating. Each motor shall be sized per the following:
  - a. Motor Horsepower: Less than or equal to 3 hp
  - b. Motor Speed: 1200 rpm
  - c. Motor Design Voltage/Phase/Frequency: 460/3/60
2. Duplicate motor junction box shall be mounted on exterior of each fan housing for electrical connection.
3. Duplicate motor nameplate shall be mounted on each fan exterior.

G. Testing and Certification:

1. Fans shall be tested and certified in accordance with ANSI/ASHRAE 51 and ANSI/AMCA 210 test codes and guaranteed by manufacturer to deliver at rated published performance levels.
2. Fan sound level shall be less than 73 dBA at 5 feet'. Fan sound data shall be included in submittal to Engineer.
3. Test each unit prior to shipment. Test certification(s) shall be provided to Engineer for approval prior to installation.
4. Fan shall be designed to meet wind load requirements or provided with tie downs to meet wind load requirements.

H. Submittals:

1. Shop Drawings: Complete assembly and installation drawings, together with detailed specifications and data covering materials used, drive unit, parts, devices, and other accessories forming a part of the equipment furnished shall be submitted to Engineer and Owner for approval.
2. Operation and Maintenance: Manuals shall be submitted complete with manufacturer's instructions for equipment installation, equipment function, start-up procedures, operation, preventative maintenance, servicing, troubleshooting and manufacturers/suppliers contact information.

I. Warranty:

1. Manufacturer/supplier shall warrant that the products sold shall be free from defects in workmanship and material upon delivery under normal use and service for a period of 1 year from the date of original installation or 18 months from the date of shipment, whichever occurs first. Costs of dismantling, reinstallation, time and materials, and freight are not covered under this warranty unless agreed upon and accepted in writing with the manufacturer/supplier.

J. Manufacturer:

1. Markair/Aerovent, fan model 28D6-VP, or Engineer and Owner approved equal.
2. Other Manufacturers/Suppliers may submit literature demonstrating compliance with this specification for the Engineer and Owner to review. Literature shall include at least five examples of different satisfactory installations. Provide a list of references for each installation with owner contact information. Owner reserves the right to request additional information. Determination if reservoir fans are approved equal shall be at the sole discretion of the Engineer and Owner.

2.17 INTAKE HOODS

A. General:

1. Provide two intake hoods as specified herein, to be installed on the Ground Storage Tank No. 2 as shown on the Contract Drawings.

2. Hoods shall be designed to fit concrete curbs. Hood Manufacturer or representative shall field measure and verify existing concrete curb dimensions.
3. Hood intake area shall be designed for 750 fpm intake velocity or less to prevent water penetration
4. Hood roof shall have a cross break to create pitch for drainage.
5. Equipment shall be designed for corrosive environment, specifically exposure to hydrogen sulfide and reduced sulfur components.
6. The area of the intake hoods shall be sized for pressure drop of less than 0.5 inches at rated air flow.

B. Material:

1. All assembly hardware shall be 316 SS.
2. Hood shall be fabricated of welded aluminum. 0.125-inch material for curb cap, throat and hood.
3. Support structure of hoods shall be 2-in x 2-in x 1/4-in welded aluminum angle.
4. Hood shall have 24-mesh stainless steel insect screen on gasketed frame panels.
5. Screen panels shall be easy access and open via stainless steel De-Sta-Co clamps, hinged on one side with stainless piano hinge.

C. Testing:

1. Hoods shall meet the wind load requirement as shown on the structural drawings. The calculations shall be performed by a professional engineer registered in the State of Florida and submitted to the Engineer for approval.

D. Submittals

1. Shop Drawings: Complete assembly and installation drawings, together with detailed specifications and data covering materials used, drive unit, parts, devices, and other accessories forming a part of the equipment furnished shall be submitted to Engineer and Owner for approval.
2. Operation and Maintenance: Manuals shall be submitted complete with manufacturer's instructions for equipment installation, equipment function, operation, preventative maintenance, servicing, troubleshooting, and manufacturers/suppliers contact information.

E. Warranty:

1. Manufacturer/supplier shall warrant that the products sold shall be free from defects in workmanship and material upon delivery under normal use and service for a period of 1 year from the date of original installation or 18 months from the date of shipment, whichever occurs first. Costs of dismantling, reinstallation, time and materials, and freight

are not covered under this warranty unless agreed upon and accepted in writing with the manufacturer/supplier.

F. Manufacturer:

1. Markair Model RIH intake hood, or Owner and Engineer approved equal.
2. Other Manufacturers/Suppliers may submit literature demonstrating compliance with this specification for the Engineer and Owner to review. Literature shall include at least five examples of different satisfactory installations. Provide a list of references for each installation with owner contact information. Owner reserves the right to request additional information. Determination if reservoir fans are approved equal shall be at the sole discretion of the Engineer and Owner.

2.18 COATINGS

- A. Two options are presented below for the interior coatings of the tank (Option A and Option B). The tank manufacturer may provide either of the coating options.
- B. Interior and exterior tank colors shall be selected by Owner during the shop drawing process.
- C. Interior Coatings – Option A
  1. Underside of dome and interior walls.
    - a. Surface preparation: Sweep blast to ICRI CSP-5.
    - b. Apply surfacer across the entire interior surface to fill all bug holes and coat all peaks: Tnemec Series 218 at 1/16 inch to 1/8 inch above the peaks.
    - c. Conduct a detailed inspection of the surfacer application, paying attention to bug holes that have not been properly covered.
    - d. Apply a second application of the surfacer (Tnemec Series 215) to areas where bug holes are discovered. Assume 1,000 sf of surfacer is required.
    - e. Prime coat: Tnemec Series 20 UHS at 4 to 6 mils DFT.
    - f. Apply a third application of surfacer (Tnemec Series 215) to areas where bug holes are discovered. Assume 500 sf of surfacer is required.
    - g. Stripe coat all concrete edges and sharp points with a brush or roller to within 3 inches of the edge with Tnemec Series 20 UHS at 4 to 6 mils DFT. Note this coating will be a different color than the primer and top coat.
    - h. Top Coat: Tnemec Series 22 at 18 to 28 mils DFT.
    - i. Holiday test the entire surface.
    - j. Repair any pinholes with Tnemec Series 22.
  2. Interior Floor
    - a. Surface preparation: Sweep blast to ICRI CSP3.
    - b. Prime Coat: Tnemec Series FC20 at 4 to 6 mils DFT.
    - c. Top Coat: Tnemec Series 22 at 16 to 20 mils DFT.
  3. All interior metal surfaces (including, but not limited to pipes and pipe supports).
    - a. Surface preparation: Pressure wash at 4,000 psi and abrade primer with sandpaper to develop a surface profile.
    - b. Prime coat: Tnemec Series 20 HS at 4 to 6 mils DFT.

- c. Stripe coat: All edges and sharp points shall be coated with a brush or roller to within 3 inches of the edge with Tnemec Series 20 HS at 4 to 6 mils DFT.
- d. Spot prime with Tnemec Series 20 HS at 4 to 6 mils DFT.
- e. Top coat: Tnemec Series 22 at 18 to 28 mils DFT.

D. Interior Coatings – Option B

- 1. Underside of dome and interior walls.
  - a. Surface preparation: Sweep blast to ICRI CSP-5.
  - b. Apply surfacer across the entire interior surface to fill all bug holes and coat all peaks: Sherwin-Williams Dura-Plate 2300 at 1/16 inch to 1/8 inch above the peaks.
  - c. Conduct a detailed inspection of the surfacer application, paying attention to bug holes that have not been properly covered.
  - d. Apply a second application of the surfacer (Sherwin-Williams Dura-Plate 2300) to areas where bug holes are discovered.
  - e. Prime coat: Sherwin-Williams Dura-Plate UHS at 5 to 8 mils DFT.
  - f. Apply a third application of surfacer (Sherwin-Williams Dura-Plate 2300) to areas where bug holes are discovered. Assume 500 sf of surfacer are required.
  - g. Stripe coat all concrete edges and sharp points with a brush or roller to within 3 inches of the edge with Sherwin-Williams Dura-Plate UHS primer at 5 to 8 mils DFT. Note this coating will be a different color than the primer and top coat.
  - h. Top Coat: Sherwin-Williams Sher-Plate PW at 20 to 25 mils DFT.
  - i. Holiday test the entire surface.
  - j. Repair any pinholes with Sherwin-Williams Sher-Plate PW.
- 2. Interior Floor
  - a. Surface preparation: Sweep blast to ICRI CSP3.
  - b. Prime Coat: Sherwin-Williams Dura-Plate UHS at 5 to 8 mils DFT.
  - c. Top Coat: Sherwin-Williams Dura-Plate UHS at 20 to 25 mils DFT.
- 3. All interior metal surfaces (including, but not limited to pipes and pipe supports).
  - a. Surface preparation: Pressure wash at 4,000 psi and abrade primer with sandpaper to develop a surface profile.
  - b. Prime coat: Sherwin-Williams Dura-Plate UHS primer at 5 to 8 mils DFT.
  - c. Stripe coat: All edges and sharp points shall be coated with a brush or roller to within 3 inches of the edge with Sherwin-Williams Dura-Plate UHS at 5 to 8 mils DFT.
  - d. Spot prime with Sherwin-Williams Dura-Plate UHS at 5 to 8 mils DFT.
  - e. Top coat: Sherwin-Williams Dura-Plate UHS at 20 to 25 mils DFT.

E. Exterior Coatings

- 1. Provide an elastomeric breathable coating for the exterior of the new prestressed concrete tank (walls and dome). Exterior coating shall be a modified waterborne acrylate applied in two coats.
  - a. Surface preparation: Remove all contaminants by power washing per SSPC-SP1.
  - b. First coat:
    - 1) Tnemec Series 156 Enviro-Crete – 4 to 6 mils DFT.
    - 2) Sherwin-Williams, Conflex XL (smooth) – 6 mils DFT
      - a) This coating system requires a primer – Loxon Primer at 3 mils DFT.
  - c. Second coat:
    - 1) Tnemec Series 156 Enviro-Crete – 4 to 6 mils DFT.

2) Sherwin-Williams, Conflex XL (smooth) – 6 mils DFT

PART 3 EXECUTION

3.01 INSTALLATION

A. Reinforcing Steel

1. Reinforcing steel shall be installed in accordance with the CRSI, Code of Standard Practice.

B. Placing Concrete

1. General Placement
  - a. Cast-in-place concrete floor shall be installed in accordance with ACI 318 and ACI 350 except as specified herein.
  - b. No concrete shall be mixed or placed during freezing weather without explicit permission. When placing concrete when air temperature is below 40 degrees F, the water, sand and gravel shall be heated so that the temperature of the concrete will be at least 50 degrees F. This temperature shall be maintained for 72 hours after placing. No concrete shall be placed on frozen ground.
  - c. In hot weather, concrete, when deposited, shall have a placing temperature that will not cause difficulty from loss of slump, flash set, or formation of cold joints. In no case shall the temperature of concrete being placed exceed 90 degrees F.
2. Floor Slab
  - a. Prior to placement of the floor slab, a 6-mil polyethylene moisture barrier shall be placed over the subbase. Joints in the polyethylene shall be overlapped a minimum of 6 inches.
  - b. The floor slab including the thickened portion for the wall footing shall be placed in one continuous concrete placement. Construction joints between the floor slab and footings shall not be allowed. Where a construction joint is approved in writing by the Engineer, the joint shall have 6-in wide, 3/8-in thick PVC waterstop conforming to the same requirements as the wall - base slab waterstop.
  - c. The tank floor shall be wood/bull float finished first. The floor shall receive a light broom finish. No water shall be added to the slab during finishing.
  - d. Curing of the tank floor shall be accomplished by ponding the entire area within the waterstops with 2-in minimum of water within 24 hours after concrete placement. The floor shall be kept ponded for a minimum of 7 days.

C. Core Walls

1. Prestressed Core wall(s)
  - a. Exterior wall details including the steel diaphragm, PVC waterstops, elastomeric bearing pads, sponge rubber fillers, prestressing steel, prestressing earthquake cables (if needed), and shotcrete shall conform to the requirements of AWWA D110 Type II.
  - b. A PVC waterstop shall be installed in the wall to base joint on translating floor-wall joints. Field splices shall be in accordance with the manufacturer's specifications. The waterstops shall be installed so as to form a continuous watertight dam. Adequate provisions shall be made to support and protect the waterstop during the progress of the work. Where the waterstop is placed in a concrete cove attached to the inner face

of the wall, the cove shall attain 60 percent of its 28-day strength prior to the start of prestressing the wall.

c. Diaphragm Erection:

- 1) The diaphragm shall be protected against damage before, during, and after erection. Nail or other holes shall not be made in the diaphragm for erection except in the top 3 inches. Holes shall not be made in the diaphragm except for inserting wall pipes or sleeves, reinforcing steel, bolts, or other special appurtenances. Such penetrations shall be sealed with an epoxy sealant which complies with Section 2.8 Epoxy.

d. Shotcrete:

- 1) All shotcrete shall be applied by or under direct supervision of experienced nozzle men certified by the American Concrete Institute (ACI) as outlined in ACI certification publication CP-60.
- 2) Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer.
- 3) No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray.
- 4) No less than 1/8" thick shotcrete shall separate reinforcing steel and prestressing wire.
- 5) The diaphragm shall be encased and protected with no less than 1.5" of shotcrete in all locations.
- 6) The interior shotcrete shall receive a light broom finish.

e. Curing:

- 1) Interior and exterior portions of the shotcrete wall shall be water cured for a minimum of 7 days or until prestressing is completed.

D. Dome:

1. All concrete shall be consolidated by means of a vibrator for proper encasement of reinforcing steel and welded wire fabric.
2. All surfaces at the joint between the wall and the dome shall be coated with bonding epoxy which complies with Section 2.8 Epoxy.
3. Plastic bolsters shall be used to support reinforcing steel and welded wire reinforcement to ensure positive control on placement of steel.
4. The exterior surface of the dome shall receive a light broom finish.
5. The dome shall be water cured for a minimum seven (7) days after casting or until dome band prestressing is completed.
6. The dome roof shall be constructed of reinforced concrete and shall be circumferentially prestressed.
7. The dome roof design shall take into consideration a minimum of six 20-inch diameter downcomers. The downcomers shall be located at the low point next to the aerator housing to ensure complete drainage inside aerator housing.

8. Dome shell reinforcement shall consist of reinforcing bars or welded wire fabric, not galvanized. Bolsters for wire fabric and reinforcing bars shall be plastic. Wire ties shall be galvanized.
9. The dome ring girder shall be prestressed with sufficient wire to withstand the dome dead load and design live loads. The ring girder shall have cross section suitable to accept the applied prestressing forces.
10. The high water level in the tank shall be permitted to encroach on the dome shell no higher than the upper horizontal plane of the dome ring girder.
11. Overflow outlets or the overflow pipe shall be capable of providing an overflow open area three times the area of the largest influent pipe.

E. Circumferential Prestressing

1. Stress readings on a calibrated stressometer, furnished by the tank manufacturer, shall be made on every prestressing wire. A running log shall be maintained by the tank manufacturer of the stress readings and used to determine the final number of wires required. Averaging or estimating the force of the wire on the wall shall not be considered satisfactory evidence of correct placement of prestressing wires.
2. In computing the final tension in the wires, an allowance for prestress loss due to creep, shrinkage, elastic deformation, and residual compression shall be provided for. The tank manufacturer shall submit an "as-built" revision to the design diagram showing the location and number of wires actually used for the project records only.
3. Prestressing shall be accomplished by a machine capable of continuously inducing a uniform initial tension in the wire before it is positioned on the tank wall. Tension in the wire shall be generated by methods not dependent on cold working or re-drawing of the wire. In determining compliance with design requirements, the aggregate force of all tensioned wires per foot of wall shall be considered rather than the force per individual wire, and such aggregate force shall be no less than that required by the design and as shown on approved drawings.

F. Shotcreting

1. No prestressing wire shall remain exposed during inclement weather over a holiday or weekend, it shall be covered with shotcrete and subsequently wet cure.
2. Vertical shooting wires shall be installed to establish uniform and correct thickness of shotcrete. Shooting wires shall be at 2-ft on center around the circumference of the tank. The final coat shall be applied true to shooting wires so as to form a cylindrical surface.
3. At the end of the day's work, or similar stoppage period, the shotcrete shall be sloped off at an angle of approximately 45 degrees. Before placing adjacent sections, the sloped portions shall be thoroughly cleaned and wetted by means of air and water blast. Shotcrete with a strength lower than specified due to cold weather shall be removed and replaced with sound material.
4. The shotcrete shall be cured by keeping the shotcrete continuously wet for 7 days.

5. After all circumferential prestressing wires have been placed, a shotcrete cover having a thickness of no less than 1 inch shall be placed over the prestressing wires.
6. Wet mix shotcrete shall receive a gun finish free from ridges or other defects. Flash coating for finishing will not be permitted.

G. Ladders

1. Interior ladder shall be installed at location shown on the Drawings. Ladders, ladder accessories and ladder clearances shall be installed to conform to the requirements of OSHA.
2. Ladder supports shall be installed by 316 stainless steel expansion bolts or 316 stainless steel bolts with cast-in-place threaded inserts. Prior to installing expansion bolts, the reinforcing bars shall be located with a "rebar locator" supplied by the tank manufacturer. The location of the reinforcing bars shall be marked on the concrete surface indicating the spacing and direction of the bars.
3. Where interference occurs, adjust anchor locations to clear reinforcing bars and alter supports at no additional cost to the Owner.

H. Roof Hatches

1. Roof hatch shall be installed at locations shown on the Drawings. The hatches shall be installed on a concrete curb with a minimum height of 8-in and a minimum of 5-in wide. The hatches shall be installed with a watertight gasket and 316 stainless steel expansion bolts.

I. Handrail.

1. Handrail shall be installed at locations shown on the Drawings. The handrails shall be installed to conform to the requirements of OSHA.
2. Installation of the handrails shall be either by 316 stainless steel expansion bolts or cast-in-place threaded inserts. Prior to installing expansion bolts, the reinforcing bars shall be located with a "rebar locator" supplied by the tank manufacturer. The location of the reinforcing bars shall be marked on the concrete surface indicating the spacing and direction of the bars.
3. Where interference occurs, adjust anchor locations to clear reinforcing bars and alter supports at no additional cost to the Owner.
4. Handrail attached to the cast-in-place dome roof shall be installed with 316 stainless steel bolts and thin slab ferrule inserts. Expansion bolts shall not be allowed.

J. Ventilator(s)

1. Shall be installed at locations shown on the Drawings. The ventilators shall be installed with a watertight gasket.

2. The "eye lid" ventilators shall be installed at locations shown on the Drawings. The invert of the "eye lid" ventilators shall be installed 3-in above the design overflow elevation.

K. Wall Manway(s)

1. Manway(s) shall be installed at locations shown on the Drawings.
2. The invert of the manhole shall be 3-ft, 10-in above the finished grade. The invert shall be at least 26 inches above the footer to allow adequate room for prestress. The manway shall be installed at least 6 inches above the backfill so the manway is accessible.
3. Liquid level indicators shall be installed at locations shown on the Drawings, so that level indicator is visible from the operator building.

L. Wall Openings:

1. When it is necessary for a pipe to pass through the tank wall, the invert of such pipe or sleeve shall be no less than 18" above the floor slab. The prestressing wires required at the pipe elevation shall be distributed into circumferential bands immediately above and below the opening to maintain the required prestressing force while leaving an unbanded strip around the entire tank.
2. Unbanded strips shall have a vertical dimension of no more than 36" unless an axis-symmetric shell analysis is performed to account for compressive forces plus shear and moments caused by displacement of the prestressing wires into adjacent bands.
3. All wall pipes, sleeves and manholes passing through the wall shall be sealed to the diaphragm by epoxy injection.

3.02 TANK ACCESSORIES

- A. Minimum of two, 3' 0" x 5' 0" rectangular Type 316 stainless steel wall manholes for access to the interior of the tank. The cover shall also be of Type 316 stainless steel and hinged. The wall manhole shall be designed to resist hydraulic loading without excessive deflection.
- B. Aluminum handrail shall be fabricated from 6061-T6 aluminum and shall conform with all applicable OSHA standards. Aluminum accessories shall have a "mill" finish.
- C. Interior ladder shall be fabricated from NSF approved fiberglass shall conform with all applicable OSHA standards. The ladder shall have a safety climbing device manufactured from Type 316 stainless steel as required to meet applicable OSHA standards.
- D. Roof hatch cover and liquid level indicator shall be fabricated from fiberglass.
- E. Through-wall pipe sleeves shall be Type 316 stainless steel sleeves with neoprene modular seal units.
- F. Baffle Curtains of the dimensions and locations shown on the construction drawings. All associated hardware, cables, and fasteners shall be Stainless Steel Type 316 except NSF approved fiberglass framing angles.

- G. Fiberglass Natural Draft Aerator – One (1) 10,000-gpm fiberglass perforated tray natural draft aerator suitable for contact with potable water shall be provided at the apex of the dome. The tray aerator shall be constructed to the dimensions shown on the drawings. All fasteners shall be of 316 stainless steel. A watertight circular fiberglass catch basin and roof, roof support columns, and screen shall be provided for the aerator housing. A minimum of six (6) 20-inch diameter downcomers shall be provided. Downcomers shall be located at the low point next to the aerator housing to ensure complete drainage inside aerator housing. Ponding of water shall not be acceptable. Tray aerator shall be provided by the tank manufacturer.
- H. Accessory hardware, unless otherwise noted, shall be Type 316 stainless steel conforming to ASTM F593.
- I. Appurtenances
  - 1. Settlement Monument
    - a. Provide settlement monuments centered on the perimeter top of wall of the tank (four) at 90-deg increments to survey and monitor total, differential, and angular settlement for compliance with ACI 372R and settlement estimates.
- J. Internal fiberglass flanged flare for 16-inch DIP overflow pipe 23½ inches in diameter at flare.
- K. Fiberglass dome overflow eyelids with 24/24 mesh screens
- L. Reservoir sample lines shall be 3/4-inch schedule 40 pipe, Type 316 stainless steel. The reservoir sample lines shall be configured and constructed to the dimensions shown on the drawings. The reservoir sample line taps shall be housed in a stainless steel, single door enclosure with continuous hinged clamped cover as provided by Enclosure Hub or equal.

### 3.03 COATINGS

- A. The tank manufacturer shall be responsible for the paint and coatings. The tank construction company shall apply and have system responsibility for all interior and exterior coatings and shall not subcontract the work.
- B. All coatings shall be applied a minimum of 28 days after final application of concrete and shotcrete.
- C. Application procedures for coatings shall meet the requirements of Section 2.06 and the manufacturer's recommendations.
- D. The interior coating systems shall be designed for a corrosive hydrogen sulfide environment resulting in a pH of 3.0 or greater.
- E. Tank manufacturer shall issue a 10-year warranty on internal and external coating system directly to the Owner from date of substantial completion. The coating manufacturer shall provide a letter to the Owner documenting that coatings were applied in accordance to the coating manufacturer's recommendations.

### 3.04 CONCRETE AND SHOTCRETE TESTING

- A. Compression Tests

1. Compression tests specimens shall be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. At least one set of test specimens shall be made for each 50 cubic yards of shotcrete and every 100 cubic yards of concrete placed. Each set of test specimens shall be a minimum of 5 cylinders.
  2. Compression test specimens for concrete/shotcrete shall conform to ASTM C172/C172M for sampling and ASTM C31/C31M for making and curing test cylinders. Test specimens shall be 6-inch diameter by 12-inch high or 4-inch diameter by 8-inch high cylinders.
  3. Compression test shall be performed in accordance with ASTM C39/C39M. Two test cylinders will be tested at 7 days and two at 28 days. The remaining cylinder will be held to verify test results, if needed.
- B. Air Content Tests (concrete only):
1. Air content tests shall conform to ASTM C231/C231M (Pressure Method for Air Content).
  2. Tests for air content shall be made prior to concrete placement and whenever compression test specimens are made.
- C. Slump Tests (concrete only):
1. Slump tests shall be made in accordance with ASTM C143/C143M.
  2. Slump tests shall be made whenever compression test specimens are made.
- D. Hydrostatic Testing the Completed Tank(s)
1. After the tank(s) have been completed, but before any backfill is placed, the tank(s) shall be filled slowly in the presence of the Engineer. Careful observation for leaks shall be made and any leaks that occur shall be immediately repaired.
  2. The tank(s) shall be kept full of water until the Engineer is satisfied that all defects have been discovered and repaired. There shall be no flowing water allowed through the walls or floor slab. Damp spots that glisten on the surface of the tank(s) and spots where moisture can be picked up on a dry hand will not be allowed. Damp spots on the top of footing projections that are not from flowing water shall not be considered to be leakage.
  3. All water for the first test will be furnished by the Owner. However, Contractor shall be responsible for supplying the water to the tank at means acceptable to the Owner. If additional piping, valves, or pumps are needed Contractor shall supply and install for testing.

### 3.05 CLEANING AND DISINFECTION

- A. The tank(s) shall be disinfected in accordance with AWWA C652, Chlorination Method 2 or JEA preferred method, and as specified herein.
- B. The chlorine solution shall be applied directly to all surfaces of the tank(s) including the underside of the roof by spray equipment.

END OF SECTION

FORM 13205-A  
P.E. CERTIFICATION FORM

The undersigned hereby certifies that he/she is a professional engineer licensed in the

State of \_\_\_\_\_ and that he/she has been employed by

\_\_\_\_\_ to design  
(Name of Contractor)

One (1) 1.1-MG wire- wrapped, prestressed concrete tank in conformance with Section 13205 for the Greenland Water Treatment Plant Expansion.

The undersigned further certifies that he/she has performed the design of the tank, that said design is in conformance with all applicable local, state and federal codes, rules, and regulations, including the requirements AWWA D110 and that his/her signature and P.E. stamp have been affixed to all calculations and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all "as-built" design drawings and calculations available to Owner or Owner's representative within seven days following written request therefor by the Owner.

\_\_\_\_\_  
P.E. Name

\_\_\_\_\_  
Contractor's Name

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Address

\_\_\_\_\_  
Title

\_\_\_\_\_  
Address

SECTION 13280  
OZONE SYSTEM - GENERAL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor, through the Ozone System Supplier (OSS) shall furnish all labor, materials and equipment necessary to design, fabricate, test and make completely ready for operation the modifications to the Greenland WTP ozone system as specified herein for a complete and fully functional Ozone System. The modifications to the Ozone System shall include, but not be limited to the following:
  - 1. Addition of one new redundant ozone injector and off-gas air release valve.
  - 2. Replacement of the existing ORP analyzer with a redundant dissolved ozone residual analyzer.
  - 3. All associated valves and instruments associated with the ozone system modifications.
  - 4. Update ozone system controls for addition of new redundant injector, well pump No. 3, and redundant ozone analyzer.
  - 5. All electrical work (conduits, control cables, trays, etc.) associated with the ozone system modifications.
  - 6. Startup and training services as specified herein.
- B. The Ozone System modifications specified herein shall be furnished by a single OSS who shall provide all services, equipment, and appurtenances required to achieve a complete, fully integrated, and operational system meeting all the design conditions, testing requirements, performance guarantees, and warranties specified herein.
- C. The ozone equipment and subsystems specified below shall be considered as integral components of the Ozone System.
  - 1. Ozone System testing and training, and the Ozone Control System and safety equipment, is included this Section.
  - 2. Ozone Contacting Equipment is included in Section 13292.
- D. All Ozone System piping, electrical equipment, conduit, wires, electrical components, anchor bolts and related hardware, and other components not specifically specified to be provided by the OSS shall be supplied by the Contractor.
- E. Ozone Control System
  - 1. The Ozone Control System (OCS) shall be updated and installed under this Section and shall comply with Division 13, Division 16, and the Drawings.

2. The OSS shall coordinate any graphical displays required with the current plant standards and work performed by the HMI Integrator.
3. The work performed by the OSS shall include, but not be limited to, furnishing, programming, and testing the following items for a complete, fully integrated and operational OCS, except for programming work to be completed by the HMI Integrator, as specified in this Section.
  - a. Operator Interface Terminal (OIT).
  - b. Programmable logic controllers (PLC).
  - c. Remote I/O (RIO) and Local I/O (LIO).
  - d. Dissolved ozone-in-water analyzer, Well No. 3 flow meter and any other instruments shown on the Drawings as part of the Ozone System.
  - e. Primary elements (e.g., flow, pressure, and power elements that provide control signals to the OCS PLCs).
  - f. Transmitters.
  - g. Indicators.
  - h. Project control descriptions
  - i. Communication equipment - all cards, cables, and connectors required for the PLCs to communicate with the Remote I/O racks and on the plant process fiber optic network, as shown on the Drawings.

#### 1.02 RELATED WORK

- A. Instrumentation work, except as provided as part of the Ozone System, is included in Division 13.
- B. Piping and valves for the Ozone System modifications shall be as specified in Division 15.
- C. Electrical work, except as provided as part of the Ozone System, is included in Division 16.

#### 1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, complete shop drawings to establish compliance with this Section. Submittals shall include, at a minimum, the following:
  1. Complete manufacturer's specifications, including parts list, material description, details of construction, equipment dimensions, locations and sizes of connections, and equipment weights to indicate full compliance with these Specifications.
  2. Submittal data for the main components of the Ozone Control System as follows:
    - a. Submittal data for the instrumentation, PLC modifications, and computer-based ozone control system submittals, as specified in this Section and Section 13300.
    - b. Submittal data for dissolved ozone residual analyzer 13.
    - c. Submittal data for control system field tests as specified herein.
- B. Ozone Control System Submittals
  1. Submit complete electrical and instrumentation and control information in sufficient detail to allow proper installation of instrumentation and controls, and electrical components, and demonstrate full compliance with Section 13300. Additional requirements for these submittals are specified below.

- a. Complete instrumentation and control schematics, presented in conformance with ISA Bulletin S5.1, latest edition.
  - b. Ozone System process control descriptions, and point-to-point component interconnection diagrams.
  - c. Wire numbers and/or color coding.
  - d. Terminal numbers.
  - e. Operation, installation and troubleshooting instructions.
  - f. Complete external electrical interconnection diagrams for control panels and field junction boxes.
2. SCADA Communications and/or I/O List Submittal (as specified in Section 13300 and supplemented as specified herein.
  - a. The I/O list shall be modified in conformance with the Contract Documents, and any other revisions made after awarding of the Contract.
  - b. The I/O list shall include all addressing (PLC/drop/slot/point/register address) for each point.
  - c. The OSS shall coordinate with Owner to ensure that all standards and tag numbering conventions match those of Owner's existing system]
3. The OSS shall prepare modified loop diagrams, as specified in Section 13300, in conformance to the Specifications and Drawings.
4. The OSS shall develop modified process control strategies as a written narrative on a loop by loop basis based on information from the Specifications and Drawings. Each control strategy shall include:
  - a. Brief scope of the control strategy including a hierarchical description of each control loop (as applicable).
  - b. Describe local operation of equipment detailing functionality of all selector switches, pushbuttons, indicators. Include LCP functionality and hardwired safety interlocks.
  - c. Listing of all monitoring and control functions at the LCP level and the Ozone Work Station (OWS) level for each loop. Programming by HMI Integrator herein and in Section 13300 for each loop.
  - d. Listing of all software inputs from I/O required for the control strategy.
  - e. Any assumptions made in developing the control strategy.
  - f. Failure contingencies for each loop shall be described in detail, including recovery from power failure.
  - g. Listing of all software inputs from the existing PLC programs required for the control strategy.
5. Testing Plan for the Control System
  - a. Preliminary test procedure submittals
    - 1) Outlines for the specific proposed tests shall be submitted prior to the preparation of the detailed test procedures.
    - 2) Submittals shall include examples of the proposed forms and checklists.
  - b. Test Procedure Submittals
    - 1) Detailed test procedures shall be submitted for all required tests. The OSS shall refer to Part 3 of this Section for testing requirements.
    - 2) Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests.

- c. Each loop shall have a status report to organize and track its inspection, adjustment and calibration. These reports shall include the following information and check off items:
  - 1) Project Name.
  - 2) Loop Number.
  - 3) Detailed test procedure indicating exactly how the loop will be tested including all required test equipment, necessary terminal block numbers, and simulation techniques required.
  - 4) Check offs/signoffs for each component.
    - a) Identification
    - b) Installation
    - c) Termination - wiring
    - d) Termination - tubing
    - e) Calibration/adjustment
  - 5) Check offs/signoffs for the loop.
    - a) Panel interface terminations
    - b) I/O interface terminations
    - c) I/O signal operation
    - d) Inputs/outputs operational: received/sent, processed, adjusted
    - e) Total loop operation
  - 6) Space for comments.
  - 7) Sign off and date fields for the Contractor and the Engineer.
- d. Each instrument and PLC I/O module shall have a Component Calibration Sheet. These sheets shall have the following information including space for data entry:
  - 1) Project name.
  - 2) Loop number.
  - 3) I/O module address.
  - 4) Manufacturer.
  - 5) Model number/serial number.
  - 6) Summary of functional requirements.
    - a) Scale ranges for indicators.
    - b) Scale and chart ranges for transmitters/converters.
    - c) Function for computing elements.
    - d) Action (direct/reverse) control modes for controllers.
    - e) Unit range, differential (fixed/adjustable), and reset (auto/manual) for switching elements.
    - f) Input or output for I/O modules.
  - 7) Summary of calibrations requirements:
    - a) Required and actual inputs and outputs for analog devices at 0, 10, 50 and 100 percent of span, rising and falling.
    - b) Required and actual trip points and reset points for discrete devices.
    - c) Mode settings for controllers.
    - d) Required and actual inputs or outputs for I/O modules at 0, 10, 50 and 100 percent of span, rising and falling.
  - 8) Space for comments.
  - 9) Sign off and date fields for the Contractor and the Engineer.
- e. Upon completion of each required test, the OSS shall document the test by submitting a copy of the signed off test procedures.

- C. The OSS shall furnish an operations and maintenance (O&M) manual in compliance with Sections 01730 and 13300 for I&C components, and as specified herein. Each O&M manual shall include, but not be limited to, the following:
1. Diagrams and illustrations.
  2. Detailed description of the function of each principal component of the system required for the modification.
  3. Performance and nameplate data.
  4. Installation instructions.
  5. Procedure for proper adjustment of equipment.
  6. Test procedures.
  7. Procedure for operating.
  8. Shutdown instructions.
  9. Emergency operating instructions and troubleshooting guide.
  10. Safety precautions.
  11. Maintenance and overhaul instructions shall include detailed assembly drawings with part numbers, parts list, instructions for ordering spare parts, and complete preventive maintenance instructions required to ensure satisfactory performance and longevity of the equipment.
  12. Lubrication instructions shall list points to be greased or oiled; recommend type, grade, and temperature range of lubricants; and recommend frequency of lubrication.
  13. List of electrical relay, control, and alarm contact settings.
  14. Electrical interconnection wiring diagram for equipment furnished, including all control and lighting systems.
- D. No work shall be performed in connection with the fabrication or manufacture of materials and equipment, nor shall any accessory or appurtenance be purchased until the shop drawings and data have been reviewed and approved by the Engineer, except at the OSS' own risk and responsibility.
- E. Equipment, piping, control system test procedures, certifications and test reports/results as indicated in Division 13.
- F. Should the OSS propose any item on his shop drawings, or incorporate an item into the Work, and that item should subsequently prove to be defective or otherwise unsatisfactory, the OSS shall, at his own expense, replace the item with another item that will perform satisfactorily.

- G. The OSS shall describe completely all non-conforming aspects in the event it is not possible to conform to certain details of these Specifications.

#### 1.04 REFERENCE STANDARDS

- A. The Ozone System design shall conform to the latest editions or revisions in effect at the time of the bid opening of the following applicable codes and standards, and regulations generally available from the association, society, governing body, or regulatory agency named in the title:

1. American National Standards Institute (ANSI).
2. American Society of Mechanical Engineers (ASME).
  - a. Boiler Pressure Vessel Code Section VIII - Rules for Construction of Pressure Vessels, (2004 including Addenda issued in July 1, 2006).
3. Compressed Gas Association (CGA).
  - a. CGA G-4-1 - Cleaning Equipment for Oxygen Service, (2004).
4. Institute of Electrical and Electronic Engineers (IEEE).
  - a. IEEE 519 - IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
5. National Fire Protection Association (NFPA).
  - a. NFPA 70, National Electrical Code (NEC).
6. ASTM International (ASTM).
  - a. ASTM E591 - Safety and Health Requirements Relating to Occupational Exposure to Ozone, (1991).
7. American Water Works Association (AWWA).
8. American Welding Society (AWS).
9. Hydraulic Institute (HI).
10. International Society of Automation (ISA).
11. National Electrical Manufacturers Association (NEMA).
12. Underwriters Laboratory Inc. (UL).

#### 1.05 OZONE SYSTEM FUNCTIONAL CONTROL DESCRIPTION

##### A. General

1. The Ozone System modifications shall include the subsystems and equipment as delineated in Paragraph 1.01.C and as specified elsewhere in Division 13.

##### B. Ozone Generation Equipment

1. The existing ozone generation control scheme shall be modified to account for the addition of Well No. 3. The total well flow from all three wells (Well No. 1, Well No. 2 and Well

No. 3) shall be used to achieve an ozone dose set-point. After a pre-determined amount of time, the dose-trim control shall be enabled.

2. The dose-trim control is currently dependent on the existing ozone residual analyzer. The control scheme shall be modified such that the ozone residual analyzer utilized for dose-trim control can be selected from the existing and new. If either of the ozone residual analyzer's ever faults, the other ozone residual analyzer shall automatically be selected. If the two ozone residual analyzer's vary by a pre-set amount (in mg/L) for a pre-set time period (in minutes) an alarm shall be generated.

#### C. Ozone Contacting System

1. The ozone contacting system control scheme shall be modified to account for the installation of the new injector. The lead and lag injectors shall automatically advance sequentially after each shutdown.

#### D. Ozone Control System

1. The Ozone Control System (OCS) shall be modified as a sub-system of the treatment plant's Supervisory Control and Data Acquisition (SCADA) System and shall be integrated by connecting all signals (except for signals internal to a skid-mounted control system) from the Ozone System to the SCADA System. All equipment, materials, programming, services and submittals required to develop the OCS shall be provided under this Section by the OSS.
2. The OSS shall coordinate the OCS design with the HMI Integrator, who is responsible for the plant SCADA System as specified in Section 13300. The OSS shall provide for alarms to reflect any alarm condition that is annunciated by the Ozone System operator interface software. The OSS shall also provide alarms for all conditions within the Ozone System that would require personnel evacuation. The initiation of any of these alarms shall modify separate status bits in the master ozone PLC for monitoring by the plant SCADA System.
3. The OSS shall map all applicable data (I/O registers and bits) for the Ozone System into contiguous registers such that the HMI Integrator can monitor and control the entire Ozone System by simply interfacing with these mapped points. A list of all of the mapped data points for the Ozone System equipment modifications shall be submitted by the OSS in Excel format including point type, description, and PLC address. The list shall be submitted to the Engineer as part of the process control strategy, software submittal and final O&M manual.
4. The OSS shall furnish, configure, program, and test all modifications made to the OITs and LCPs, and master ozone PLC, in accordance with the loop diagrams and control descriptions in Paragraph 1.08 and as shown on the Drawings. The OSS shall attend at least 1 coordination meeting (in-person or by phone conference) with the HMI Integrator to establish operator interface, display graphics and alarm conventions to be used for the Ozone System. Upon acceptance of the Ozone System, the OSS shall turn over all final operator interface graphic, trend and historical graphic displays and configuration information to the Owner.

#### 1.06 DELINEATION OF RESPONSIBILITIES

- A. The OSS shall be responsible for programming the modifications to the Master Ozone PLC and individual equipment PLCs as required for the modifications, including control logic for the ozone generator, and ozone contacting systems, as specified in Paragraph 1.05.
- B. In addition to the programming responsibilities, the OSS shall be responsible for supplying all valves, equipment and instruments associated with the Ozone System modifications. The Contractor shall be responsible for installation of all valves, equipment and instruments associated with the Ozone System Modifications.
- C. The Contractor shall be responsible for providing and installing all piping, gaskets, bolts and hardware associated with the Ozone System modifications as specified herein and as shown in the Contract Drawings.
- D. The ozone contacting system upgrades shall be provided by the ozone contacting system supplier and installed by the Contractor. The OSS shall be responsible for providing valves in instrumentation associated with the new redundant injector as shown in the Contract Drawings and for incorporating the new redundant injector into the OCS modifications.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Delivery and storage shall be in compliance with Sections 01600 and 13300.

#### 1.08 MAINTENANCE

- A. Tools and Spare Parts
  - 1. Tools and spare parts shall be furnished in compliance with Sections 01730 and 13300.
  - 2. Furnish all spare parts recommended by the manufacturer for the normal operation and maintenance of the equipment during the warranty period.

#### 1.09 PERFORMANCE GUARANTEE AND WARRANTIES

- A. The installed Ozone Control System modifications shall be warranted against defects in work quality and material for a minimum period of one year from date of acceptance by the Owner (i.e., beginning at the end of the successful 7-day operation and commissioning period as specified in Section 01740.

#### 1.10 OZONE AND OXYGEN SERVICE

- A. All equipment, valves, analyzers, seals, gaskets, valve seats and associated appurtenances to be used with oxygen or ozone-in-oxygen shall be cleaned and certified for oxygen service before shipping to the plant site.
- B. All equipment, valves, valve seats, analyzers, seals, gaskets, welds and all associated appurtenances to be used with oxygen and ozone-in-oxygen must be resistant to degradation and gas losses due to the use of these gases.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. The OCS shall be guaranteed against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials furnished shall be suitable for actual site conditions.
- B. All equipment shall be designed, fabricated, and assembled in accordance with accepted industry standards. Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by factory tests.
- C. All electrical work shall conform to Division 16, the National Electrical Code, and NFPA 79 Electrical Standard for Industrial Machinery.
- D. Valves and valve actuators to be provided by the OSS as a part of the Ozone System modifications are in Section 15100.
- E. Instruments to be provided by the OSS as a part of the Ozone System modifications are in Section 13340.
- F. Ozone contacting equipment (to be provided by ozone contacting equipment supplier) are in Section 13292.

### 2.02 SURFACE PREPARATION AND SHOP PAINTING

- A. Surface preparation and shop priming shall be in compliance with Section 09901.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. All OCS equipment shall be installed in strict compliance with the instructions and recommendations of the OSS and as specified in Section 13300.
- B. All marred and damages coatings shall be repaired and corrected by the Contractor so as to maintain coating integrity in accordance with the manufacturer's requirements.

### 3.02 FIELD PAINTING

- A. Field painting is included in Section 09902.

### 3.03 FIELD INSPECTION AND TESTING

- A. On-site testing procedures shall be coordinated as specified herein. If tests need to be repeated due to the failure of the OCS to meet the specified performance requirements, then the Contractor shall pay for any and all costs incurred, including the Engineer's costs, for any repeat testing. The Owner will not pay for any additional costs due to non-performance of equipment.

B. Instrumentation and Measurements

1. The OSS shall provide all personnel, instruments, and other supplies necessary for conducting all OCS tests prior to substantial completion.

C. After the Ozone System equipment have been completely installed, inspected and operationally tested as specified, equipment acceptance tests shall be performed by the OSS and equipment manufacturer in the presence of the Engineer as follows:

1. The new injector for the side-stream injection system, new dissolved ozone analyzer, and programming to account for the new Well No. 3 shall be tested as specified below.
2. Field Tests for Ozone Control System
  - a. At a minimum, the field tests shall include Operational Readiness Test and Functional Acceptance Test.
  - b. Operational Readiness Test
    - 1) All modifications made to the OCS shall be checked for proper installation, calibrated and adjusted on a loop-by-loop and component-by-component basis by the OSS following field installation, to demonstrate and document that the system is in conformance with related submittals and this Section.
    - 2) The OSS shall maintain the Loop Status Reports and Components Calibration sheets at the job site and make them available to the Engineer at any time.
    - 3) The Engineer reserves the right to witness and sign off all tests conducted by the OSS. Any deficiencies found shall be corrected. Final test sheets shall be submitted to the Engineer.
  - c. Functional Acceptance Test
    - 1) Prior to the Functional Acceptance Test (FAT), the entire installed OCS shall be certified by the OSS that it is ready for operation.
    - 2) All preliminary testing, inspection, and calibration shall be complete as defined in the Operation Readiness Test.
    - 3) The intent of the FAT is to prove for all responsible parties working together that the installed OCS operates in accordance with the Specifications.
    - 4) Once the facility has been started up and is operating, the FAT shall be performed on the modifications made to the OCS to demonstrate that it is operating and in compliance with these specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
    - 5) During testing, the OSS shall be present during the Functional Acceptance Test.
    - 6) In the event of rejection of any part or function of the modifications made to the OCS, the OSS shall perform repairs or replacement within 10 days.
    - 7) One copy of all O & M manuals shall be made available to the Owner at the job site both before and during FAT.

D. If the performance of the OCS during the FAT does not meet the Specifications, corrective measures shall be taken or the equipment shall be removed and replaced by the OSS with equipment that will meet these Specifications at no additional cost to the Owner.

3.04 TRAINING OF OWNER'S PERSONNEL

A. General

1. The OSS shall provide training of Owner personnel in the operation and maintenance of the modifications made to the Ozone System, including the OCS.
2. Training shall consist of hands-on sessions conducted at the site of the Work and at times acceptable to the Owner.
3. Training of Owner personnel in the operation and maintenance of the Ozone System shall meet all requirements of Section 01730, plus the requirements specified in this Paragraph.

B. Ozone System Training

1. The OSS personnel shall provide detailed Ozone System training including, at a minimum, the following:
  - a. System operations philosophy with emphasis on the modifications for this project.
  - b. System Control
    - 1) The understanding of loop functions including interlocks for any modifications made.
    - 2) The understanding of loop operation for all modifications made to the Ozone System.
    - 3) Interfaces with other loops and subsystems.
  - c. Operator interface/system set points associated with the modifications made to the Ozone System.
  - d. Component performance requirements for all modifications made to the Ozone System.
  - e. Component functions for all modifications made to the Ozone System.
  - f. Component maintenance for all modifications made to the Ozone System.
  - g. Component troubleshooting for all modifications made to the Ozone System.
  - h. Instrument operation, maintenance, troubleshooting, replacement, and calibration procedures for all modifications made to the Ozone System.
2. Major component manufacturers shall provide detailed maintenance instruction, in addition to the above requirements, for major components as required in the detailed equipment and instrument specifications.
3. Manufacturer's representative shall be familiar with plant O&M requirements as well as with the installed equipment.
4. The training periods shall be coordinated with operating personnel and manufacturers' representatives, and with submittal of O&M Manuals.
  - a. Pre-startup training shall be completed at least 5 days prior to actual startup, but not more than 30 days prior to startup.
  - b. O&M Manuals shall be reviewed, accepted, and resubmitted, in accordance with Section 01300, before pre-startup training.

END OF SECTION

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SECTION 13292  
OZONE CONTACTING EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The sidestream venturi injection (SVI) ozone dissolution system shall include the following equipment:
1. Ozone Contacting Equipment:
    - a. One sidestream venturi injector/eductor to inject gaseous ozone-in-oxygen into the existing sidestream water system.
    - b. One air release valve to expel ozone off-gas to the existing off-gas destruct units.
- B. Existing System Description: The existing SVI system consists of three sidestream injection pumps (2 duty and 1 standby), two injectors, one flash mixing reactor, a pipeline contactor and off-gas tee with three off-gas air release valves (2 duty and 1 standby). The existing SVI equipment operates at an injector ozone gas to liquid ratio of 0.18 to 1.0 (standard cubic feet per minute (SCFM) gas flow to CFM of injector liquid flow) at a maximum gas inlet pressure of 0-5 pounds per square inch gauge (psig) and a maximum injector outlet pressure of 26 psig. The system (sidestream booster pumps, venturi injectors, and pipeline mixing reactor) provides dynamic small bubble gas-liquid mixing at a minimum nozzle discharge velocity of 23 feet per second (fps) under all plant flow conditions.
- Proposed Upgrade Description: One additional sidestream redundant venturi injector/educator so there will be a total of three (2 duty and 1 standby). One additional off-gas air release valve to be installed as shown on the Contract Drawings.
- C. Pressure drop across the pipeline mixing reactor shall be less than 3.6 psig under all treatment plant flow and gas feed conditions.
- D. The pipeline mixing reactor shall be pre-engineered with documentation of design performance across a broad range of gas/liquid mixing ratios and injector performance operating conditions. Overall transfer efficiency of the ozone mass transfer system shall be 96 percent (%) or better under the design conditions specified in this section.
- E. The sidestream booster pumps will be furnished and installed by the Contractor. General characteristics anticipated for these pumps are described herein.
- F. The ozone system supplier (OSS) shall be responsible for all programming associated with the operation of the new injector. All valves and instrumentation associated with the new injector shall be provided by the OSS.

1.02 SUBMITTALS

- A. Submit, in accordance with Section 01300, complete shop drawings for the SVI system to establish compliance with this Section. Submittals shall include, at a minimum, the following:
1. Complete drawings and data as required fully describing the Ozone Contacting Equipment components and indicating full compliance with this Section. At a minimum, this shall

include scaled plans, sections and details showing dimensioned equipment and data sheets or catalog cuts on all appurtenances and piping system components.

2. Certified dimensional drawings, bill of materials, and weights of each item of equipment and auxiliary apparatus to be furnished including shop fabrication drawings, installation drawings, and details.
3. Tables and graphs fully characterizing the gas suction capacity of the sidestream venturi injectors over the entire range of operational conditions as specified herein. At a minimum, the tables and curves shall provide gas suction capacity for the following:
  - a. Motive water pressure (psig) 70
  - b. Outlet discharge back pressure (psig) 26
  - c. Gas inlet pressure (psig) < 0, 2, 4, 6, 8 and 10
4. Data on pressure drops across the ozone injection assembly of the dissolution system over the entire range of operational conditions. In addition, provide pressure data for the venturi injectors and injection nozzles.
8. Manufacturer and model number, size, type, materials of construction, shipping and operating weights, capacity, etc. for each piece of equipment provided.
9. Certified dimensional drawings of equipment and auxiliary apparatus including installation drawings and details.

B. Operation and Maintenance Data

1. Operating and maintenance instructions shall be furnished in compliance with Section 01730.

1.03 SYSTEM DESCRIPTION

- A. The SVI system shall be designed for a range of total plant flow rates from 3.4 million gallons per day (MGD) to 8.6 MGD with the capacity to deliver the following quantities of ozone to the raw water:
  1. Maximum capacity of 630 pounds per day (lbs/day) of ozone at 12%-by-weight ozone-in-oxygen concentration, at a plant flow rate of 8.6 MGD, with three nozzle manifolds and eight nozzles of the existing mixing reactor in service.
  3. Capacity of 460 lbs/day of ozone at 12%-by-weight ozone-in-oxygen concentration, at a plant flow rate of 6.7 MGD, with two nozzle manifolds and six nozzles of the existing mixing reactor in service.
  4. Capacity of 190 lbs/day of ozone at 12%-by-weight ozone-in-oxygen concentration, at a plant flow rate of 3.4 MGD, with one nozzle manifold and four nozzles of the existing mixing reactor in service.

1.04 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI)
- B. American Society of Mechanical Engineers (ASME)

- C. American Society for Testing and Materials (ASTM)
- D. Compressed Gas Association (CGA)
  - 1. CGA G-4.1 – Cleaning Equipment for Oxygen Service.
- E. Institute of Electrical & Electronics Engineer (IEEE)
  - 1. IEEE Standard 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
- F. National Electrical Code (NEC)
- G. National Electrical Manufacturers Association (NEMA)
- H. Underwriters Laboratories (UL)
- I. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Delivery and storage shall be in compliance with Section 01600.

#### 1.06 MAINTENANCE

- A. Tools and Spare Parts
  - 1. Furnish all tools and spare parts recommended by the manufacturer for the normal operation and maintenance of the equipment and Section 01730.

#### 1.07 UTILITIES

- A. Sidestream water will be raw water with a total sulfide concentration typically ranging from 2.0 to 3.0 mg/L.

#### 1.08 WARRANTY

- A. The equipment shall be warranted for a period of one year from date of substantial completion as defined under the General Conditions, Division 0, to be free from defects in workmanship, design or material. If the equipment should fail during the warranty period due to a defective part(s), the part(s) shall be replaced in the equipment and the unit(s) restored to service at no additional cost to the Owner.

#### 1.09 OZONE AND OXYGEN SERVICE

- A. All equipment, valves, seals, gaskets, valve seats and associated appurtenances to be used with oxygen or ozone-in-oxygen shall be cleaned and certified for oxygen service before shipping to the plant site per CGA standards.

- B. All equipment, valves, valve seats, seals, gaskets, welds and all associated appurtenances to be used with oxygen and ozone-in-oxygen shall be resistant to degradation and gas losses due to the use of these gases.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. The components of the SVI equipment to be provided shall be designed per Paragraph 1.03.A.
- B. The sidestream ozone injection system shall be designed in accordance with the following hydraulic conditions:
  - 1. Centerline elevation of the pipeline mixing reactor is approximately 30.80 feet above mean sea level (msl).
  - 2. The centerline elevation of the sidestream injection pumps is approximately 30.80 feet msl.
  - 3. The sidestream venturi injector will be located in a vertical orientation directly above the third nozzle manifold of the mixing reactor as shown in the Contract Drawings.
  - 4. The water pressure in the mainstream pipeline at the centerline of the pipeline mixing reactor is approximately 21 psig.

### 2.02 SVI OZONE DISSOLUTION SYSTEM

- A. The SVI system shall generally include the following:

Existing:

- 1. One pipeline mixing reactor with three integral nozzle manifolds, with associated injection mixing nozzles.
- 2. Three sidestream booster pumps (2 duty and 1 standby)
- 3. Two sidestream venturi injectors.
- 4. Three off-gas air release valves (2 duty and 1 standby)

Equipment to be installed:

- 1. One sidestream venturi injector
- 2. One off-gas air release valve

- B. The Ozone Contacting Equipment shall be manufactured by Mazzei Injector Corp to match existing equipment.
- C. Sidestream Venturi Injectors/Eductors

1. Each sidestream injection pump shall be equipped with one sidestream venturi injector designed for liquid, gas, and gas/liquid mixtures corresponding to the following service conditions:
  - a. Fluid: Groundwater; 0 mg/L to saturation, dissolved ozone-in-water
  - b. Fluid Pressure (psig) Atmospheric to 70 with 80 test pressure
  - c. Fluid Temperature (°F) 64 to 78
  - d. Gas 0 to 12% by weight, ozone-in-oxygen
  - e. Gas Pressure (psig) - 5 to 10
2. The high-efficiency, venturi-type, differential pressure injector shall be operated at a constant motive water flow rate, constant motive water pressure, variable outlet water back pressure (includes water column and nozzle losses), and variable ozone gas supply pressure, to produce the range of gas suction capacities as follows:
  - a. Motive flow per injector  
gallons per minute (gpm)) 494
  - b. Motive water inlet pressure (psig) 70
  - c. Outlet water backpressure (psig) 26
  - d. Ozone generator outlet pressure (psig) 10 to 15
  - e. Gas suction capacity per injector (scfm) 22 to 24.5
  - f. Maximum gas inlet pressure at injector  
suction port (psig) 10
3. The injector shall have 4-in Type 316L stainless steel flanged inlet and outlet connections and single 3-in NPT gas suction port. The injector shall be constructed of all Type 316L stainless steel.
4. The injector shall be Model 4091 by Mazzei Injector Co., LLC.

D. Valves and Appurtenances

1. Refer to Section 15100 for the off-gas air release valve requirements.
2. Valves and appurtenances associated with the ozone contacting system shall be furnished by the OSS and installed by the Contractor, refer to Section 13280. All stainless steel piping shall be supplied and installed by the Contractor.

2.03 FACTORY INSPECTIONS AND TESTING

- A. The equipment shall be given the manufacturers' standard quality control inspections and tests to ensure the quality of materials used in the manufacture of the equipment and workmanship conform to the specified requirements. Factory-certified one-hundred-percent testing (not sample testing) of all components shall be conducted.

2.04 SURFACE PREPARATION AND SHOP PAINTING

- A. Ozone and oxygen service piping shall be prepared in accordance with Section 13280, Section 15067 and per Paragraph 1.09.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Installation of the equipment shall be performed to manufacturer's specifications.

### 3.02 FIELD INSPECTION AND TESTING

- A. Furnish the services of an OSS direct employee for 1 day who has complete knowledge of the proper installation, startup and operation of the ozone dissolution equipment, to inspect the final installation and supervise a test run of the equipment. If there are difficulties in operation of the systems due to the manufacturer's fabrication, additional service shall be provided at no additional cost to the OWNER.
- B. After installation of the SVI system has been completed and approved by the manufacturer's direct employee and the system operated for a sufficient period to make all desirable corrections and adjustments, the equipment shall be given a field test in the presence of the Owner or Owner's Representative to determine that operation is satisfactory and in compliance with this Section and that all safety and protective devices are in proper adjustment. During this test period, the equipment shall be operated for not less than 2 hours for each test condition, during which time readings of all essential data shall be taken and recorded at 15-minute intervals. A field test report, including a test data sheet, shall be submitted to the Owner or Owner's Representative for approval at least 30 days prior to testing the equipment. Testing shall include the following:
  - 1. The SVI system shall be tested when the plant is operational to determine that the operation is satisfactory at the ozone dosage required to treat the actual water at the time of the test while maintaining a minimum ozone residual of 0.1 mg/L at the sample station in the mainstream pipeline. The following test data, at a minimum, shall be entered on an EXCEL spreadsheet: ozone gas flow rate, ozone gas pressure at injector suction port, mainstream gas-to-liquid ratio, sidestream gas-to-liquid ratio, inlet ozone-in-oxygen concentration, off-gas ozone concentration, ozone-in-water residual concentration, motive water inlet pressure to injector, motive water outlet pressure from injector, and flow rate through the mixing reactor. Readings shall be taken and recorded at 15-minute intervals and a minimum of three consecutive readings shall be taken and recorded for each interval.
  - 2. The following test conditions shall be included in the testing plan:
    - a. Test Condition No. 1: Plant flow: 6.7 MGD (Well No. 3 and No. 2 in operation); two injectors in service (including the new injector); two nozzle manifolds in service, two sidestream pumps in service; ozone-in-oxygen concentration: 12%; ozone residual: 0.1 mg/L.
    - b. Test Condition No. 2: Plant flow: 3.4 MGD (Well No. 3); one injector in service (new injector); one nozzle manifold in service, one sidestream pump in service; ozone-in-oxygen concentration: 12%; ozone residual: 0.1 mg/L
  - 3. Submit certified copies of the test results to the Owner or Owner's Representative in accordance with Section 01300 within five days of completion of the tests.
- C. In the event the equipment fails to meet the requirements specified herein, corrective measures shall be taken or the equipment shall be removed and replaced with units that meet these specifications and retested at no additional cost to the OWNER.

END OF SECTION

SECTION 13300  
INSTRUMENTATION AND CONTROLS – GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The CONTRACTOR shall procure the services of a single Instrumentation System Supplier (ISS) to furnish and install all materials, equipment, labor and services, except for those services and materials specifically noted, required to achieve a fully integrated and operational system as specified herein and in other Specification Sections listed below.
- B. The work shall include furnishing, installing and testing the equipment and materials detailed in the following Sections:

| <u>Section No.</u> | <u>Title</u>  |
|--------------------|---|
| 13300              | Instrumentation and Controls (I&C) - General Provisions |
| 13302              | I&C - Testing   |
| 13311              | I&C - Digital Hardware and Software                     |
| 13321              | I&C - Fiber Optic Cabling and Equipment                 |
| 13330              | I&C - Control Panels and Panel Mounted Equipment        |
| 13340              | I&C – Field Instruments                                 |

Requirements specified in this Section apply to all equipment specified in the above sections, unless otherwise specified.

- C. The responsibilities of the ISS shall be generally as follows:
1. Furnish and install all field instrumentation as shown in the Drawings and listed in Section 13340.
  2. Provide all PLC, Remote I/O, and other control panels as shown in the Drawings and listed in Section 13330. Modifications to existing control panels shall follow such requirements of Section 13330 as are applicable. Additional control panel components are described in Sections 13300, 13311, and 13321.
  3. Provide testing as described in Section 13302. Provide temporary PLC equipment, cables and other accessories, and temporary configuration programming, where required to conduct testing.
  4. Provide and install networks for communication of data between plant programmable logic controllers (PLCs) and distributed remote I/O (RIO) nodes, variable speed drives, and other equipment. Furnish and install all associated switches, converters, connectors, cables and interface devices, where shown on Drawings or indicated in Specifications. Coordinate with the Electrical subcontractor regarding the installation and termination of cables. Coordinate with the suppliers of equipment specified in other Divisions (as listed in Related Work) for their detailed networking requirements.
  5. Furnish fiber optic cable, patch panels and other accessories, to extend the plant

communications networks as shown in the Drawings. Coordinate with the Electrical subcontractor regarding the provision, installation, and termination of network cables.

- D. The following activities are excluded from the ISS scope of supply:
  - 1. The OWNER will provide all programming for PLCs, operator interface terminals (OITs), and the human-machine interface (HMI), and will configure the Ethernet network.
- E. Auxiliary and accessory devices necessary for system operation or performance, such as transducers, relays, signal amplifiers, intrinsic safety barriers, signal isolators, software, and drivers to interface with existing equipment or equipment provided by others under other Sections of these specifications, shall be included whether they are shown on the Drawings or not.
- F. Substitutions on functions or type of equipment specified shall not be acceptable unless specifically noted. In order to confirm compatibility between all equipment, coordinate all interface requirements with mechanical and electrical systems and furnish any signal isolation devices that might be required.
- G. Equipment shall be fabricated, assembled, installed and placed in operating condition in full conformity with the project Specifications, Drawings, Engineering data, instructions, and recommendations of the equipment manufacturer as approved by the ENGINEER.
- H. To facilitate the OWNER'S future operation and maintenance, similar products shall be supplied from the same manufacturer.
- I. All equipment and installations shall satisfy applicable Federal, State and local codes.
- J. Use the equipment, instrument, and loop numbering scheme that has been developed and shown on the Drawings and specifications in the development of the submittals. Do not deviate from or modify said numbering scheme without the ENGINEER'S approval.

#### 1.02 RELATED WORK

- A. Process & Instrumentation Diagrams (P&ID) are included in the Drawings.
- B. Control System Architecture Block Diagram is included in the Drawings.
- C. General conditions are specified in Divisions 0 and 1.
- D. Process and mechanical equipment is specified in Divisions 11, 13 and 15.
- E. Electrical is specified in Division 16.

#### 1.03 SUBMITTALS

- A. General submittal requirements include:
  - 1. Refer to Section 01300 for general submittal requirements.
  - 2. Additional submittal requirements are contained in related Instrumentation Sections in Division 13.

3. Shop drawings shall demonstrate that the equipment and services to be furnished comply with the provisions of these specifications and shall provide a complete record of the equipment as manufactured and delivered. Submittals shall be complete; giving equipment specifications, details of connections, wiring, ranges, installation requirements, and specific dimensions. Submittals consisting of only general sales literature shall not be acceptable.
4. Submittals shall be bound in separate three-ring binders, with an index and sectional dividers, with all drawings reduced to a maximum size of 11-inch by 17-inch, then folded to 8.5 inch by 11 inch for inclusion within the binder. Maximum binder size shall be 3 inches.
5. The submittal drawings' title block shall include, as a minimum, the ISS's registered business name and address, OWNER and project name, drawing name, revision level, and personnel responsible for the content of the drawing.
6. Incomplete or partial submittals not complying with the submittal arrangements outlined in this Section may be returned without review.

**B. Input/Output (I/O) Address List Submittal**

1. Submit a complete system Input/Output (I/O) address list for equipment connected to the control system under this Contract.
2. I/O list shall be based on the P&ID's, the Drawings, the design I/O list (if included within these specifications), and requirements outlined in the Specifications.
3. The I/O list shall reflect all active and spare I/O points. Add points to accommodate spare I/O.
4. The I/O list shall be arranged such that each control panel has a dedicated worksheet. At a minimum, I/O worksheet tables shall include the following information:
  - a. TAG NUMBER(S): The identifier assigned to a device that performs a function in the control system. As part of this information, the loop number of the tag shall be broken out to allow for sorting by loop.
  - b. DESCRIPTION: A description of the function of the device (text that includes signal source, control function, etc.) Include the text "Spare Points" for all I/O module points that are not connected to equipment.
  - c. PHYSICAL LOCATION: The Control Panel designation of where the I/O point is wired to.
  - d. PHYSICAL POINT ADDRESS: Rack, Slot, and Point (or Channel) assignment for each I/O point.
  - e. LOGICAL POINT ADDRESS: I/O address of each point.
  - f. I/O TYPE: use DO - Discrete Output, DI - Discrete Input, AO - Analog Output, AI - Analog Input, PI - Pulse Input, or PO – Pulse Output.
  - g. RANGE/STATE: The range in engineering units corresponding to an analog 4-20 mA signal, or, the state at which the value of the discrete points are "1."
  - h. ENGINEERING UNITS: The engineering units associated with the Analog I/O.
  - i. ALARM LIMITS: Include alarm limits based on the control descriptions and the Drawings.
  - j. P&ID – the P&ID or drawing where the I/O point appears on. Mark as "NA" (Not Applicable) if the I/O point is derived from a specification requirement and is not on the P&IDs.

5. The I/O list shall be sorted in order by:
  - a. Physical location
  - b. I/O Type
  - c. Loop Number
  - d. Device Tag
6. After the I/O list is approved, do not modify the PLC I/O addresses without approval by the ENGINEER. Provide the approved I/O list in a Microsoft Excel readable electronic file format for use by the OWNER.
7. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single I/O module will not disable all mechanical components of the redundant system. This applies to all I/O types.

C. Field Instruments Submittal

1. Submit complete documentation of all field instruments using ISA-TR20.00.01-2001 (updated in 2004-2006) data sheet formats. Submit a complete Bill of Materials (BOM) or Index that lists all instrumentation equipment. The list shall be sorted by Loop Number.
2. Submit separate data sheets for each instrument including:
  - a. ISA tag number.
  - b. Product (item) name used herein and on the Drawings.
  - c. Manufacturer's complete model and/or part number(s).
  - d. Location of the device.
  - e. Input - output characteristics.
  - f. Range, size, and graduations in engineering units.
  - g. Physical size with dimensions, enclosure NEMA classification and mounting details in sufficient detail to determine compliance with requirements.
  - h. Materials of construction for enclosure and wetted parts.
  - i. Instrument or control device sizing calculations where applicable.
  - j. Certified calibration data for all flow metering devices.
  - k. Two-wire or four-wire device type as applicable.
3. Submit manufacturer's catalog cuts for all instruments. Submit descriptive literature for each component that fully describes the component being provided.
4. Submit proposed mounting details of all instruments.

D. Hardware Submittal

1. Submit a bill of materials that lists, at a minimum, product name, manufacturer, model number, and location, for each hardware component.
2. Submit manufacturer cut sheets for supplied Programmable Logic Controller (PLC), process controller equipment, including central processing units, memory, input modules, output modules, modems, network interface modules, mounting racks, and power supplies. Submit descriptive literature for each hardware component that fully describes the units being provided. Any deviations from the requirements of the Specifications shall be explained in detail.

3. Submit a complete system architecture diagram showing in schematic form the interconnections between major hardware components, including control centers, panels, power supplies, consoles, computer and peripheral devices, networking equipment, processors, I/O modules, local operator interfaces, and like equipment. The system architecture shall depict all required cables, patch panels, media type between components, network protocol used at each network level, details on connection requirements such as cable pin-outs, port numbers, and rack slot numbers. The intent of this specification requirement is for the ISS to develop a diagram that is complete in every aspect to allow purchase of all required equipment by part number, and to allow a qualified technician to interconnect all equipment without having to refer to additional manuals or literature. Sheet size shall be 11"x17".

E. Panel Layout Drawings and Wiring Diagrams Submittal

1. Panel Layout Drawings: Drawings shall be furnished for all panels, consoles, and equipment enclosures specified. Panel assembly and elevation drawings shall be drawn to scale and detail all equipment in or on the panel. Panel drawings shall be 11"x17" in size. The panel drawings shall include the following:
  - a. Interior and exterior panel elevation drawings to scale.
  - b. Nameplate schedule.
  - c. Conduit access locations.
  - d. Panel construction details.
  - e. Cabinet assembly and layout drawings to scale. The assembly drawing shall include a bill of material on the drawing with each panel component clearly defined. The bill of material shall be cross-referenced to the assembly drawing so that a non-technical person can readily identify any component of the assembly by manufacturer and model number.
  - f. Fabrication and painting specifications including color (or color samples).
  - g. Submit construction details, NEMA ratings, intrinsically safe barrier information, gas sealing recommendations, purging system details, etc. for panels located in hazardous locations or interfacing to equipment located in hazardous areas.
  - h. Heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling.
  - i. Calculation of UPS battery life for all connected equipment, as applicable.
  - j. Submit evidence that all control panels shall be constructed in conformance with UL 508A and bear the UL seal confirming the construction. Specify if UL compliance and seal application shall be accomplished at the fabrication location or by field inspection by UL inspectors. All costs associated with obtaining the UL seal and any inspections shall be borne by the ISS and included in the Project Bid Price.
2. Panel Wiring Diagrams: Panel wiring diagrams depicting wiring within and on the panel as well as connections to external devices. Panel wiring diagrams shall include power and signal connections, UPS and normal power sources, all panel ancillary equipment, protective devices, wiring and wire numbers, and terminal blocks and numbering. Field device wiring shall include the device ISA-tag and a unique numeric identifier. The diagrams shall identify all device terminal points that the system connects to, including terminal points where I/O wiring lands on equipment not supplied by the ISS. Wiring labeling used on the drawings shall match that shown on the Contract Documents or as

developed by the ISS and approved by the ENGINEER. I/O wiring shall be numbered with rack number, slot number, and point number. Two-wire and four-wire equipment shall be clearly identified, and power sources noted. Submit final wire numbering scheme. Panel drawings shall be 11" x17" in size.

3. Where direct hardwired interfaces exist between the ISS control panels and vendor provided control panels furnished under other Divisions, coordinate with the General Contractor to obtain the approved shop drawings and submittals that include complete wiring diagrams showing all wiring connections in the I/O system. This includes but is not limited to terminal block numbering, relay contact information, instruments, equipment, and control panel names. These drawings will be included in the Final Documentation submittal. Leaving this information blank on the Final Documentation drawings is not acceptable.

F. Testing Submittals. Refer to Section 13302.

G. Spares, Expendables, and Test Equipment Lists Submittal

1. This submittal shall include for each Subsystem:
  - a. A list of, and descriptive literature for, spares, expendables, and test equipment as specified in Division 13.
  - b. A list of, and descriptive literature for, additional spares, expendables, and test equipment recommended by the manufacturer.
  - c. Unit and total costs for the additional spare items specified or recommended for each subsystem.

H. Final System Documentation (O&M)

1. Submit in accordance with Section 01730.
2. The Final System Documentation shall consist of operations and maintenance manuals as specified herein. The manuals shall be bound in three-ring binders, maximum size of three inches, with Drawings reduced to 11 inch by 17 inch, then folded to 8.5 inch by 11 inch for inclusion. Each section shall have a uniquely numbered tab divider, and each component within each section shall have a separate binder tab divider.
3. The operations and maintenance manuals shall, at a minimum, contain the following information:
  - a. Table of Contents
    - i. A Table of Contents shall be provided for the entire manual with the specific contents of each volume clearly listed. The complete Table of Contents shall appear in each volume.
  - b. As-Built Submittal Information
    - i. Provide complete final documentation based upon final approved submittals specified in this section in the "Submittals" paragraphs and revised as necessary to reflect as-built conditions, including all bills of materials, data sheets, manufacturer cut sheets, drawings, and spare parts information.
    - ii. Drawings that include wiring external to the ISS-furnished equipment shall be filled in with all as-built terminal block and wire numbers.

- iii. For any component requiring dip switch settings or custom software configuration, that information shall be included along with the corresponding data sheets and O&M information.
  - iv. Provide all test and calibration documentation required in Section 13302.
4. The cover and edge of each hard-copy volume shall contain the following information:
- Project Name (refer to Contract Documents)
  - Contract Number (refer to Contract Documents)
  
  - Instrumentation and Control System
  - Hardware [or Applications Engineering] Operations and Maintenance Manual
  - Specification Sections \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_
  
  - Subcontractor Name
  - Date
  - Volume X of Y
  - (Where X is the volume number and Y is the number of volumes)
5. Electronic O&M Information
- a. Provide an electronic version of the O&M documentation on CD-R or DVD-R.
  - b. The completed manual shall be in PDF format, fully indexed and searchable.
  - c. Provide the final I/O list, and any text or spreadsheets used, also in Microsoft Office format.
  - d. Provide drawings also in AutoCAD ".dwg" format. Drawings shall be provided using the AutoCAD eTransmit feature to bind external references, pen/line styles, and fonts into individual zip files along with the drawing file.
6. Provide as-built panel drawings, for both new and modified control panels, to be stored within that panel.
- a. Provide one complete set of drawings that shall be stored in the print pocket: 11x17 inch size; laser printed, not inkjet; in full color where appropriate.
  - b. An additional copy of all key electrical drawings, such as power distribution, networking and I/O, shall be laminated and affixed to the inside of the door. 8.5x11 inch size may be used if there is not enough room for 11x17 inch size.

#### 1.04 REFERENCE STANDARDS

- A. Publications are referred to in the text by basic designation only. Where a date is given for reference standards, that edition shall be used. Where no date is given for reference standards, the latest edition in effect at the time of bid opening shall apply.
- B. International Society of Automation (ISA)
  - 1. ISA S5.2, Binary Logic Diagrams for Process Operations

2. ISA S5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems.
  3. ISA S5.4, Instrument Loop Diagrams.
  4. ISA S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
  5. ISA RP60.3, Human Engineering for Control Centers
  6. ISA RP60.6, Nameplates, Labels, and Tags for Control Centers
- C. Institute of Electrical and Electronics Engineers (IEEE)
1. IEEE 1016-1998, Recommended Practice for Software Design Descriptions
- D. National Electrical Manufacturers Association (NEMA)
- E. National Fire Protection Agency (NFPA)
1. NFPA 70, National Electrical Code (NEC).
- F. PROFIBUS & PROFINET International
1. PROFIBUS Design Guideline (8.012), version 1.13, May 2015
  2. PROFIBUS Assembling Guideline (8.022), version 1.14, May 2015
  3. PROFINET Installation Guideline for Cabling and Assembly (8.072), version 1.0, January 2009
- G. Underwriters Laboratories, Inc. (UL)
1. UL 508, 508A, and 1449.
  2. A nationally recognized testing laboratory, as approved by the Authority having jurisdiction, may substitute for UL listing on commercial off the shelf products.
- 1.05 QUALITY ASSURANCE
- A. The Instrumentation System Supplier (ISS) shall be a "systems integrator" regularly engaged in the design and the installation of instrumentation systems and their associated subsystems as they are applied to the municipal water and wastewater industry. For the purposes of this Specification Section, a "systems integrator" shall be interpreted to mean an organization that complies with all of the following criteria:
1. Employs personnel on this project who have successfully completed ISA or manufacturers training courses on general process instrumentation and configuration and implementation of the specific programmable controllers, computers, and software proposed for this project. Key personnel shall hold ISA CCST Level 1 certification or have a minimum of 10 years of verifiable plant startup experience. Key personnel shall include, as a minimum, the lead field technician.

2. Has successfully completed work of similar or greater complexity on at least three previous projects within the last five years. Successful completion shall be defined as a finished project completed on time, without any outstanding claims or litigation involving the ISS. Potential references shall be for projects where the contract was of similar size to this project.
  3. Has been actively engaged in the type of work specified in this Specification Section for a minimum of five years.
  4. The individual(s) developing the PLC and HMI projects shall be certified in Siemens STEP 7 and WinCC software.
- B. The ISS shall maintain a permanent, fully staffed and equipped service facility within 200 miles of the project site with full time employees capable of designing, fabricating, installing, calibrating, and testing the systems specified herein. At a minimum, the ISS shall be capable of responding to on-site problems within 12 hours of notice. Provide an on-site response within 4 hours of notification starting at two months before scheduled startup to two months after startup completion.
- C. Actual installation of the instrumentation system need not be performed by the ISS's employees; however, the ISS as a minimum shall be responsible for the technical supervision of the installation by providing on site supervision to the installers of the various components.
- D. The ISS shall be one of the following:
1. Control Instruments Inc. (C2i)  
5253 Oakdale Road  
Smyrna, GA 30082  
TEL: (404) 351-1085  
ATTN: Matt Healey
  2. EG Controls  
11790 Philips Hwy  
Jacksonville, FL 32256  
TEL: (904) 292-0110  
ATTN: Sonia McKenzie
  3. Infamation Technologies Group (ITG)  
11235 St. John's Industrial Parkway North, Unit #2  
Jacksonville, FL 32246  
TEL: (904) 425-4760  
ATTN: Dale Young

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery, storage, and handling shall be in accordance with Section 01600.
- B. Shipping Precautions
1. After completion of shop assembly, factory test and approval of all equipment, cabinets, panels and consoles shall be packed in protective crates and enclosed in heavy duty (5 mil) polyethylene envelopes or secured sheeting to provide protection from damage, dust and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The

equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing and handling at the job site.

2. Manufacturer's special instructions for field handling, storage and installation required for protection, shall be securely attached to the packaging for each piece of equipment prior to shipment. The instructions shall be stored in resealable plastic bags or other means of protection.
3. If any apparatus has been damaged, such damage shall be repaired at no additional cost to the OWNER.

#### 1.07 NOMENCLATURE AND IDENTIFICATION

##### A. Field Instrument Tags

1. A stainless steel or other non-corrosive metal tag firmly attached and permanently and indelibly inscribed with the instrument tag number, as indicated in the Drawings, shall be provided on each piece of equipment supplied under this Section. Equipment shall be tagged before shipping to the site.
2. Provide 1/8-in by 3/8-in, Type 316 stainless steel button head machine screws.
3. All supplied field instrument transmitters and field instrument transmitter elements shall have a stainless steel identification tag attached to each transmitter and element prior to shipment. Tag shall be attached via stainless steel chain or stainless steel wire (24 gauge min) to a non-removable part of the device. The tag size shall be a minimum of 1.5 square inches. Tag shall include the ISA alphanumeric instrument number as indicated in the P&ID, loop, and detail drawings. The alphanumeric instrument number shall be stamped into the tag and shall have a minimum of 3/16-in high alphanumeric characters.

##### B. Panel Nameplates

1. See Section 13330.

#### 1.08 WARRANTY

- A. Provide warranty per Section 01740, Warranties and Bonds, and as specified herein.
- B. The ISS shall provide a two (2) year unconditional warranty beginning at Final Completion of all work furnished by them under this Contract. The warranty shall include materials, installation, and applications; and shall constitute complete replacement and delivery to the site of materials, installation and applications to replace defective material or defective workmanship with new materials/workmanship conforming to the Contract Drawings and Specifications. The ISS shall also ensure that the warranties of supplied components are honored by their respective manufacturers.
- C. The ISS shall provide remote technical support by telephone or internet within 4 hours of warranty claim. If the problem cannot be resolved remotely, ISS shall provide onsite technical support within 24 hours of warranty claim.

#### 1.09 MAINTENANCE CONTRACT

- A. The ISS shall provide a written proposal to the OWNER for a maintenance contract for on-site preventive maintenance services related to the plant control system. The cost of this maintenance contract shall not be included in the Contract Price.
- B. This proposal shall be provided prior to Final Completion for one year of maintenance after the warranty period specified herein. Standard per diem rates for providing breakdown service shall be set forth in the contract. Such rates shall be fair and reasonable and reflect the lowest rates offered to most favored customers. The fee quoted shall be firm for a minimum of 90 days from date of issue.
- C. This maintenance contract shall include all labor, parts, and emergency calls providing on-site response within 24 hours, to provide complete system maintenance for a period of one year after the date of Substantial Completion of the system for all equipment and software provided as part of the ISS scope of work.
- D. Provide software updates throughout the maintenance contract period. Provide latest official released version for all software provided under this Contract. OWNER shall have the latest software releases at the end of the maintenance contract period.
- E. The maintenance contract shall also include a minimum of one (1) preventive maintenance visit by qualified service personnel of the Supplier who is familiar with the type of equipment provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning and lubrication of system equipment and verification of correct operation.
- F. Visits to the sites to correct deficiencies under warranty shall not be included in this preventive maintenance service contract.
- G. Emergency maintenance procedures or plant visits may coincide with a preventive maintenance visit, however, they shall not replace the work intended to be performed during a preventive maintenance visit. The Supplier shall have full responsibility for the system hardware preventive and corrective maintenance.
- H. During the one-year maintenance period, observation of maintenance operations by plant personnel and the instruction of said personnel in the details of the maintenance work being performed, shall be provided.

#### 1.10 PROJECT/SITE REQUIREMENTS

- A. Environmental Requirements. Refer to Section 16000 for specific environmental and hazardous area classifications.
- B. Elevation: Equipment shall be designed to operate at the project ground elevation.
- C. Temperature:
  - 1. Outdoor areas' equipment shall operate between -10 and 50 degrees C ambient.
  - 2. Equipment located in indoor locations shall operate between 0 and 40 degrees C ambient.

3. Storage temperatures shall range from 0 to 50 degrees C ambient.
  4. Additional cooling or heating shall be furnished if required by the equipment as specified herein.
- D. Relative Humidity. Air-conditioned area equipment shall operate between 20 to 95 percent relative, non-condensing humidity. All other equipment shall operate between 0 to 100 percent relative, condensing humidity.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. All instrumentation and electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and epoxy or equal coating to prevent contamination by dust, moisture and fungus. The field mounted equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.
- B. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks unless otherwise noted. Fasteners for securing control panels and enclosures to walls and floors shall be either hot-dipped steel galvanized after fabrication, or stainless steel. Only stainless steel fasteners will be acceptable in corrosive areas rated NEMA 4X on the Drawings or as defined under Section 16000. Provide and size anchors in accordance with Division 1 and 5 as required per the seismic calculations. Provide minimum size anchor of 3/8-inch.
- C. All indicators shall be linear in process units, unless otherwise noted. All transmitters shall be provided with indicators in process units, accurate to two percent or better.
- D. All equipment, cabinets and devices furnished shall be heavy-duty type, designed for continuous industrial service. The system shall contain similar products of a single manufacturer, and shall consist of equipment models, which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.
- E. All electronic/digital equipment shall be provided with radio frequency interference protection.
- F. Electrical
  1. Equipment shall operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
  2. With the exception for field device network connected devices, all electronic instrumentation shall utilize linear transmission signals of isolated 4 to 20 mA DC (milliampere direct current) capable of driving a load up to 750 ohms, unless specified otherwise. However, signals between instruments within the same panel or cabinet may be 1-5 VDC (volts direct current).

3. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero-based signals are permitted.
4. Discrete signals shall be nominal 24VDC.
5. All switches shall have double-pole double-throw contacts rated at a minimum of 600 VA, unless noted otherwise.
6. Switches and/or signals indicating an alarm, failure or upset condition shall be wired fail-safe to the SCADA system. A fail-safe condition is an open circuit when in an alarm state.
7. Materials and equipment shall be UL approved. Where components are not available with UL approval, integrate the device with ground fault protective devices, isolation transformers, fuses, or other protective equipment necessary to achieve compliance with UL 508 requirements.
8. All equipment furnished shall be designed and constructed so that in the event of power interruption, the systems specified herein shall go through an orderly shutdown with no loss of memory and shall resume normal operation without manual resetting when power is restored, unless otherwise noted.
9. All transmitter output signals shall include signal and power source isolation.

## 2.02 ELECTRICAL SURGE PROTECTION

- A. General - Surge protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines from lightning, utility, or the plant electrical system. The protection systems shall be such that the protective level shall not interfere with normal operation but shall be lower than the instrument surge withstand level. Protection shall be maintenance free and self-restoring. Devices shall have a response time of less than 50 nanoseconds and be capable of handling a discharge surge current (at an 8x20 $\mu$ s impulse waveform) of at least 8 kA. Ground wires for all instrumentation device surge protectors shall be connected to a low resistance ground in accordance with Section 16660.
- B. Provide protection of all analog and serial signal circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit.
- C. Provide the following surge protection devices:
  1. 230VAC power feeds (single phase): Citel DS42S-230
  2. 120VAC power feeds: Citel DS41S-120
  3. 24VDC power feeds: Citel DS220S-24DC
  4. 24VDC/4-20mA analog signals (inside panel): Citel DLAW-24D3
  5. Profibus DP signals (inside panel): Citel DLAW-06D3

6. Profibus DP and 120VAC power (at field instrument): Citel CAD2-120S-112-A

## 2.03 TUBING AND FITTINGS

- A. Instrument tubing shall be fully annealed ASTM A269 Seamless Type 316 stainless steel, ½-inch O.D. by 0.035 wall thickness, free of OD scratches.
- B. All instrument shut-off valves and associated fittings shall be supplied in accordance with the piping specifications and all instrument installation details. The materials for fittings and valves shall be compatible with process fluids. Where metallic fittings and valves are compatible, wetted materials shall be Type 316 stainless steel. Connections shall be threaded type.

## 2.04 SPARE PARTS

- A. All spare parts shall be wrapped in bubble wrap, sealed in a polyethylene bag complete with dehumidifier, then packed in cartons and labeled with indelible markings. Complete ordering information including manufacturer's contact information (address and phone number), part name, part number, part ordering information, and equipment name and number(s) for which the part is to be used shall be supplied with the required spare parts. The spare parts shall be delivered and stored in a location directed by the OWNER or ENGINEER.
- B. Furnish one of each type of surge protection device used (see paragraph 2.02.C).
- C. Other spare parts are specified in each related Section (see paragraph 1.01.B).

# PART 3 EXECUTION

## 3.01 GENERAL INSTALLATION

- A. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices indicated are approximate only. Exact locations of all devices shall be as approved by the ENGINEER during construction. Obtain in the field, all information relevant to the placing of process control equipment and in case of any interference with other work, proceed as directed by the CONTRACTOR and furnish all labor and materials necessary to complete the work in an approved manner at no additional cost to the OWNER.
- B. The P&IDs and Drawings indicate the intent and not the precise nature of the interconnection between the individual instruments. Where indicated on the P&IDs or Drawings as not requiring installation, provide the instruments suitably packaged for storage.
- C. All equipment used in areas designated as hazardous shall be designed for the Class, Group and Division as required for the locations as shown on the Drawings and specified in Division 16. All work shall be in strict accordance with codes and local rulings.
- D. Unless specifically indicated, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, 5-valve manifolds for calibration, testing and blow down service shall also be provided. For chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

- E. All piping and tubing to and from field instrumentation shall be provided with necessary unions, calibrations and test tees, couplings, adaptors, and shut-off valves. Process tubing shall be installed to slope from the instrument toward process for gas measurement service and from the process toward the instrument for liquid measurement service. Provide drain/vent valves or fittings at any process tubing points where the required slopes cannot be maintained.
- F. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed as shown and not interfere with any other equipment.
- G. The shield on each process instrumentation cable shall be continuous from source (PLC) to destination and be grounded at only one point for each shield on the PLC side.
- H. Investigate each space in the building through which equipment must pass to reach its final location. If necessary, ship material in sections sized to permit passing through restricted areas in the building. Provide on-site service to oversee the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the ENGINEER'S approval. Certify that field wiring associated with his/her equipment is installed in accordance with best industry practice. Schedule and coordinate work under this section with that of the electrical work specified under applicable Sections of Division 16.
- I. Installation of fiber optic cable within control panel and console assemblies. Refer to cable manufacturer's specifications for bend radius. Use cable breakout assembly as recommended by the cable manufacturer. Provide wire basket, strain relief as required to meet manufacturer's strain requirements.
- J. Provide sunshades for equipment mounted outdoors in direct sunlight. Sunshades shall include standoffs to allow air circulation around the cabinet. Where possible, orient equipment outdoors to face to the North or as required to minimize the impact of glare on LED, LCD, or other digital readouts.

### 3.02 TESTING

- A. Refer to Section 13302.

END OF SECTION

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SECTION 13302  
I&C – TESTING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor and materials required and installed. Complete as shown on the Drawings and as specified herein.
- B. This section covers the testing requirements for all devices and systems furnished and installed detailed on the Drawings and in the Loop Diagrams, and as described in the related Sections of Division 13.
- C. Refer to Section 13300.

1.02 SUBMITTALS

- A. Test Form Submittals: Submit the procedures proposed to be followed for each test. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests. Include sign-off forms for each control loop and sequence, and for device calibrations, with sign-off areas for the ISS, ENGINEER, and OWNER. Submit separate forms for each specified test phase.
  - 1. Each control loop and sequence shall have a form to organize and track its inspection, adjustment and calibration. These forms shall include the following information and checkoff items:
    - a. Project Name.
    - b. Loop Number.
    - c. Detailed test procedure indicating exactly how the loop will be tested including all required test equipment, necessary terminal block numbers, and simulation techniques required.
    - d. Tag Number for each component.
    - e. Checkoffs/signoffs for each component.
      - i. Tag/identification
      - ii. Installation
      - iii. Termination – wiring
      - iv. Termination – tubing
      - v. Calibration/adjustment
    - f. Checkoffs/signoffs for the loop.
      - i. Panel interface terminations
      - ii. I/O interface terminations
      - iii. I/O signal operation
      - iv. Inputs/outputs operational: received/sent, processed, adjusted
      - v. Total loop operation
      - vi. Space for comments.
      - vii. Sign off and date fields for the CONTRACTOR, the ENGINEER, and the ISS.
  - 2. Each field instrument and device shall have a Component Calibration form. These forms shall have the following information including space for data entry:
    - a. Project Name.

- b. Loop Number.
  - c. ISA Tag Number and I/O Module Address.
  - d. Manufacturer.
  - e. Model Number/Serial Number.
  - f. Summary of Functional Requirements. For example:
    - i. For Indicators: Scale ranges
    - ii. For Transmitters/Converters: Scale and chart ranges
    - iii. For Computing Elements: Function
    - iv. For Controllers: Action (direct/reverse) control modes (PID)
    - v. For Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), reset (AUTO/MANUAL)
    - vi. For I/O Modules: Input or output
  - g. Calibrations; for example:
    - i. For Analog Devices: Required and actual inputs and outputs at 0, 50 and 100 percent of span.
    - ii. For Discrete Devices: Required and actual trip points and reset points.
    - iii. For Controllers: Mode settings (PID).
    - iv. For I/O Modules: Required and actual inputs or outputs for 0, 50 and 100 percent of span.
  - h. Space for comments.
  - i. Sign off and date fields for the CONTRACTOR, the ENGINEER, and the ISS.
- B. Test Documentation: Upon completion of each required testing and calibration activity, provide documentation by submitting a copy of the signed off test forms and procedures. A test shall not be considered complete until the signed-off test procedures have been submitted and approved. Submittal of other test documentation is not an acceptable substitute for the formal test documentation.
- C. Certificate of Installation. Refer to paragraph 3.05.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 TESTING - GENERAL

- A. See execution requirements in Section 13300.
- B. As part of the requirement of this Section, it is the responsibility of the ISS to provide a complete operational control system. Confirmation of an operational control system is dependent upon results derived from test procedures as specified in this Section.
- C. The following tests shall be conducted:
  - 1. Unwitnessed Factory Test (UFT).
  - 2. Operational Readiness Test (ORT).
  - 3. Site Acceptance Test (SAT).

- D. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.
- E. All tests shall be conducted in accordance with prior ENGINEER and/or OWNER-approved procedures, forms, and checklists as submitted by the ISS under Section 13300. Each test to be performed shall be described and a space provided after it for sign-off by the appropriate parties after its satisfactory completion. The ISS shall include "punchlist" forms with the test procedures to document issues that arise during the testing. Punchlist forms, at a minimum, shall include a specification cross reference; an issues description field; a resolution description field; and a sign-off area for the ISS, OWNER, and ENGINEER. No test listed herein may proceed until the test documentation for that test has been submitted and approved by the ENGINEER.
- F. Copies of the signed-off test procedures, forms, and checklists will constitute the required testing documentation. The test result forms shall be submitted to the ENGINEER for approval within 10 days of completion of each test. Each test listed herein must be successfully completed, and its required documentation approved by the ENGINEER, before the next test may be scheduled.
- G. The ISS shall provide all facilities, materials and equipment required to conduct the test, at no additional cost to the OWNER. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation. The ISS shall describe planned simulation techniques in the test submittal(s).
  - 1. For PLC I/O testing, the ISS shall use SIMATIC STEP 7 version 5.5 software.
  - 2. The ISS shall furnish temporary PLC programming for I/O checkout if necessary to facilitate the testing procedures required herein.
- H. The ISS shall furnish the services of field service engineers, all special calibration and test equipment, and labor to perform the field tests. The ISS shall be responsible to enlist the services of the Control Panel Builder as required during all applicable testing.
- I. The ISS shall coordinate all required testing with the CONTRACTOR, the Control Panel Builder, all other affected Subcontractors, the ENGINEER, and the OWNER. Witnessed tests must be witnessed by at least one representative of the ENGINEER and/or the OWNER.
- J. The ENGINEER reserves the right to test or retest all specified functions, whether or not explicitly stated on the Test Procedures, as required to determine compliance with the functional requirements of the overall system. Such testing required to determine compliance with the specified requirements shall be performed at no additional cost to the OWNER. The ENGINEER'S decision shall be final regarding the acceptability and completeness of all testing.
- K. No equipment shall be shipped until the ENGINEER and/or OWNER has received all test results and approved the system is ready for shipment.
- L. Correction of Deficiencies

1. All deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet specification requirements at no additional cost to the OWNER.
2. Testing, as specified herein, shall be repeated after correction of deficiencies is made until the specified requirements are met. This work shall be performed at no additional cost to the OWNER.

### 3.02 FACTORY TESTING - UNWITNESSED FACTORY TEST (UFT)

- A. Prior to shipment of the equipment, all available elements of the system shall be interconnected and tested to ensure the system will operate as specified. All analog and discrete input/output points, controllers, and other equipment not connected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions, and control devices/functions.
- B. Tests to be performed shall include, but not be limited to, the following. Each of these tests shall be specifically addressed in the Test Procedure submittal.
  1. All panels and enclosures being provided shall undergo a thorough inspection to verify the integrity of the cabinet enclosures, frame structures, paint work and finish, etc.
  2. Panel wire pull tests shall be performed on all wiring to ensure all wiring has been connected to the appropriate torque to prevent wires from coming loose.
  3. Panel heat loading tests shall be performed to ensure proper cooling/ventilation is being provided.
  4. For each subpanel, inspection shall include, but not be limited to, I/O subsystem physical layout, power supply sizing and mounting, cable routing, wire runs across hinges properly installed, fans and blowers unobstructed and mounted to maximize air flow, power conditioning correctly installed, and overall layout and installation of components meets manufacturer's recommendations and standard industry accepted practices.
  5. An I/O point checkout shall be performed to verify proper operation of the input/output points. The verification of the signals will be accomplished via the use of the PLC configuration files and the PLC programming software. At a minimum, the I/O checkout shall consist of four steps.
    - a. Digital input signals shall be jumpered within the termination connections of the PLC panels and verification of proper alarming, statuses, etc., shall be performed utilizing the tools available in the PLC programming software.
    - b. Analog input signals shall be connected to a signal generator at the termination connections and signals shall be verified at 0, 25, 50, 75, and 100 percent of full scale. The appropriate scaled value shall be verified utilizing the tools available in the PLC programming software.
    - c. Digital output signals shall be initiated by the user by writing to the signals utilizing the PLC programming software. Verification shall occur in the PLC panel by connecting a digital multimeter to measure the continuity at the terminations, thus verifying the command from the PLC has properly executed the contact closure.
    - d. Analog output signals shall be initiated by the user by writing to the signals utilizing the PLC programming software. Verification shall occur in the PLC panel by utilizing a digital multimeter to measure the current/voltage generated at the termination points.

6. Demonstrate network communication among the PLC, all Remote I/O racks, and other devices being furnished. Conduct a checkout of all “soft” (networked) I/O points utilizing the same approach as for hardwired I/O points in this Section.
  7. UPSs shall be tested with all equipment connected to verify the UPSs have been sized correctly to maintain the specified run time.
  8. Demonstrate all system software functions specified, including clock synchronization.
  9. Test system recovery from failure scenarios including cold boot, warm boot, communication loss, power failure, etc.
- C. Provide, in addition to the documentation described in the Test Documentation Submittal paragraphs in Section 13300, digital photos and/or videos that clearly show that the panel size, finish, layout, components, construction, etc., are correct and in conformance with Drawings, Specifications, and approved shop drawings.

### 3.03 FIELD TESTING - OPERATIONAL READINESS TEST (ORT)

- A. Following installation of the process control system components and prior to startup and functional testing, the entire system shall be certified (inspected, wired, calibrated, tested, etc., and documented) that it is installed and ready for the ORT as defined below.
- B. Tests to be performed shall include, but not be limited to, the following. Each of these tests shall be specifically addressed in the Test Procedure submittal.
1. All panels and enclosures being provided shall be inspected to verify that they have been installed correctly and without damage to any component.
  2. Panel wire pull tests shall be performed on all field wiring connections to ensure they have been connected to the appropriate torque to prevent wires from coming loose.
  3. Panel heat loading tests shall be performed to ensure proper cooling/ventilation is being provided.
  4. An I/O wiring and point checkout shall be performed to verify proper operation of all input/output points. The verification of the signals will be accomplished via the use of the PLC configuration files and the PLC programming software. The same procedures and techniques required for the UFT in this Section shall be used, except that the actual connected equipment shall be monitored and controlled wherever possible.
  5. Demonstrate network communication among the PLC, all Remote I/O racks, and other devices being furnished. Conduct a checkout of all “soft” (networked) I/O points utilizing the same approach as for hardwired I/O points in this Section.
  6. Demonstrate all system software functions specified, including clock synchronization.
- C. Inspect and calibrate all instruments according to the requirements of this and related Sections. Confirm correct installation, including but not limited to appropriate piping and tubing, wiring and grounding, location, environmental protection, elevation, and operator accessibility.

Perform calibration and verification including but not limited to span and zero, set points, deadbands, failure and reset behaviors.

- D. These inspections, calibrations, and tests do not require witnessing by the ENGINEER. However, the ENGINEER will review Loop Status Sheets and spot-check the ISS test process periodically. Any deficiencies found shall be corrected by the ISS prior to commencement of the Functional Demonstration Test.
- E. Upon successful completion of the ORT, the ISS shall submit a record copy of the test results to the OWNER and ENGINEER.

#### 3.04 FIELD TESTING - SITE ACCEPTANCE TEST (SAT)

- A. After completion of the Operational Readiness Test, the OWNER will install self-developed PLC, OIT and HMI programming. The OWNER will notify the ISS in writing of the start and end dates of their installation activities, not to exceed 30 calendar days. This period constitutes the Site Acceptance Test.
- B. During this time, ISS personnel shall be present as required to address any potential issues with equipment furnished under the ISS's scope of supply. The ISS shall provide contact information for OWNER personnel to use to ensure that support staff are available by phone and/or on-site within four hours of a request by operations staff.
- C. While this test is proceeding, the OWNER shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes. Plant operations shall remain the responsibility of OWNER and the decision of plant operators regarding plant operations shall be final.
- D. Any malfunction during the tests shall be analyzed, and corrections made by the ISS where applicable. The ENGINEER and/or OWNER will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.
- E. Any malfunction within the ISS scope of supply that occurs during this 30 consecutive day test period, which cannot be corrected by the ISS's personnel within 24 hours of occurrence, or more than two similar failures of any duration, will be considered as a non-field-repairable malfunction. Upon completion of repairs by the ISS, the SAT will be re-started from the date which the ISS successfully corrected the malfunction(s) and the OWNER and ENGINEER have accepted and signed off on the repairs.
- F. In the event of rejection of any part or function, the ISS shall perform repairs or replacement within 10 days.
- G. All data base, process controller logic, and graphical interface system errors must be functioning as required per the specifications prior to the start of each test period. The 30-day test will not be considered successful until all data base points and logic functions are tested and verified to be correct.
- H. The total availability of the system shall be greater than 99.5 percent during this test period. Availability shall be defined as:

$$\text{Availability in percent} = 100 * (\text{Total Testing Time} - \text{Down Time}) / \text{Total Testing Time}$$

- I. Down times due to power outages or other factors outside the normal protection devices or backup power supplies provided shall not contribute to the availability test times above.
- J. Upon successful completion of the 30-day operation test and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete and the warranty period shall commence.

### 3.05 CERTIFICATE OF INSTALLATION

- A. Following successful completion of the 30-day test, the ISS shall issue a Certification of Installation. Certification shall be on ISS corporate letterhead and signed by an officer of the firm. Certification shall state that the process control system has been completed in conformance with plans and specifications. Certification shall be submitted to the ENGINEER as specified herein.

END OF SECTION

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SECTION 13311  
INSTRUMENTATION AND CONTROLS –  
DIGITAL HARDWARE AND SOFTWARE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Refer to Section 13300.

1.02 RELATED WORK

- A. Refer to Section 13300.

1.03 REFERENCE STANDARDS

- A. ASTM D999-91: Vibration
- B. (CFR) Title 47, Part 18 (European EN 55011 (formerly CISPR 11))
- C. CSA Certification Class I, Division 2, Group A, B, C, D Hazardous or non-hazardous locations
- D. IEC 60068-2.1 Environmental testing – Part 2-1: Tests - Test A: Cold, 2.2 Environmental testing - Part 2: Tests. Tests B: Dry heat, 2.3, 2.6 Environmental testing - Part 2: Tests - Test Fc: Vibration (sinusoidal) and 2.27 Environmental testing. Part 2: Tests. Test Ea and guidance: Shock
- E. IEC 61000 Electromagnetic compatibility (EMC) - Testing and measurement techniques
  - 1. Part 4-2: Electrostatic discharge immunity test
  - 2. Part 4-3: Radiated, radio-frequency, electromagnetic field immunity test
  - 3. Part 4-4: Electrical fast transient/burst immunity test
  - 4. Part 4-5: Surge immunity test
  - 5. Part 4-6: Immunity to conducted disturbances, induced by radio-frequency fields
- F. IEC 61131-3: Programmable controllers - Part 3: Programming languages
- G. IEC 801-3: RFI Immunity
- H. IEC 801-5: Ground Continuity
- I. IEC 801-2: Electrostatic Discharge
- J. IEEE 472-1974/ANSI C37.90/90A-1974 (Surge Withstand) IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
- K. MIL STD 461B CS02: RFI/EMI Susceptibility

- L. NEMA Pub No ICS2-230.42: Showering Arc Test
- M. NSTA Project 1A
- N. UL 508 and CSA Standard C22.2 No. 142 (Isolation Voltages)

#### 1.04 NOMENCLATURE AND IDENTIFICATION DEFINITIONS

- A. AI: Analog Input
- B. AO: Analog Output
- C. Fixed I/O: A PLC style consisting of a fixed number of I/O, a processor, and a power supply all in one enclosure. Some fixed PLCs have limited expansion ability.
- D. CPU: Central Processing Unit
- E. DI: Discrete Input
- F. Distributed I/O: Hardware specially designed to function as Remote I/O.
- G. DO: Discrete Output
- H. HMI: Human-Machine Interface
- I. I/O Input and/or Output
- J. Modular: A PLC style consisting of modules assembled to comprise a complete unit. All I/O, CPU, and Power Supply are dedicated cards. Typically, modules are inserted into a chassis.
- K. Master/Slave: Communication between devices in which one device, the master, controls all communications. The other devices, the slaves, respond only when queried by the master. Typically used in a Remote I/O application.
- L. Peer to Peer: Communication between two or more devices, typically PLC's, in which each device can control the communication exchange.
- M. PID: Control action, proportional plus integral plus derivative.
- N. PLC: Programmable Logic Controller
- O. Remote I/O: I/O that is located remotely from the processor. Remote I/O can communicate over a variety of communication protocols and can use standard rack based I/O, or special Remote I/O hardware referred to as Distributed I/O.
- P. SCADA: Supervisory Control and Data Acquisition

#### 1.05 SPARE I/O

- A. Each new I/O location shall include at least 25 percent (minimum of four) points of each type (AI, AO, DI, and DO) for future use, regardless of whether any of those point types are used in that location or not. The spares shall be the same type of I/O modules supplied.

- B. Spare output points that require the use of an external relay shall be supplied with the external relay. Analog input and output points require surge suppressors.
- C. Regardless of the spare requirement, all installed unused points on all I/O modules shall be wired to terminal blocks in the order that they occur on the I/O modules. Unwired spares shall not be acceptable.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Provide PLC equipment with the required memory and functional capacity to perform the specified sequence of operation with the scheduled input and output points. Include processor, power supply, input/output modules, communication modules, and remote interface modules as required to meet system requirements
- B. All required accessories, including but not limited to racks, chassis, cables, connectors, terminating resistors, unused slot fillers, faceplates, covers, rails, endcaps, mounting hardware, onboard batteries and memory modules, shall be furnished whether listed herein or not, as needed to compose a complete system.
- C. Furnish products designed for continuous industrial service, listed and classified by Underwriters Laboratories (UL), CSA, or FM approval as suitable for purpose specified and indicated.
- D. All PLC components shall be manufactured by Siemens or shall be specifically authorized and designed for use in conjunction with Siemens equipment, and shall consist of models or parts that are currently in production.

### 2.02 PLC EQUIPMENT LIST

- A. Substitutions of the model and part numbers specifically listed herein must be approved by the Engineer. Note that not all parts required to assemble a complete system are listed.
- B. Main PLC (O2-MCP-100; Main Ozone Control Panel)
  - 1. Digital Input module, 32x24VDC (6ES7 421-1BL01-0AA0)
  - 2. Digital Output module, 16x120VAC (6ES7 422-1BL00-0AA0)
  - 3. Analog Input module, 4-20mA, 8x16bit, isolated (6ES7 431-7KF00-0AB0)
  - 4. Analog Output module, 4-20mA, 8x13 bit (6ES7 432-1HF00-0AB0)
- C. Remote I/O (RIO) Locations
  - 1. Power Supply, Rack Mounted: PS307, 2 Amp (6ES7 307-1BA01-0AA0) or 5 Amp (6ES7 307-1EA01-0AA0)
  - 2. Profibus Communication module: CP341 RS422/485 (p/n 6ES7 341-1CH02-0AE0)

3. Rack Expansion Modules: IM365, 2 modules + cable (6ES7 365-0BA01-0AA0)
4. Remote I/O: IM153-1, ET 200M interface (6ES7 153-1AA03-0XB0)
5. Digital Input module, 16x24VDC (6ES7 321-1BH02-0AA0)
6. Digital Output module, 16x24VDC (6ES7 322-1BH01-0AA0)
7. Analog Input module, 4-20mA plus HART, 8x16bit, optically isolated (6ES7 331-7NF00-0AB0)
8. Analog Output module, 4x16bit (6ES7 332-7ND02-0AB0)

## 2.03 ETHERNET SWITCHES

### A. General

1. Provide managed Ethernet switches as shown in the Drawings and specified herein.

### B. Physical Features

1. Fiber uplinks: 2 x 100/1000 FX ports, minimum; ST connectors
2. Copper ports: 16 x 10/100 TX RJ45 ports, minimum
3. Operating temperature: 32 to 130 degrees F
4. Power: 24 VDC redundant power supply inputs
5. Enclosure: Metal case, DIN-rail mountable
6. Rating: UL Class 1, Division 2 Groups A, B, C, and D

### C. Network Features

1. Full duplex on all port
2. Auto negotiation and manual configurable speed and duplex
3. Wire speed switching fabric
4. IEEE 802.1w RSTP
5. IGMP snooping
6. IGMP filtering
7. Configuration password protected
8. Configuration backup capability required
9. SNMP V3

D. Manufacturers

1. For the process side networking, furnish Siemens SCALANCE X212-2, or approved alternate model/part numbers by the same manufacturer.
2. For the admin/corporate side networking, furnish Cisco IE 3000 or approved equal.

2.04 DIAGNOSTIC REPEATERS

- A. PROFIBUS DP Multi-Channel Diagnostic Repeater: Procentec ProfiHub B4FO2+ or approved equal.

2.05 MEDIA CONVERTERS

A. General

1. Provide fiber-to-copper media converter(s) for digital communications as shown in the Drawings and specified herein.
2. Operating Temperature: -20 to +60 degrees C
3. Power: 24 VDC
4. Enclosure: DIN-rail mountable
5. Fiber ports: Two (2) channels for multimode fiber with ST connectors. Refer to Section 13321 for more fiber optic cable details.

B. Specific Protocols

1. PROFIBUS DP. Furnish Siemens OLM G12 (6GK1503-3CB00), no equal.
2. Ethernet TCP/IP. The unit shall include qty.(1) RJ45 port supporting 10/100BaseTX. Manufacturer shall be Moxa, Phoenix Contact, or equal.

2.06 WIRES AND CONNECTORS

A. Ethernet 10/100/1000 BASE-T/TX Cable

1. The unshielded twisted pair cable shall be designed for use with a high speed (10/100/1000 Mbps) Ethernet 10/100/1000 BASE-T/TX communications network. The twisted pair cable shall have a nominal impedance 100 ohms at one MHz, a maximum attenuation of 8 dB per 1000 feet at one MHz. The twisted pair cable must have frequency tested up to 250 MHz or more. The twisted pair cable shall be plenum rated and shall have a minimum of four 23 AWG solid copper conductor pairs. All 10/100/1000 BASE-T/TX (RJ-45) terminations on the twisted pair cable shall be done in a professional and workman like manner. Terminations shall provide for proper strain relief on the cable jacket. Strain relief on the wire and/or wire insulation shall not be acceptable. Connectors shall be industrial type, Siemens 6GK1901-1BB10-2AA0 or equal.

B. PROFIBUS DP Cable

1. Where required, provide shielded twisted pair cable designed for use with a PROFIBUS DP network. The twisted pair cable shall be non-plenum, with one 22AWG solid copper conductor pair, a tinned copper braid shield, and sunlight resistant PVC jacket. The cable shall have nominal impedance of  $150 \pm 15$  ohms at 3-20MHz, and maximum attenuation of 5.4dB per 100m at 16MHz. All RS485 bus connector terminations shall be done in a professional and workmanlike manner and shall provide for proper shield grounding and strain relief. Connectors shall be Brad Harrison MA9D00-42 and MA9D01-42 type or equal.

## 2.07 PLC SOFTWARE AND PROGRAMMING EQUIPMENT

- A. Refer to Section 13300, paragraph 1.01.C.3, and Section 13302.

## 2.08 SPARE PARTS

- A. Refer to Section 13300.
- B. The following spare parts shall be furnished under this Section:
  1. CPU: Provide one (1) spare processor unit of each type installed.
  2. I/O: Provide 10%, minimum one (1), spare for each unique I/O module type installed.
  3. PLC Power supplies: Provide one (1) spare power supply for each unique power supply installed.
  4. Media converters: Provide one (1) spare of each type installed.
  5. Miscellaneous components (including cables): Provide one (1) spare for each unique component installed.

# PART 3 EXECUTION

## 3.01 GENERAL INSTALLATION

- A. Maintain area free of dirt and dust during and after installation of programmable controller products.
- B. Anchor PLC and Remote I/O racks within enclosures as recommended by the PLC manufacturer.
- C. Ventilation slots shall not be blocked or obstructed by any means.
- D. Examine areas, surfaces, and substrates to receive PLCs for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Install in accordance with manufacturer's instructions.

## 3.02 PANEL LAYOUT

- A. Coordinate size and configuration of enclosure to meet project requirements.

- B. Comply with clearance dimensions and wire sizes recommended by PLC manufacturer. Doors on all components shall be able to be fully closed when all the wires are installed. No wiring, wire ducts, or other devices shall obstruct the removal of cards from the rack. PLC status lights, keyholes, communication ports, and memory card slots shall not be blocked at any time.
- C. Control panel designer shall provide independent line fuses or circuit breakers, per the PLC manufacturer recommendation, for each power supply, input module, output module, and other modules with separately derived power requirements.
- D. All analog, discrete, and communication signals shall be protected from surge and interference as prescribed in Section 13300.
- E. All PLC equipment shall be powered from the UPS power conditioning system in Section 13330.
- F. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single module will not disable all mechanical components associated with the process redundancy (e.g., inputs and outputs for redundancy device 1 shall reside on different modules than the inputs and outputs for redundancy device 2, etc.), irrespective of the number of used points resulting from this configuration.
- G. Provide all required cables, cords, and connective devices for interface with other control system components.

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SECTION 13321  
INSTRUMENTATION AND CONTROLS –  
FIBER OPTIC CABLING AND EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Work of this Section includes providing a fiber optic communications infrastructure including, but not limited to, fiber optic cable (FOC), patch panels, terminations, testing, and implementation.
- B. The Work includes testing individual fiber cables installed under this Contract and testing a completed fiber optic communications network.

1.02 RELATED WORK

- A. Delivery, Storage and Handling in Section 01600.
- B. Process Instrumentation and Control System in Section 13300.

1.03 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Sections 01300 and 01730, the following:
  - 1. Bill of materials and catalog data for cables, termination devices, patch panels, breakout enclosures, splice kits, pigtails, and fan-outs where applicable. Product data sheets shall include the manufacturer's name and catalog number for each item, the manufacturer's descriptive literature, catalog cuts, and any power supply requirements.
  - 2. Provide a fiber optic power budget for each cable run in excess of 1000 feet. The budget shall include transmitter power, receiver sensitivity, connector losses, cable losses, and a 3db-aging margin. Fiber optic transmission line shall maintain a minimum of 10db safety margin.
  - 3. Catalog data on all testing devices proposed for use plus certifications of accuracy, calibration, and traceability to standards of the National Institute for Standards and Testing.
- B. Test reports, for the tests required in Part 3 herein.

1.04 REFERENCE STANDARDS

- A. The optical fiber cable shall conform to the latest issue of the following standards documents, which are incorporated by reference into this specification:
  - 1. EIA-455: Standard Fiber Optic Test Procedures (FOTPs) Devices.
  - 2. EIA-598-A: Standard Colors for Color Identification and Coding.
  - 3. MIL-202: Test Methods for Electronic and Electrical Component Parts.

4. MIL-454: Standard General Requirements for Electronic Equipment.
  5. MIL-810: Environmental Test Methods and Engineering Guidelines.
  6. EIA-568-B.3: Commercial Building Telecommunications Cabling Standard: Optical Fiber Cabling Components.
  7. ICEA 5-83-696: Fiber Optic Premises Distribution Cable (Indoor/Outdoor).
  8. National Electrical Code (NEC) Article 770.
  9. UL 1581 VW-1 - Vertical Tray Cable Flame Test.
  10. UL 1666 - UL Standard for Safety Test for Flame-Propagation Height of Electrical and Optical-Fiber Cables Installed in Vertical Shafts.
  11. NFPA 262 – Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use IN Air-Handling Spaces.
  12. IEEE Standard 383 - Flame Retardancy.
  13. DOD-STD-1678.
  14. National Electrical Manufacturers Association (NEMA).
  15. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- B. All fiber optical cables shall be constructed in accordance with EIA-455, and 100 percent of all optical fibers and jacketing shall meet or exceed the requirements contained in this specification.

#### 1.05 QUALITY ASSURANCE

- A. The cable manufacturer shall be ISO9001 certified and registered.
- B. The fiber optic cabling system materials furnished under this Section shall be provided by Fiber Optic Suppliers who have been providing these types of materials for the past three years. The Fiber Optic Suppliers shall provide personnel capable of providing technical assistance during installation.
- C. The installation of fiber optic cabling system materials furnished under this Section shall be performed by an installation contractor who has been installing these types of materials and systems for the past three years.
- D. Supplier must furnish five working installation references.
- E. The ENGINEER shall determine whether a product is an Equal based upon the information listed herein and the manufacturer's data sheets regarding the models specified. Alternate equipment must meet the criteria listed herein and any additional information in the manufacturer's data sheets in order to be accepted as an Equal.

1.06 SYSTEM DESCRIPTION (NOT USED)

1.07 DELIVERY, STORAGE AND HANDLING

- A. The cable shall be packaged in cartons and/or wound on spools or reels. Each package shall contain only one continuous length of cable. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.
- B. When the length of an order requires a large wooden reel, the cable will be covered with a three-layer laminated protective material. The outer end of the cable shall be securely fastened to the reel head so as to prevent the cable from becoming loose in transit. The inner end of the cable shall project into a slot in the side of the reel or into housing on the inner slot of the drum, in such a manner and with sufficient length to make it available for testing.
- C. Test tails shall be at least two meters long. The inner end shall be fastened so as to prevent the cable from becoming loose during shipping and installation. Reels shall be permanently marked with an identification number that can be used by the manufacturer to trace the manufacturing history of the cable and fiber.
- D. Wooden reels shall be plainly marked to indicate the direction in which it should be rolled to prevent loosening of the cable on the reel.
- E. All fiber optic cables shall be attenuated tested. The attenuation of each fiber shall be provided with each cable reel by the manufacturer.
- F. The attenuation shall be measured at 1310 nm and 1550 nm for single-mode fibers and 850nm and 1300nm for multimode fiber cables after received on site. The manufacturer shall submit the test results prior to installation of the cable.
- G. Packaging
  - 1. The completed cable shall be packaged for shipment on non-returnable wooden reels. It is the responsibility of the CONTRACTOR to determine all required cable lengths.
  - 2. Top and bottom ends of the cable shall be available for testing.
  - 3. Both ends of the cable shall be sealed to prevent the ingress of moisture.
  - 4. Each reel shall have a weatherproof reel tag attached identifying the reel and cable. The reel tag shall include the following information:
    - a. Cable Number Gross Weight.
    - b. Shipped Cable Length in Meters.
    - c. Product Number.
    - d. Date Cable was Tested.
    - e. Cable Length Markings Item Number.
- H. Each cable shall be accompanied by a cable data sheet.

## 1.08 SPARE PARTS AND TEST EQUIPMENT

### A. Spare Parts

1. Provide five percent spares of ST connectors and dust covers, minimum 10 spare ST style connectors and dust covers.
2. Provide five percent spare 36" spare multimode patch cables with connectors (both ends) terminated, minimum one.

### B. Test Equipment and Tools

1. One complete fiber optic connector termination tool kit. The kit shall be the CTS version with VFL, Model TKT-UNICAM-CTS by Corning Cable Systems, or equal.

## PART 2 PRODUCTS

### 2.01 GENERAL MATERIALS

#### A. Cabinets: cabinets shall be provided as indicated on the contract Drawings.

#### B. Provide tight buffered cables that are not gel filled and are suitable for indoor/outdoor applications. These cables shall be flame retardant for indoor applications and water and fungus resistant for outdoor applications.

#### C. Optical Fiber Characteristics

1. All fibers in the cable must be usable fibers and meet required specifications.
2. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding. The fiber shall be matched clad design.
3. Multi-mode: Provide multimode, optical glass fiber compatible with LED or laser-based transmission systems.

#### D. Cable Size/Capacity. Fiber optic cables shall be a minimum of 24 fibers except where otherwise indicated on the Drawings.

#### E. Manufacturers

1. Corning Cable Systems Corp.
2. CommScope.
3. Belden Cable.
4. Or equal.

### 2.02 STANDARD 62.5/125 $\mu$ M FIBER

#### A. The multimode fiber shall meet EIA/TIA-492AAAA-A-1997, "Detail Specification for 62.5- $\mu$ m Core Diameter/125- $\mu$ m Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers."

#### Geometry

|                                |                   |                 |
|--------------------------------|-------------------|-----------------|
| Core Diameter                  | ( $\mu\text{m}$ ) | $62.5 \pm 3.0$  |
| Core Non-Circularity           |                   | $\leq 5 \%$     |
| Cladding Diameter              | ( $\mu\text{m}$ ) | $125.0 \pm 2.0$ |
| Cladding Non-Circularity       |                   | $\leq 1.0 \%$   |
| Core-to-Cladding Concentricity | ( $\mu\text{m}$ ) | $\leq 1.5$      |
| Coating Diameter               | ( $\mu\text{m}$ ) | $245 \pm 5$     |
| Colored Fiber Nominal Diameter | ( $\mu\text{m}$ ) | 253 - 259       |

#### Optical

|  |          |                   |
|--|----------|-------------------|
| Cabled Fiber Attenuation                       | (dB/km)  |                   |
| 850 nm   |          | $\leq 3.5$        |
| 1300 nm  |          | $\leq 1.0$        |
| Point Discontinuity                            | (dB)     |                   |
| 850 nm   |          | $\leq 0.2$        |
| 1300 nm  |          | $\leq 0.2$        |
| Cabled Effective Modal Bandwidth <sup>1)</sup> | (MHz•km) |                   |
| 850 nm   |          | $\geq 220$        |
| IEEE 802.3 GbE Distance                        | (m)      |                   |
| 1000BASE-SX Window (850 nm)                    |          | up to 300         |
| 1000BASE-LX Window (1300 nm)                   |          | up to 550         |
| OFL Bandwidth                                  | (MHz•km) |                   |
| 850 nm   |          | $\geq 200$        |
| 1300 nm  |          | $\geq 500$        |
| Numerical Aperture                             |          | $0.275 \pm 0.015$ |

- 1) As predicted by RML BW, per TIA/EIA 455-204 and IEC 60793-1-41, for *intermediate performance laser based systems* (up to 1 Gb/s).

### 2.03 LOOSE TUBE FIBER OPTIC CABLE (INDOOR/OUTDOOR)

- A. Cable shall be flame-retardant, UV stabilized, fully water blocked with dielectric central member for use in indoor/outdoor applications. The buffer tubes shall be gel-free. Each buffer tube shall contain a water-swellaable yarn for water-blocking protection. Cable manufacturer shall have a minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance. Cable and fiber manufacturer shall be the same company to ensure long-term reliability of the cabled fiber and to ensure the availability of fully integrated technical support. Cable shall be suitable for installation in duct, aerial, and riser environments. Cable shall meet UL OFNR specifications and not require transition splicing upon building entry in order to meet fire codes.
- B. Optical fibers shall be placed inside a buffer tube.
- C. Each buffer tube shall contain up to 12 fibers.
- D. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

- E. Buffer tubes shall be kink-resistant within the specified minimum bend radius.
- F. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.
- G. The central anti-buckling member shall consist of a glass-reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.
- H. The cable core shall contain a water-blocking material. The water-blocking material shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional non-toxic solvents. Cable shall contain water-blocking threads between tubes.
- I. The cable shall contain at least one ripcord under the sheath for easy sheath removal.
- J. Tensile strength shall be provided by a combination of high tensile strength dielectric yarns.
- K. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.
- L. All dielectric cables (with no armoring) shall be sheathed with medium density polyethylene (MDPE). The minimum normal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water-blocking material. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

## 2.04 CABLE CONSTRUCTION

### A. Riser Cables

- 1. Riser cables up to 24 fibers: In cables with more than one fiber, the fibers shall be stranded around a dielectric member and surrounded by layered aramid yarns. The aramid yarns shall serve as the tensile strength member of the cable. A ripcord may be applied between the aramid yarns and the outer jacket to facilitate jacket removal. The outer jacket shall be extruded over the aramid yarns for physical and environmental protection.
- 2. Riser cables with more than 24 fibers: The buffered fibers shall be grouped into six fiber subunits. In each subunit, the individual fibers shall be stranded around a dielectric central member and surrounded by layered aramid yarns. A ripcord shall be incorporated in the subunit design to facilitate access to the individual fibers. The subunit jacket shall be extruded over the aramid yarns for additional physical and environmental protection. The subunits shall be stranded around a dielectric central member. A ripcord shall be inserted beneath the outer jacket to facilitate jacket removal. The outer jacket shall be extruded around the units for physical and environmental protection.

### B. Plenum Cables

- 1. Plenum cables up to 24 fibers: The fibers shall be stranded around a dielectric member and surrounded by layered aramid yarns. The aramid yarns shall serve as the tensile strength member of the cable. A ripcord may be applied between the aramid yarns and the outer

jacket to facilitate jacket removal. The outer jacket shall be extruded over the aramid yarns for physical and environmental protection.

2. Plenum cables with 24 to 72 fibers: The buffered fibers shall be grouped into six fiber subunits. In each subunit, the individual fibers shall be stranded around a dielectric central member and surrounded by layered aramid yarns. A ripcord shall be incorporated in the subunit design to facilitate access to the individual fibers. The subunit jacket shall be extruded over the aramid yarns for additional physical and environmental protection. The subunits shall be stranded around a dielectric central member. A ripcord shall be inserted beneath the outer jacket to facilitate jacket removal. The outer jacket shall be extruded around the units for physical and environmental protection.
  3. Plenum cables with more than 72 fibers: The buffered fibers shall be grouped into twelve fiber subunits. In each subunit, the individual fibers shall be stranded around a dielectric central member and surrounded by layered aramid yarns. A ripcord shall be incorporated in the subunit design to facilitate access to the individual fibers. The subunit jacket shall be extruded over the aramid yarns for additional physical and environmental protection. The subunits shall be stranded around a dielectric central member. A ripcord shall be inserted beneath the outer jacket to facilitate jacket removal. The outer jacket shall be extruded around the units for physical and environmental protection.
- C. The strength member shall be a high modulus aramid yarn. The aramid yarns shall be helically stranded around the buffered fibers. Non-toxic, non-irritant talc shall be applied to the yarn to allow the yarns to be easily separated from the fibers and the jacket.
- D. Cable Jacket
1. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as is consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.
  2. The cable and subunit jacket color shall be orange for cables containing multimode fibers.
  3. The cable and subunit jacket color shall be yellow for cables containing single-mode fibers.
  4. For cables with more than two fibers, the cable jacket shall be designed for easy removal without damage to the optical fibers by incorporating a ripcord under each cable jacket. Non-toxic, non-irritant talc shall be applied to the aramid yarns to allow the yarns to be easily separated from the fibers and the jacket.
  5. The nominal thickness of the cable outer jacket shall be sufficient to provide adequate cable protection while meeting the mechanical, flammability, low smoke, and environmental test requirements of this document over the life of the cable.
- E. The cable shall be all-dielectric.

## 2.05 CABLE IDENTIFICATION

- A. The individual fibers shall be color coded for identification. The optical fiber color coding shall be in accordance with EIA/TIA-598, "Color Coding of Fiber Optic Cables." The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color coded buffered fibers shall not adhere to one another. When fibers are grouped into individual units, each unit shall be numbered in the unit jacket for identification. The number shall be repeated at regular intervals.
- B. The outer cable jacket shall be marked with the manufacturer's name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet. The markings shall be in contrasting color to the cable jacket.

## 2.06 CABLE TESTING REQUIREMENTS

- A. Fiber cables shall be tested by the manufacturer in accordance with the following industry standard (EIA-455) tests:
  - 1. FOTP-41, Compressive Loading Resistance Test.
  - 2. FOTP-104, Fiber Optic Cable Cyclic Flexing Test.
  - 3. FOTP-25, Repeated Impact Testing.
  - 4. FOTP-33, Fiber Optic Cable Tensile Loading and Bending Test.
  - 5. FOTP-85, Fiber Optic Cable Twist Test.
  - 6. FOTP-181, Lightning Damage Susceptibility Test.
  - 7. FOTP-3, Procedure to Measure Temperature Cycling Effects on Optical Fibers, Cables, and other Passive Fiber Optic Components.
  - 8. FOTP-82, Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable.
  - 9. FOTP-37, Low or High Temperature Bend Test for Fiber Optic Cable.
  - 10. FOTP-98, External Freezing Test.
  - 11. FOTP-27, Fiber Diameter Measurements.
  - 12. FOTP-28, Measurement of Dynamic Tensile Strength.
  - 13. FOTP-34, Interconnection Device Insertion Loss Test.
  - 14. FOTP-89, Cable Jacket Elongation and Tensile Strength Test.
- B. The CONTRACTOR shall submit laboratory test reports on representative samples of similar cable design to demonstrate compliance prior to cable installation.

## 2.07 FIBER CABLE TERMINATIONS, CONNECTORS, AND CABLE ASSEMBLIES

- A. Pigtail Splicing

1. For termination of fiber cables at a termination or connector panel (patch panel), with one end of a piece of cable preconnectorized and the other end unterminated for splicing to the cable that needs to be terminated. Splicing and connectors shall meet the requirements listed in this Section.
2. A splice/termination tray shall house the splices and serve to fully protect excess lengths of loose tube fibers from exposure. Splice tray shall be compatible with the selected patch panel and installed for easy access to the spliced cable sections.
3. Pigtail assemblies shall match fiber cable type and model and shall be as manufactured by Corning Cable Systems or equal.

**B. Buffer Tube Fan-Out Kits**

1. Individual fibers within a loose tube cable with 250  $\mu$ m coated fibers shall use a fan-out kit to maintain flexibility and ease of handling fibers within a termination cabinet. Fan-out kits shall be installed in the patch panel enclosures to transition the loose tube fibers to ruggedized tight-buffered fiber pigtail cables. Optical fusion splices shall connect the loose tube fibers to the tight-buffered pigtail cables. The optical splice loss shall comply with the specifications for optical splices. Splice protection sleeves shall be employed on all splices to protect the splices.
2. The tight-buffered pigtails shall be factory-preconnectorized with STTM connectors as specified.

**C. Connectors (Cable Assemblies)**

1. The fiber optic communications system shall utilize stainless steel ST style connectors for all fiber optic connections. SC style connectors will be acceptable only if ST style connectors are not compatible with the equipment being provided. The connectors shall be designed for use with 50/62.5/125/250 micron cable. Each connector shall cause a maximum signal attenuation of 1.6 dB.
2. Field-Installed Connectors: Type ST compatible, SC or LC design with ceramic or polymer ferrule and strain relief boot. The connector installation shall not require the use of epoxies, adhesives or ovens. The connector shall be installable upon 900  $\mu$ m buffered fiber in one minute or less and upon 2.9 mm jacketed cable in three minutes or less total time. The connector shall contain a mechanical splice and have a tool kit available to aid in assembly. The installation tools used to terminate the connector shall be able to terminate other small-form-factor and single-fiber UniCam connector designs. The connector shall not require end-face polishing in the field. The connector shall have a factory polished optical fiber stub in the connector ferrule that is bonded in the ferrule micro hole. Ferrule material shall be available in ceramic or polymer. Connector specifications shall be as follows:
  - a. Insertion loss (typical): 0.3 dB
  - b. Durability (mating cycles): 500 (minimum)
  - c. Repeatability: Less than 0.2 dB
  - d. Operating Temperature: 0 to plus 60 degrees C

3. After termination with connectors, the fiber ends must be visually inspected at a magnification of not less than 100 power for multimode and 200x for single mode to check for cracks or pits in the endface of the fiber.
4. Connectors shall have a maximum allowable connection loss of 0.3 dB per mated pair, as measured per EIA-455-34. No index-matching gel is to be used; dry interfaces only.
5. Each connector shall be of the industry standard ST type compatible; designed for single-mode and multimode tolerances; shall meet or exceed the applicable provisions of EIA-455-5, 455-2A, and 455-34; and shall be capable of 100 repeated ratings with a maximum loss increase of 0.1 dB. Connectors shall incorporate a key-way design and shall have a Zirconia ceramic ferrule. Connector bodies and couplings shall be made of corrosion-resistant and oxidation-resistant materials such as nickel-plated zinc, designed to operate in humid environments without degradation of surface finishes. Connectors shall be capable of operating in a range of -40 to 80 degrees C.
6. Manufacturers
  - a. Corning Cable Systems, Hickory, NC
  - b. AMP, Inc., Harrisburg, PA
  - c. 3M Telecom Systems Group, Austin, TX or equal.

D. Fiber Optic Patch Cables

1. Fiber optic patch cable shall be two-fiber zipcord 50/62.5/125 core/clad micron multimode riser rated cable.
2. Installation of patch cables shall include all spares and observe the minimum fiber bend radius and strain relief.

2.08 FIBER OPTIC TERMINATION PATCH PANELS

A. General

1. Patch panels shall be suitable for wall mounting, comprised of internal mounting plate, cable holders, slack cable take up/organizer blocks, patch block with connectors, and ground lugs as indicated. Panels shall be NEMA 4X, 316 stainless steel construction for outdoors; and NEMA 12, 316 stainless steel or fiberglass for indoor use. Patch panels shall be suitable for multimode system operation at 800 and 1300 nanometers. Patch panels shall be suitable for ST or LC connectors. The patch panels shall be sized to handle the number of fibers as required. All fibers shall be terminated in the patch panel.
2. Where shown on the plans or in the related specification Sections, the fiber optic cable shall terminate inside a communications cabinet on a termination patch panel. All fiber sub-cables within the exposed buffer tube shall be terminated with fan-out kits with preconnectorized pigtails. The patch panel shall have a fiber capacity equal to the total number of fibers (connected and spare) for all cables to be connected.
3. Unused buffer tubes shall be uncut and looped within the patch panel for continuous routing of the fiber buffer tube within the cable assembly.

4. Patch panels shall be designed for either rack mounting on a standard equipment rack or housed in an enclosure for direct wall mounting. The patch panel shall contain "ST" type bayonet or LC couplings. All unused couplings shall have protective dust covers. All panels shall be furnished with locking doors.
5. Factory-terminated, tight-buffered, aramid-reinforced fiber optic jumper assemblies or interconnect cables, standard 3.0-mm O.D., shall connect the optical cable terminations to the patch panel couplings.
6. The termination patch panel shall be equipped with a suitable means for routing and securing of cables and shall provide a suitable means of protection for the mounted fiber connectors to prevent damage to fibers and connectors during all regular operation and maintenance functions. All cables shall be provided with strain relief. Bend diameters on cable fibers and jumpers must be greater than four inches at all times to ensure optical and mechanical integrity of the optical fibers.
7. Termination panels shall be equipped with splice trays (where applicable) and holders for pigtail and through fiber splicing.
8. Termination panels shall be provided with all hardware, options, and accessories to provide for a complete installation of the fiber optic system.
9. Panels shall be as manufactured by Corning Cable Systems LANscape or equal.

B. Rack Mount Fiber Distribution Center (FDC) Splice Housing

1. A rack-mountable Fiber Distribution Center splice housing shall be provided for pigtail splicing and through fiber splicing equipment.
2. The splice housing shall be compatible with the FDC for interconnection of the splicing equipment with the fiber cable management, termination, and distribution rack equipment.
3. Splice trays shall be provided for pigtail splicing.
4. The splice housing shall be sized and equipped with sufficient capacity to terminate and feed through all required fiber cable, plus an additional 20 percent.
5. Provide one spare splice tray.
6. Splice housing shall be Corning Cable Systems LANscape CSH series.

C. Rack Mount Fiber Distribution Center (FDC)

1. The Fiber/Network equipment rack shall be supplied with two rack-mountable Fiber Distribution Centers (FDCs) capable of 48 ST fiber termination points each. The connector center shall be 19" rack-mountable and provide for internal fan-out, splicing, and connection of the fiber optic cable to front panel ST connection patch panel.
2. The FDC shall provide backbone and intermediate connects and cable strain relief for a maximum of five fiber cable systems. The front shall be swing open construction with keyed latch mechanism.

3. The FDC shall be compatible for interconnection with the FDC Splice Housing and provide space and support the addition of fiber cable splice trays for future cable connection and termination.
4. The Fiber Connection Center shall be Corning Cable Systems LANscape CCH series.

D. Wall/Panel Mount Fiber Distribution Center (WDC)

1. The field-mounted fiber termination enclosures shall be supplied with a Wall Mount Fiber Distribution Center (WDC) capable of 48 ST fiber termination points. The distribution center shall be panel-mounted and provide for internal fan-out, splicing, and connection of the fiber optic cable to the patch panel assemblies.
2. Splice trays shall be provided for pigtail splicing. The WDC shall be provided with pass-thru splice trays for continuation of the fiber cable system to additional sites.
3. Provide one spare splice tray.
4. The WDC shall provide space and support the addition of future fiber cable splice trays.
5. The Wall Mount Fiber Distribution Center shall be Corning Cable Systems LANscape (WCH) series.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide all material, equipment, and labor to test and integrate the fiber optic system as indicated and as specified.
- B. Installation shall comply with EIA/TIA Standards 568 and 569.
- C. Fiber optic cables shall be continuous from component to component. Intermediate fiber splices shall not be allowed.
- D. Provide delivery, storage, and handling of materials and equipment in accordance with Section 01600.

3.02 IDENTIFICATION

- A. Label each termination point.
- B. Label each cable, buffer tube, and fiber with permanent waterproof typewritten tags.

3.03 PHYSICAL CHECKOUT

A. General Procedures

1. Conduct physical checkout of the fiber optic data highway network.
2. Physical checkout shall be performed prior to functional testing.

B. Check Procedures

1. Verify that fiber optic cable reels have been off-loaded from truck carefully and not damaged.
2. Submit to the ENGINEER all test data provided by the fiber manufacturer.
3. Verify that the optical fibers of the cable assembly are the type and quantity as specified and as recommended by the Instrumentation System Supplier.
4. Verify that cable construction is the type specified.
5. Verify that fiber optic patch panels have been installed plumb and level at locations indicated.
6. Verify that optical fiber connections or terminations within patch panels and splice closures are in accordance with cable manufacturer's recommendations.

3.04 FIBER OPTIC CABLE TESTING

- A. General: The CONTRACTOR shall perform pre-installation and post-installation FOC tests. The Construction Manager shall be notified a minimum of 10 days in advance so that these tests are witnessed. All test equipment shall be traceable to NIST standards.
- B. Test equipment: The CONTRACTOR shall use the following to perform pre-installation and post-installation FOC tests:
1. Optical time domain reflectometer (OTDR). The OTDR shall be laser precision and be able to test single mode or multimode systems with a visual fault locator. The OTDR shall be as manufactured by Corning, Agilent Technologies, Fluke Networks, or equal.
- C. Pre-installation Tests
1. The purpose of these tests is to perform acceptance tests on the cable prior to installation to verify that the cable conforms to the manufacturer's specifications; is free of defects, breaks, and damages by transportation and manufacturing processes; and to provide baseline readings in dB.
  2. Prior to removal of each cable from the delivery reel, all optical fibers within the cables shall be tested by the CONTRACTOR using an OTDR. The OTDR tests shall consist of end-to-end length and fiber attenuation (dB/km) measurements to ensure proper performance of the fiber optic cable. The tests shall be performed from both ends of each fiber to ensure complete fiber continuity within the cable structure.
  3. Pre-installation, "on-reel" test results shall be compared with the manufacturer's test report delivered with the cable. Gross dissimilarities shall be noted and remedied between the CONTRACTOR and manufacturer. In all cases, all fibers must meet the optical attenuation specifications prior to cable installation.
  4. The CONTRACTOR shall perform tests on all reels of cable. The Construction Manager shall be notified a minimum of 15 days prior to any test.

5. The CONTRACTOR shall document each test and submit the report to the Construction Manager for review. Documentation shall consist of both hard copy and 3.5-inch electronic disk complete with all application software.
  6. Cable shall not be installed until the Construction Manager has reviewed the test report.
  7. Maximum allowable attenuation is 0.5 dB/km at 1310 and 1550 nm. The CONTRACTOR shall replace any cable in which any fiber does not meet this requirement.
- D. Post-installation tests: After FOC has been installed and connectorized, the following tests shall be performed:
1. Visually inspect terminal connectors for out-of-round condition and surface defects such as micro-chips and cracks using a 200X (minimum) inspection microscope.
  2. A recording OTDR shall be used to test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall have an X-Y plotter to provide a hard copy record of each trace of each fiber. The OTDR shall be equipped with sufficient internal masking to allow the entire cable section to be tested. This may be achieved by using an optical fiber pigtail of 30 feet or more to display the required cable section.
  3. The maximum permissible end-to-end loss shall be 0.5 dB/km. The CONTRACTOR shall replace any cable in which any fiber does not meet this requirement.
  4. The OTDR shall be calibrated for the correct index of refraction to provide proper length measurement for the known length of reference fiber.
  5. A transmission test shall be performed with the use of a 1310 and 1550 nm stabilized light sources and 1310 nm/1550 nm power meters for SMF. This test shall be conducted in both directions on each fiber of each cable.
  6. Hard and electronic copies of test documentation shall be submitted to the Construction Manager. The documentation shall include:
    - a. The trace plot.
    - b. Index.
    - c. dB/km loss.
    - d. Cable length.
    - e. Date and time of test.
    - f. Wavelength.
    - g. Pulse width.
    - h. The test site.
    - i. Cable ID.
    - j. Fiber number and type.
    - k. Operator's initials.The CONTRACTOR shall compare the pre-installation test results to the post-installation results. If a deviation of greater than one dB occurs, the Construction Manager shall be notified in writing by the CONTRACTOR, and the cable shall be removed and replaced at no additional cost to the OWNER.
  7. Upon completion of the previous tests, all FOC coils shall be secured with ends capped to prevent intrusion of dirt and water.

- E. Certification of completion of pre- and post-fiber installation testing including test results shall be provided to the ENGINEER, CONTRACTOR, and Ozone Control System Supplier. Test results shall be submitted on paper in a binder, including results indicated in tables or a spreadsheet. Test results that exceed specification limits shall be noted. The electronic copy shall be included in the binder.
- F. Required OTDR Trace Information
  - 1. All traces shall display the entire length of cable under test, highlighting any localized loss discontinuities (installation-induced losses and/or connector losses). The trace shall display fiber length (in kilofeet), fiber loss (dB), and average fiber attenuation (in dB/km), as measured between two markers placed as near to the opposite ends of the fiber under test as is possible while still allowing an accurate reading. Care shall be taken to ensure that the markers are placed in the linear region of the trace, away from the front-end response and far-end Fresnel reflection spike. Time averaging shall be used to improve the display signal to noise ratio. The pulse width of the OTDR shall be set to a sufficient width to provide adequate injected power to measure the entire length the fiber under test.
  - 2. If connectors exist in the cable under test, then two traces shall be recorded. One trace shall record the fiber loss (dB) and average attenuation (dB/km) of the entire cable segment under test, including connectors. The second trace shall display a magnified view of the connector regions, revealing the connector losses (dB). All connector losses shall be measured using the five-point splice loss measurement technique.
  - 3. The OTDR trace shall also include the following information:
    - a. The date and time of the test.
    - b. The cable ID number.
    - c. The cable segment ID number.
    - d. The fiber color or sub-cable number.
    - e. Launch point connector number.
    - f. The optical wavelength used for the test.
    - g. The refractive index setting of the OTDR.
    - h. The pulse width setting of the OTDR.
    - i. The averaging interval of the test.

### 3.05 WARRANTY

- A. Refer to Section 13300.
- B. The CONTRACTOR shall provide an unconditional warranty on all installed cable for a minimum period of 20 years, commencing at the time of final acceptance by the OWNER.
- C. This Section describes the material and installation requirement for the fiber optic cabling system and associated equipment.

END OF SECTION

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SECTION 13330  
INSTRUMENTATION AND CONTROLS –  
CONTROL PANELS AND PANEL MOUNTED EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Refer to Section 13300.
- B. Furnish and install new control panels and panel mounted equipment as specified herein and shown on the Drawings.
- C. Additions and modifications to existing panels shall conform to the standards and requirements of this Section wherever applicable.
- D. All new panels and panel components shall match existing equipment makes and models wherever possible, so that system additions can be most easily integrated with respect to operation and maintenance training, spare parts inventory, and service contracts. Even when exact matches are not possible, equipment furnished must be fully compatible with the existing system. Color, size, and material of new panels should conform to that of existing panels.
- E. The following new control panels shall be provided under this Section:
  - 1. Well No. 3 RIO Control Panel. Located outside adjacent to Well No. 3. NEMA 4X 316 stainless steel construction, wall or strut mounted. Maximum size: 48"H x 36"W x 18"D.
- F. The following existing control panels shall be modified in conformance with this Section:
  - 1. 02-MCP-100 Control Panel. Add I/O points as indicated on the Drawings.
  - 2. Main Ozone Control Panel (MOCP). Add I/O points as indicated on the Drawings.
  - 3. Monitoring Well Control Panel. Modify as required to connect Well No. 3 RIO Control Panel to the plant network.
- G. Furnish and install instrument racks as specified herein and shown on the Drawings. The following instrument racks shall be provided:
  - 1. Well No. 3 Instrument Rack. Maximum size (including sun shield and struts): 90"H x 72"W x 24"D. Refer to drawing I-11.

PART 2 PRODUCTS

2.01 LIGHTNING/SURGE PROTECTION

- A. Refer to Section 13300.

2.02 CONTROL PANEL GENERAL REQUIREMENTS

- A. The dimensions within this Section and on the Contract Drawings are for general reference only. Ensure that final enclosure sizing and panel arrangements accommodate all required

equipment for a fully integrated and operational system as specified herein and in the Contract Documents.

- B. Each control panel and terminal cabinet shall bear the UL label. The UL label shall apply to the enclosure, the specific equipment supplied with the enclosure, and the installation and wiring of the equipment within and on the enclosure. If required for UL labeling, provide ground fault protective devices, isolation transformers, fuses and any other equipment necessary to achieve compliance with UL 508A requirement. The Drawings do not detail all UL 508A requirements.
- C. All panel doors shall have a lock installed in the door handle, or a hasp and staple for padlocking. Locks for all panels provided under this Contract shall be keyed alike.
- D. The devices designated for rear-of-panel mounting shall be arranged within the panel according to respective panel drawings and in a manner to allow for ease of maintenance and adjustment. Heat generating devices such as power supplies shall be located at or near the top of the panel.
- E. All components shall be mounted in a manner that shall permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component mounting shall be oriented in accordance with manufacturer's recommendations. The internal components shall be identified with suitable plastic or metal engraved nametags mounted adjacent to (not on) each component identifying the component in accordance with the drawing, specifications, and ISS's data.
- F. All hardware and fasteners shall be 316 stainless steel. All mounting screws shall be drilled and tapped; self-tapping screws are not permitted.
- G. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc. required to maintain the NEMA rating of the panel.
- H. Nameplates
  - 1. All panels and panel devices shall be supplied with suitable nameplates, which identify the panel and individual devices as required. Unless otherwise indicated, each device nameplate shall include up to three lines with the first line containing the device tag number as shown on the drawings, the second line containing a functional description (e.g., Recirculation Pump No. 1), and the third line containing a functional control description (e.g., Start).
  - 2. Nameplates shall be 3/32-inch thick, plastic laminate with engraved inscriptions. The letters shall be White against a Black background unless otherwise noted. Edges of the nameplates shall be beveled and smooth. Nameplates with chipped or rough edges will not be acceptable.
  - 3. Nameplate fasteners and mounting shall be epoxy adhesive or stainless steel screws.
  - 4. For every panel, provide a main panel nameplate with a minimum of 1" high letters. Provide legend plates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of door mounted control devices, pilot lights, and meters.

5. Single lamicoid nameplates with multiple legends shall be used for grouping of devices such as selector switches and pilot lights that relate to one function.

#### I. Mounting Elevations

1. ISA Recommended Practice RP60.3 shall be used as a guide in layout and arrangement of panels and panel mounted components. Dimensions shall account for all housekeeping pads that panels will sit on once they are installed.
2. Centerline of indicators and controllers shall be located no lower than 48-inches or higher than 66-inches above the floor on a panel face.
3. Centerline of lights, selector switches, and pushbuttons shall be located no lower than 32-inches or higher than 70-inches above the floor on a panel face.
4. Tops of annunciators shall be located no higher than 86-inches above the floor on a panel face.
5. Installation of panel components shall conform to component manufacturers' guidelines.

### 2.03 PANEL MATERIALS AND CONSTRUCTION

#### A. Structure and Enclosure

1. All panels in indoor, dry, non-corrosive environments shall be NEMA 12 unless otherwise noted and shall be of steel construction. All panels in outdoor, wet, or chemically corrosive environments shall be NEMA 4X and of stainless steel construction. All panels located in a hazardous location shall be rated for the type of hazard (e.g., NEMA 7 for Class 1, Division 1).
2. Provide angle stiffeners as required on the back of the panel face to prevent panel deflection under instrument loading or operation. Internally the panels shall be supplied with a structural framework for instrument support purposes and panel bracing. The internal framework shall permit panel lifting without racking or distortion. Provide removable lifting rings designed to facilitate simple, safe rigging, and lifting of the control panels during installation.
3. Each panel shall be provided with full height, fully gasketed access doors. Doors shall be provided with a three-point stainless steel latch and heavy-duty stainless steel locking handle. Panel access doors shall be provided with full length, continuous, piano type stainless steel hinges with stainless steel pins. Front access doors with mounted instruments or control devices shall be of sufficient width to permit door opening without interference from flush mounted instruments. Clamp-type door latches are not permitted.
4. The panels, including component parts, shall be free from sharp edges and welding flaws. Wiring shall be free from kinks and sharp bends and shall be routed for easy access to other components for maintenance and inspection purposes.
5. The panel shall be suitable for top and bottom conduit entry as required by the Electrical Drawings. For top mounted conduit entry, the panel top shall be provided with nominal one-foot square removable access plates, which may be drilled to accommodate conduit and cable penetrations. All conduit and cable penetrations shall be provided with ground

bushings, hubs, gasketed locknuts, and other accessories as required to maintain the NEMA rating of the panel and electrical rating of the conduit system.

- B. Freestanding and Floor-Mounted Vertical Panels. Freestanding and floor-mounted vertical panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of 12 gauge sheet steel, suitably braced internally for structural rigidity and strength. All panels shall be constructed of 316 stainless steel. Front panels or panels containing instruments shall be not less than 10 gauge stretcher leveled sheet steel, reinforced to prevent warping or distortion.
- C. Wall and Unistrut Mounted Panels. All wall and Unistrut mounted panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of not less than USS 14 gauge steel, suitably braced internally for structural rigidity and strength. All wall mounted panels shall be constructed of 316 stainless steel.
- D. Instrument Racks
  - 1. Instrument racks shall be sized and configured to support all indicated instruments and accessories, such that they are easily accessible to operators. Mounting elevation requirements provided herein shall apply. Elements to be mounted on an instrument rack may include transmitters and controllers; sensor assemblies; sample and drain pipes, tubes, valves and manifolds; sample pumps or compressors; power supplies, surge suppressors and disconnects.
  - 2. Instrument rack plates shall be fabricated from .125 Marine Grade Aluminum and .125 316 Alloy Stainless Steel back plate, powder-coated white on all surfaces. Depending on overall size, racks may be fabricated in single or multiple segments for attachment to the support framing, to preserve rigidity. All exposed corners, edges, and other projections shall be smooth rounded or chamfered to prevent injury.
  - 3. Each instrument rack shall be securely attached by stainless steel hardware to two or more steel support struts. Struts shall be aluminum, 3-inch square with 1/4-inch thick walls, permanently installed in concrete as shown on the Detail drawing. All exposed corners, edges and protruding bolts shall be smooth rounded or capped to prevent injury.
  - 4. Instrument racks located outdoors shall be fully covered by sun shields as described herein.
- E. Finish Requirements (except for NEMA 7 rated enclosures)
  - 1. All sections shall be descaled, degreased, filled and ground, phosphate cleaned, and finished.
  - 2. Enclosure finish shall be polyester powder-coated. NEMA 12 indoor enclosure exterior shall be ANSI 61 gray. The exterior of outdoor panels and NEMA 4X panels shall be white. All instrument rack panels and sun shield panels shall be white. All enclosure interiors shall be white.
- F. Print storage pockets shall be provided on the inside of each panel. The storage pockets shall be constructed of compatible material with the panel door, welded onto the door, and finished to match the interior panel color. The storage pocket shall be sufficient to hold all of the prints required to service the equipment, and to accommodate 8.5 inch by 11 inch documents without folding.

## 2.04 ENVIRONMENTAL CONTROL

- A. Heat load calculations shall be submitted for all unvented control panels that are not located in air-conditioned areas. The internal temperature of all panels shall be regulated to minimum 5°C; maximum 40°C, or 5°C below the lowest rated component, whichever is greater; under all conditions. Heat calculations shall account for:
  - 1. Loading and dissipation effects on all surfaces of the enclosure. Any surface not available for heat transfer, e.g. against a wall, shall be accounted for. The effects of sun shields shall be accounted for.
  - 2. Internal heat load of components (load and duty cycle).
  - 3. Outside temperature: assume 95°F.
- B. Provide custom fabricated sun shields for all outdoor panels and instrument racks in accordance with the following requirements:
  - 1. Sun shields shall be fabricated from .125 Marine Grade Aluminum, powder-coated white on all surfaces. Units shall be designed, fabricated, installed, and supported to fully cover and shade the top, sides and back of the enclosure, and to partially shade the front panel of the enclosure, from direct exposure to sunlight from sunrise to sunset.
  - 2. Depending on overall size, sun shields may be fabricated in single or multiple segments for attachment to the enclosure support framing or to separate free standing framing around the enclosure, to preserve rigidity.
  - 3. Sun shields shall not be attached directly to the enclosure by drilling holes through, or welding studs to, the enclosure surfaces, and shall be designed and mounted to provide a minimum 3-inch air gap all around the enclosure for air circulation and heat dissipation.
  - 4. The top section of all sun shields shall be sloped at a minimum angle of 5 degrees from horizontal. For wall mounted enclosures, the top section shall slope downward away from the wall and towards the front of the enclosure. For free standing, floor mounted and frame mounted enclosures the top section shall slope downward towards the back side of the enclosure.
  - 5. The front edge of the top section of all sun shields shall incorporate a narrow and more steeply sloped drip shield segment which sheds water away from the front of the enclosure and prevents it from dripping or running directly onto the front panel of the enclosure.
  - 6. All seam welds used in sun shield fabrication shall be continuous and shall be ground smooth.
  - 7. All exposed corners, edges and projections shall be smooth rounded or chamfered to prevent injury.
- C. Under no circumstances shall temperature control methods compromise the NEMA rating of the panel. Air conditioners are not allowed.
- D. All control panels that are located outdoors or in unconditioned indoor process areas shall be provided with an integral heater, fan, and adjustable thermostat to reduce condensation and

maintain the minimum internal panel temperature. Mount the unit near the bottom of the enclosure with discharge away from heat-sensitive equipment. Heater shall be Hoffman DAH or equal.

## 2.05 CORROSION CONTROL

- A. Panels shall be protected from internal corrosion by the use of corrosion-inhibiting vapor capsules as manufactured by Northern Technologies International Corporation, Model Zerust VC; Hoffman Model AHCI; or equal.

## 2.06 CONTROL PANEL - INTERNAL CONSTRUCTION

### A. Internal Electrical Wiring

1. Wire type 12 AWG and smaller shall be Hook-Up/Lead tinned copper, minimum 18 AWG stranded, Belden 35612 Hook-Up Lead-UL AWM Style 3173-XL-DUR or equal.
2. Wiring for systems operating at voltages in excess of 120 VAC shall be segregated from other panel wiring either in a separate section of a multi-section panel or behind a removable Plexiglas or similar dielectric barrier. Panel layout shall be developed such that technicians shall have complete access to 120 VAC and lower voltage wiring systems without direct exposure to higher voltages.
3. Power and low voltage DC wiring systems shall be routed in separate wireways. Crossing of different system wires shall be at right angles. Different system wires routed parallel to each other shall be separated by at least 6 inches. Different wiring systems shall terminate on separate terminal blocks.
4. Wiring troughs shall be wide slot, hinged cover type. Trough edges may be located no less than 1.5 inches from the nearest terminal block or component or subpanel edge. Troughs shall not be filled to more than 40 percent visible fill.
5. Power distribution wiring on the line side of fuses or breakers shall be 12 AWG minimum. Control wiring on the secondary side of fuses shall be 18 AWG minimum. Electronic analog circuits shall utilize 20 AWG minimum, foil and braided shielded twisted pair, cable insulated for not less than 600 volts. Insulation is to be stripped back 6" from the terminal connection to allow clamp on measurement of a 4-20ma loop.
6. All control wires are to have Insulated Ferrules mounted on all the ends. This includes the ends of all field wires. Proper manufacturer recommendations are to be followed when installing each ferrule.
7. Terminations
  - a. All wiring shall terminate onto single tier terminal blocks, where each terminal is uniquely and sequentially numbered. Direct wiring between field equipment and panel components is not acceptable.
  - b. Terminal blocks shall be arranged in vertical rows and separated into groups (power, AC control, DC signal). Each group of terminal blocks shall have a minimum of 25 percent spares. Terminal blocks shall be by Weidmuller.
  - c. Discrete terminal blocks shall be double deck. Analog terminal blocks are to be triple deck. Terminal block colors shall match UL508A voltage code.

- d. Terminal blocks shall be the compression type, fused, unfused, or switched as shown on the Contract Drawings or specified elsewhere in Division 13.
  - e. Discrete inputs and outputs (DI and DO) shall have two terminals per point with adjacent terminal assignments. All active and spare PLC and controller points shall be wired to terminal blocks. All active and spare PLC DO points shall be wired to interposing relays as described herein.
  - f. Analog inputs and outputs (AI and AO) shall have three terminals per shielded pair connection with adjacent terminal assignments for each point. The third terminal is for shielded ground connection for cable pairs. Ground the shielded signal cable at the PLC cabinet. All analog inputs and outputs shall also be wired to 24V surge suppressors, as specified in Section 13300. All active and spare PLC and controller points shall be wired to terminal blocks and surge suppressors.
  - g. Wire and tube markers shall be the tube type with heat impressed letters and numbers.
  - h. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 6-inches of the side panel or adjacent terminal or within 8-inches of the bottom of free-standing panels, or within 3-inches of stanchion mounted panels, or 3-inches of adjacent wireway.
  - i. Circuit power from the SCADA cabinet out to field devices (switches, dry contacts etc.) that are used as discrete inputs to the PLC input cards shall be isolated with an isolating switch terminal block with flip cover that is supplied with a dummy fuse. Isolation switch block shall be an Allen Bradley or Weidmuller. One isolating switch terminal block per loop numbered piece of equipment and one per spare I/O point is acceptable.
  - j. All PLC discrete inputs from the field shall be isolated with an isolating fuse switch terminal block with a flip cover and a neon blown fuse indicator. Two fuses per discrete input I/O module is required.
  - k. All PLC discrete outputs to the field shall be isolated with an interposing relay, as specified in paragraph 2.12 of this Section.
- 8. All wiring to hand switches and other devices, which are live circuits independent of the panel's normal circuit breaker protection, shall be clearly identified as such.
  - 9. All wiring shall be clearly tagged and color coded. All tag numbers and color coding shall correspond to the panel wiring diagrams and loop drawings. All power wiring, control wiring, grounding, and DC wiring shall utilize different color insulation for each wiring system used. The color-coding scheme shall be in accordance with UL 508a.
  - 10. Provide surge protectors on all incoming power supply lines at each panel per the requirements of Section 13300.
  - 11. Mount all terminal blocks, fuse blocks, and other devices wherever feasible, on extended DIN rail, attached to the subpanel by stainless steel screws.
  - 12. Wiring trough for supporting internal wiring shall be wide width, plastic type, with snap-on covers. The side walls shall be open top type to permit wire changing without disconnecting. Trough shall be supported to the subpanel by stainless steel screws. Trough shall not be bonded to the panel with glue or adhesives.
  - 13. Each panel shall have a work light fixture, LED type, mounted internally to the ceiling of the panel, with manual switch.

14. Each panel shall have a specification grade duplex convenience receptacle with ground fault interrupter, mounted internally. The convenience receptacle shall be powered from the UPS, shall be protected by a dedicated fuse or circuit breaker, and shall be clearly labeled "Computer Use Only – 3 Amp Maximum".
  15. Each panel shall be provided with an isolated copper grounding bus for all signal and shield ground connections. Shield grounding shall be in accordance with the instrumentation manufacturer's recommendations.
  16. Each panel shall be provided with a separate copper power grounding bus (safety) in accordance with the requirements of the National Electrical Code.
  17. Each panel shall have control, signal, and communication line surge suppression in accordance with Section 13300.
  18. All microprocessor-based electronic devices in the panel that are powered by 120VAC shall be powered by the UPS (refer to appropriate Section in Division 13).
  19. Where 24VDC power is required, provide separate power supplies for internal control devices, and for field devices such as 4-20mA loops.
  20. Each panel shall be provided with a circuit breaker to interrupt incoming power.
  21. Additional electrical components including transformers, motor starters, switches, circuit breakers, etc. shall be in compliance with the requirements of Division 16.
- B. Relays not provided under Division 16 and required for properly completing the control function specified in Division 13, Division 16, or shown on the Drawings shall be provided under this Section.
- C. The orientation of all devices including PLC and I/O when installed shall be per the manufacturer's recommendations. No vertical orientation of PLC racks shall be allowed unless specifically indicated by the manufacturer as an acceptable mounting alternative and also approved by the Engineer.

## 2.07 GENERAL PURPOSE RELAYS AND TIME DELAYS

- A. Type:
1. General purpose plug-in type.
- B. Functional:
1. Contact arrangement/function shall be as required to meet the specified control function; Mechanical life expectancy shall be in excess of 10 million.
  2. Duty cycle shall be rated for continuous operation; Units shall be provided with integral indicating light to indicate if relay is energized.
  3. Solid state time delays shall be provided with polarity protection (DC units) and transient protection.
  4. Time delay units shall be adjustable and available in ranges from .1 second to 4.5 hours.

C. Physical:

1. For 120 VAC service provide contacts rated 10 amps at 120 VAC, for 24 VDC service provide contacts rated 5 amps at 28 VDC, for electronic (milliamp/millivolt) switching applicator provide gold plated contacts rated for electronic service; relays shall be provided with dust and moisture resistant covers.

D. Options/Accessories Required:

1. Provide mounting sockets with pressure type terminal blocks rated 300 volt and 10 amps.
2. Provide mounting rails/holders as required.

E. Manufacturer(s):

1. IDEC.

2.08 INTRINSIC SAFETY BARRIERS (FOR 2-WIRE TRANSMITTER SYSTEMS)

- A. Intrinsic safety barriers shall be passive devices requiring no external voltage supply and supplied with series resistors, series fuse and shunt zener diodes to limit the transfer of energy to levels required by intrinsically safe protection between safe and hazardous locations.
- B. Unit shall be Factory Mutual approved and certified for use in accordance with National Fire Protection Association (NFPA 493).

C. Manufacturer(s):

1. P&F.
2. Gems.
3. Unitech.
4. Equal.

2.09 24 VDC POWER SUPPLY

- A. Provide one or more 24VDC power supplies as required. Each 24 VDC power supply shall meet the following requirements:
  1. Input power: 115 VAC, plus or minus 10 percent, 60 Hz.
  2. Output voltage: 24 VDC.
  3. Output voltage adjustment: 5 percent.
  4. Line regulation: 0.05 percent for 10 volt line change.
  5. Load regulation: 0.15 percent no load to full load.
  6. Ripple: 3 mV RMS.

7. Operating temperature: 32 to 140 degrees Fahrenheit.
  - B. Equip each power supply with a power on/off circuit breaker. Furnish separate power supplies for internal panel devices and for loop-powered instruments outside the panel. For the internal panel devices, furnish a redundant pair of power supplies with automatic failover unit.
  - C. Size each 24 VDC power supply to accommodate its design load plus a minimum 25 percent spare capacity.
  - D. Provide output overvoltage and overcurrent protective devices with the power supply to protect instruments from damage due to power supply failure and to protect the power supply from damage due to external failure.
  - E. Mount the 24 VDC power supply such that dissipated heat does not adversely affect other panel components.
  - F. Manufacturer: PULS.
- 2.10 24VDC UNINTERRUPTIBLE POWER SUPPLY (UPS)
- A. Type: 24 VDC uninterruptible primary switched mode power supply unit. The power supplied to all microprocessor-based equipment, principally PLCs, Remote I/O, and networking equipment, shall be protected by UPS.
  - B. Operation:
    1. Provide uninterrupted 24 VDC power to output upon loss of input power.
    2. When 24 V supply voltage is applied, connected battery module is charged.
    3. In event of a supply voltage failure, battery module is connected to the output, and stored power ensures that all connected devices continue to operate without interruption. UPS supplies a 24 VDC voltage with a load current up to 10 A.
  - C. Functional:
    1. Input voltage range: 22.5 - 30 VDC.
    2. Nominal Output Voltage: 24 VDC.
    3. Output Current: 10 A or as required.
  - D. Controls:
    1. Dry contacts shall be provided for remote monitoring of UPS conditions:
      - a. UPS on battery.
      - b. Fault.
  - E. Physical:
    1. Mounting: horizontal DIN rail mounting.
    2. Operating temperature range: 0 - 50 degrees C.

3. UL508A/1778 rated, capable of being installed in industrial control enclosures and preserving NEMA 4X or 12 rating.
  4. Batteries shall be fully sealed, high-temperature type (50°C).
- F. Performance: UPS shall provide a minimum of 5 minutes of run time for calculated full load. Unit may have either internal or external batteries as necessary to support runtime requirements.
- G. Manufacturer(s):
1. Phoenix Contact QUINT Series.
  2. Siemens SITOP Series with signaling contact module.
  3. Sola HD Series.
  4. Or equal.

## 2.11 SPARE PARTS

- A. General requirements for spare parts are specified in Section 13300 and related sections.
- B. The following control panel spare parts shall be furnished:
1. Relays and sockets - Two of each type installed.
  2. Fuses and circuit breakers - 10% (minimum of 10 fuses and 2 circuit breakers) of each type and size installed.
  3. Power supplies - one of each type installed.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Refer to Section 13300.

### 3.02 TESTING

- A. Refer to Section 13302.

END OF SECTION

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SECTION 13340  
INSTRUMENTATION AND CONTROLS –  
FIELD INSTRUMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This section covers the furnishing, installation, and services for instruments.
- B. Refer to Section 13300.

1.02 SUBMITTALS

- A. Refer to Section 13300.

1.03 MAINTENANCE

- A. Refer to Section 13300.

1.04 OZONE/OXYGEN SERVICE

- A. This paragraph applies to gaseous, liquid, or mixtures of ozone, oxygen, ozone off-gas, and ozone vent gas.
- B. All instrumentation equipment, valves, analyzers, seals, gaskets, valve seats, and associated appurtenances to be used with the above-noted special services shall be cleaned, sealed, and protected in accordance with CGA publication G-4-1 and certified for oxygen service before shipping.
- C. All equipment, valves, valve seats, analyzers, seals, gaskets, welds, and all associated appurtenances to be used with the above noted special services shall be specially certified resistant to degradation and gas losses due to the use of these gases or liquids.
- D. Greases and lubricants shall be oxidation resistant and shall be DuPont "Krytox" for the above-noted special services.
- E. Gaskets shall be expanded PTFE, Swagelok, No equal.
- F. All pipe, tube, fittings, couplings, and appurtenances for use with these services shall be Type 316L stainless steel.
- G. Where necessary, diaphragm seals shall be provided as specified herein.

PART 2 PRODUCTS

2.01 MAGNETIC FLOWMETER

- A. Flow Element
  - 1. Type:

- a. Pulsed DC type.
2. Function/Performance:
  - a. Operating Temperature: Process liquid temperatures of 0 to 140 degrees F or greater dependent upon liner and an ambient of minus 30 to 150 degrees F.
  - b. Radio Frequency Interference (RFI) protection: RFI protection shall be provided as recommended by the manufacturer.
  - c. Pressure rating: Equal to piping system where meter is installed.
  - d. Additional: Meter shall be capable of running empty indefinitely without damage to any component.
3. Physical:
  - a. Metering Tube: 304 stainless steel or equivalent.
  - b. Flanges: ANSI 150 lb. or DIN PN 16 carbon steel, as required by the piping system, unless otherwise indicated. ANSI 150 lb. or DIN PN 16 stainless steel flanges shall be used on all SS process pipes.
  - c. Liner: Polyurethane for raw water service.
  - d. Electrodes: 316 conical stainless steel standard minimum requirements. All electrodes to be compatible with process fluid as indicated on the Drawings. For sludge, polymer, or any slurry application where the electrodes will be coated, a self-cleaning or a removable electrode option must be provided with that meter.
  - e. Housing: Meters below grade shall be suitable for submergence for up to 48 hours to a depth of 30 ft (9m). Meters above grade shall be NEMA 4X (IP65). Where hazardous areas are indicated on the Drawings, the equipment shall be rated for that area.
  - f. Finish: All external surfaces shall have a chemical and corrosion resistant finish.
  - g. Hazardous Area Classification: FM, Class I, Division 2 Nonincendive.
4. Accessories/Documentation Required:
  - a. Factory calibration: All meters shall be factory calibrated. A copy of the report shall be included in the O&M manual.
  - b. Grounding: Meter shall be grounded in accordance with the manufacturer's recommendation. Provide ground ring, ground wires, gaskets, etc., as required. All materials shall be suitable for the liquid being measured and must be compatible with process fluid and with the process pipe.
  - c. Signal cable for installation between the flowtube and the transmitter. Length shall be as required by installation indicated on the Drawings.

#### B. Flow Converter/Transmitter

1. Type:
  - a. Microprocessor based, intelligent transmitter compatible with flowtube provided.
  - b. Mounted remote from the flowtube, or integral, as shown on the Drawings.
2. Functional/Performance:
  - a. Accuracy (including flowtube):  $\pm 0.2\%$  of rate.
  - b. Operating Temperature: -20 to 140 degrees F.
  - c. Power Requirements: 120 VAC.
  - d. Output: PROFIBUS DP.
  - e. Diagnostics:
    - 1) Self diagnostics with on screen display of faults.

- 2) Furnish Extended HistoROM and Heartbeat Verification + Monitoring option.
  - f. Display: Digital indicator displaying flow in engineering units.
  - g. Totalizer: A fully configurable totalizer integral to the transmitter. Totalized flow shall be displayed.
  - h. The transmitter shall include a feature that will lock the output at zero when no flow is detected. The empty tube zero feature shall be enabled automatically when the transmitter detects no flow or manually through a contact input.
  - i. Provide electrode cleaning unit to match flow element requirements.
  - j. Hazardous Area Classification: FM, Class I, Division 2 Nonincendive.
- 3. Physical:
  - a. Transmitter shall be suitable for surface mounting.
  - b. Enclosure shall be NEMA 4X (IP65).
- 4. Accessories/ Required:
  - a. Keypad where required for transmitter configuration.
- C. Manufacturer:
  - 1. Endress+Hauser Promag 400W, no exceptions.
- D. Units to be Furnished by ISS:
  - 1. FE/FIT-325: Well No.3 Flow
    - a. Line Size: 12 inch
    - b. Range: 0-2,500 gpm

## 2.02 THERMAL DISPERSION FLOW SWITCH

- A. Type:
  - 1. Thermal dispersion flow switch with integral electronics enclosure.
  - 2. Insertion type.
- B. Function/Performance:
  - 1. Range: 1 to 125 ft/s (0.3 to 38 m/s) in air.
  - 2. Process Operating Temperature: -40 to 250 degrees F.
  - 3. Operating Temperature for Electronics: 0 to 140 degrees F.
  - 4. Accuracy: Plus or minus 5 percent of reading.
  - 5. Repeatability: Plus or minus 0.5 percent of reading.
  - 6. Output: DPDT contacts rated 6 A at 120 VAC adjustable over the range of the instrument.
- C. Physical:
  - 1. Wetted parts to be per the Device Schedule.

2. Electronics head to be NEMA 4X (IP65) for non-hazardous process gases and explosion proof approved for Class 1, Division 1, Groups C and D (EEx d IIC) for hazardous process gases or where located in a hazardous area.

D. Power Requirements:

1. Transmitter shall be 120 VAC powered instrument.

E. Accessories Required:

1. For insertion type flow elements a hot tap assembly including a ball valve and packing gland that will allow removal of the sensor without shutdown of the process, shall be provided. The hot tap assembly shall be installed in a welded fitting on the pipe.

F. Manufacturers:

1. Fluid Components International FLT93S.
2. Or equal.

G. Units to be Furnished by ISS:

2. FSL-313A, 313B, 313C (qty.3): Sodium Hypochlorite Feed Pump No. 1, 2, 3 Flow Alarm
  - a. Line Size: 3/4 inch
  - b. Wetted Parts: Hastelloy C

## 2.03 SUBMERSIBLE LEVEL TRANSMITTER

A. Type

1. Submersible, hydrostatic pressure type level sensor and transmitter.

B. Function/Performance

1. Range: Range selected shall be the manufacturer's standard range closest to the span to be measured.
2. Temperature Compensation: Temperature compensated over a range of zero to 50 degrees C.
3. Accuracy:  $\pm 0.25\%$  of range.
4. Over Pressure: Transducer shall be protected for over pressure of 1.5 times the span.
5. Power: 24 VDC loop powered.
6. Output: 4-20 mA proportional to the calibrated span.

C. Physical

1. The transmitter assembly shall have a Type 316 stainless steel or titanium body with a bottom diaphragm.

2. Furnish 70 feet of sensor cable, or longer if required. Cable shall include a vent tube for the transducer.
3. Sensor shall be mounted in the well pump casing where shown on the Drawings. Provide 316 stainless steel hardware as needed.
4. Sensor shall be submersible (IP68) and shall be CSA approved or CENELEC (EEx ia IIC T4) certified intrinsically safe when intrinsically safe barriers are provided for the instrument loop.
5. Transmitter shall terminate in a NEMA 4X enclosure, wall or surface mounted, that is protected from moisture and atmospherically vented. It shall have a termination strip for power and output connections, and shall feature a pre-mounted signal conditioner.

D. Manufacturer(s)

1. Transmitter: Process Measurement & Controls (PMC), model VL4513 or MTM 3213.
2. Termination Enclosure: PMC, model TE-11C.
3. Local Display: Endress+Hauser, Model RIA46.

E. Units to be Furnished by ISS:

1. LE/LIT-320: Well No.3 Level
  - a. Range: 0-100 feet.

## 2.04 ELECTRODE RELAY LEVEL SWITCH

A. Sensor

1. Type
  - a. Conducting electrodes which actuate an induction relay (level switch) at a given liquid level.
  - b. Electrodes shall be wire suspension type with PVC-jacketed cables.
2. Function/Performance
  - a. Match level electrode requirements to the liquid being measured.
3. Physical
  - a. Electrode material shall be Teflon-coated Type 316 stainless steel.
  - b. Electrode holder shall be of the flanged PVC type with a three- inch minimum flange. Number and type of electrode openings shall be as required. All electrical connections shall be in a weatherproof enclosure attached to the flange.
4. Special Requirements
  - a. Match electrode holder to flanges supplied in tank or wet well.

B. Level Switch (Induction Relay)

1. Type
  - a. Induction relay.

2. Function/Performance
  - a. Contractor shall match the secondary coil voltage to liquid being measured and verify distance to level electrodes is not too large for selected coil voltage.
  - b. Primary coil voltage is 120 volt AC.
  - c. Output contacts configuration shall provide one normally open contact, one normally closed contact per relay. The relay shall also be provided with a holding circuit where required.
3. Physical
  - a. Output contacts shall have a minimum rating of 5 amps at 120 volt AC.
  - b. Induction relays and auxiliary controls shall be mounted in an outdoor stainless steel, NEMA 4X enclosure.
  - c. A fused disconnect switch shall be mounted in each relay control enclosure to disconnect line power to the equipment.

C. Manufacturer(s):

1. Ametek B/W Controls
2. Or equal.

D. Units to be Furnished by ISS:

1. LSH & LSL-237: Ground Storage Tank No.2 High & Low Level
  - a. Elevations: HWL, 63.16 ft; LWL, 33.83 ft.

2.05 PRESSURE TRANSMITTER

A. Type:

1. Microprocessor based, intelligent type.
2. For flow metering applications, the output shall be proportional to the square root of the input differential pressure.
3. For tank level applications, provide a factory-integrated diaphragm seal, with process connection to match that provided on the tank.

B. Function/Performance:

1. Range: Range of the transmitter shall be the standard range of the manufacturer closest to the pressure range to be metered.
2. Accuracy: 0.075 percent of span.
3. Operating Temperature: -20 to 80 degrees C.
4. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28 degrees C temperature change.

5. Output: 4-20 mA DC linear with pressure, level, or flow; with HART protocol. Zero adjustable over the range of the instrument provided calibrated span is greater than the minimum calibrated span.
6. Stability: 0.05 percent of upper range limit for 1 year.
7. Display: Digital indicator displaying pressure, level or flow, in the engineering units indicated herein.
8. Diagnostics:
  - a. Self-diagnostics with transmitter failure driving output to above or below out of range limits.
  - b. Simulation capability for inputs and loop outputs.
  - c. Test terminals available to ease connection for test equipment without opening the loop.
  - d. Registers to record minimum and maximum pressure and temperatures transmitter has been exposed to shall be available.
  - e. Run-time clock available to determine usage for warranty purposes. 5-year warranty on this clock reading is included.
9. Over Range Protection: Provide positive over range protection to 150 percent of the maximum pressure of the system being monitored by the instrument.

C. Physical:

1. Enclosure: NEMA 4X (IP66), explosion proof, approved for Class I, Division 1, Groups C and D (EEx d IIC T5).
2. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be Type 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O rings shall be Teflon.
3. Power Supply: 24 VDC loop power.
4. Sensor Fill Fluid: Silicone.

D. Accessories Required:

1. Provide span and zero adjustment using the local display and pushbuttons without the use of an external programming device.
2. For each gauge pressure transmitter that does not have an integral diaphragm seal, provide a Type 316 stainless steel block & bleed shut off valve. For each differential pressure transmitter, provide a Type 316 stainless steel 5-valve manifold. This may be mounted directly to the instrument or separately. Valves shall be by the instrument manufacturer or by D/A Manufacturing or Anderson Greenwood.

E. Manufacturer(s):

1. ABB 264HS or 264DS
2. Rosemount 3051CG or 3051CD

3. Siemens Sitrans P DS III
4. Or equal.

F. Units to be Furnished by ISS:

1. LIT-236: Ground Storage Tank No.2 Level
  - a. Device Range: 0-30 psig
  - b. Process Range: Between HWL, elev. 63.16 ft; and LWL, elev. 33.83 ft.
2. PIT-322: Well No.3 Pressure
  - a. Range: 0-120 psig
3. PIT-3620-3: Sidestream Injector No.3 Suction Pressure
  - a. Range: 0-40 psig (process range: 5-40 psig)
4. PIT-3640-3: Sidestream Injector No.3 Discharge Pressure
  - a. Range: 0-100 psig (process range: 50-85 psig)

2.06 PRESSURE GAUGE

A. Type:

1. Bourdon tube actuated dial face pressure gauge.

B. Function/Performance:

1. Accuracy:  $\pm 1.0\%$  of span.

C. Physical:

1. Case: Phenolic shock resistant or type 316 stainless steel for surface/stem mounting with a pressure relieving back. The case shall be vented for temperature/atmospheric compensation.
2. Window: Clear acrylic or shatter proof glass.
3. Bourdon tube: Stainless steel.
4. Connection:  $\frac{1}{2}$  in. NPT.
5. Gauge size: Minimum 4-1/2 in. viewable.
6. Pointer travel: Not less than 200 degrees not more than 270-degree arc.

D. Accessories/Options Required:

1. Shutoff valve: Each gauge shall have a process shutoff valve that can also be used as an adjustable pressure snubber.
2. Gauges shall include vibration and pulsation dampening that does not require fill fluid. No fill fluid shall be used.

3. Provide one complete spare gauge of each pressure range furnished.

E. Manufacturer(s):

1. Ashcroft, Model 1279 Duragauge with Plus option.
2. Or equal.

F. Units to be Furnished by ISS:

1. PI-322: Well No.3 Pressure
  - a. Range: 0-120 psig
2. PI-316A, 316B, 316C (qty.3): Sodium Hypochlorite Feed Pump No. 1, 2, 3 Pressure
  - a. Range: 0-160 psig
3. PI-405A: High Service Pump No.5 Suction Pressure
  - a. Range: 0-30 psig
4. PI-405B: High Service Pump No.5 Discharge Pressure
  - a. Range: 0-150 psig
5. PI-3630-3: Sidestream Injector No.3 Gas Pressure
  - a. Range: 0-25 psig.

## 2.07 DIAPHRAGM SEAL FOR PRESSURE INSTRUMENTS

A. Physical:

1. 316L stainless steel housing, Teflon gaskets and O-rings on process connections.
2. Wetted materials as required in the Device Schedule.
3. Stainless steel capillary tubing on the gauge side as required for the installation.

B. Manufacturer(s):

1. Ashcroft
2. Rosemount
3. Siemens
4. Or equal.

C. Units to be Furnished by ISS:

1. PE-3620-3: Sidestream Injector No.3 Suction Pressure
  - a. Wetted materials: 316L stainless steel.
2. PE-3640-3: Sidestream Injector No.3 Discharge Pressure
  - a. Wetted materials: 316L stainless steel.

3. PE-316A, 316B, 316C (qty.3): Sodium Hypochlorite Feed Pump No. 1, 2, 3 Pressure
  - a. Wetted materials: Hastelloy C.

## 2.08 CONDUCTIVITY ANALYZER

### A. Sensor:

1. Type:
  - a. Conductivity-sensitive glass membrane electrode.
  - b. For flow-through application.
2. Function/Performance:
  - a. Range: 0 to 2,000,000  $\mu\text{S}/\text{cm}$ .
  - b. Temperature Compensation: Temperature element integral to sensor for temperature compensation.
3. Physical:
  - a. Flat glass or shrouded electrode.
  - b. Sensor assembly constructed of PEEK.
  - c. Sealed electrodes.
4. Accessories Required:
  - a. Manufacturer's cable for connection of sensor to transmitter. Length as required by installation indicated on Drawings.
  - b. One year's supply of consumables for calibration.

### B. Transmitter:

1. Type:
  - a. Microprocessor-based, intelligent transmitter compatible with a minimum of sensor (digital or analog) inputs.
2. Function/Performance:
  - a. Accuracy:  $\pm 0.1\%$  of span.
  - b. Repeatability:  $\pm 0.05\%$  of span.
  - c. Response Time: 60 seconds to 90% of value on a step change.
  - d. Temperature Compensation: Compensation over entire temperature range of the instrument.
  - e. Environmental Conditions: -10 to 55 °C and 5 to 95% relative humidity.
  - f. Outputs:
    - i. One 4-20mA output.
    - ii. 120VAC, 1A, configurable relays, number as shown on P&ID.
  - g. Diagnostics: On screen instructions and display of self-diagnostics.
3. Physical:
  - a. Transmitter shall be suitable for surface or pipe stand mounting.
  - b. Enclosure shall be NEMA 4X (IP65).
  - c. Power Requirements: 120VAC/60Hz.

### C. Manufacturer(s):

1. Sensor: Rosemount, model 228-02-20-54-62 w/adaptor 23311-01 (manual retraction assembly).
2. Transmitter: Rosemount, model 1056.

D. Units to be Furnished by ISS:

1. AE/AIT-324: Well No.3 Conductivity

2.09 OZONE-IN-WATER RESIDUAL ANALYZER

A. General:

1. Provide on-line ozone residual analyzer systems including amperometric sensor, electronic control unit, interconnecting quick-disconnect cables, sample flow cell and cap, installation oversight, training, and all necessary appurtenances required for complete installation of the ozone residual analyzer systems.

B. Sensor:

1. Technology – the sensor shall be amperometric with a gas permeable membrane.
2. Measuring Range – the sensor shall measure 0 to 1 mg/L (ppm – parts per million) ozone.
3. Wetted Materials – the sensor wetted surfaces shall be corrosion resistant and shall not cause corrosion within the flow cell or stainless steel sample piping.
4. Pressure – the sensor shall operate at a pressure range of 0 to 20 psi, minimum.
5. Temperature – the sensor shall operate normally for liquid sample temperatures of 5 to 30oC and for air temperatures of -5 to 50oC.
6. Sample Flow Cell – the sample flow cell shall be a branch-flow tee, 1-1/2 in. clear PVC. For each tee, provide three 1 ½ in. x 1 in. Flush Style Reducer bushings (Spigot x FIPT). The sensor and sample flow cell shall be capable of operating at a sample flow rate of 1 to 3 gal/minute. Plugs or caps for each sample flow cell shall be provided to ensure system operation through the sample flow cell when the sensor is not installed.
7. Cable – the sensor shall be connected to the control unit by an interconnecting quick-disconnect or similar type cable, minimum 10 feet in length. Provide longer cable if required per the installation locations shown on the Drawings.
8. Parts – include all necessary parts and tools, such as membranes, electrolyte, and sensor maintenance kits, required to maintain the ozone sensors for a period of 12 months.

C. Control Unit:

1. Power Supply – the control unit shall be powered by 115 VAC, 60 HZ, nominal.
2. Enclosures – each control unit shall be housed in a NEMA 4 or NEMA 4X or dust-proof and spray proof enclosure, suitable for panel mounting. The size of the enclosure shall be

no greater than 25 in. height, by 18 in. width, by 12 in. depth, including mounting apparatus.

3. Display – the control unit shall indicate the sample reading digitally, using 3-1/2 characters, minimum. The display shall be capable of being read in dark and light areas by means of illuminated characters or back-lit displays.
4. Analog Output – the control unit shall transmit the sample reading by an isolated 4 to 20 mA current signal into a minimum 500ohm load.
5. Output Signal Processing – the control unit shall be capable of user selectable dampening, averaging, or conditioning of the output signal such that signal spikes, noise, and variability can be reduced.
6. Relay Output – the control unit shall have two normally open single-pull, single throw (SPST) relays for alarm/control signaling. The contacts shall be rated for minimum 2.0 amps at 28 VDC or 115 VAC.
7. Temperature – the control unit shall operate normally for air temperatures of -5 to 50oC.
8. Temperature Compensation – the control unit shall include automatic temperature compensation.
9. Humidity – the control unit shall operate normally in 0 to 95% non- condensing humidity.

D. Ozone Residual Analyzer System:

1. The ozone residual analyzer system is composed of the Sensor and the Control Unit.
2. Resolution – the ozone residual analyzer system resolution shall be 0.005 ppm or better.
3. Accuracy – the ozone residual analyzer system accuracy shall be +/-1% of the measured variable (residual ozone) or 0.01 ppm, whichever is greater.

E. Manufacturer(s):

1. Rosemount Analytical Model 1057 Solu Comp II, with 499AOZ Sensor
2. Hach/Orbisphere
3. Or Equal.

F. Units to be Furnished by ISS:

1. AE/AIT-3770-2: Ozone Residual

### PART 3 EXECUTION

- A. Refer to Section 13300.

END OF SECTION

SECTION 15050  
PIPING – GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies the basic administrative and testing requirements for piping. Specific piping materials, systems and related installation and testing requirements are specified in other Sections of Division 15.

1.02 RELATED WORK

- A. Piping materials and systems are included in other Sections of Division 15.
- B. Yard piping is included in Division 2.
- C. Valves are included in Section 351 JEA Water and Wastewater Standards (January 2019 or latest), and Section 15100.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, general submittals for piping and piping systems as listed below. It is not intended that all submittals listed below be provided for all piping materials and systems. The Contractor shall refer to individual System or Piping Sections for specific submittals.
- B. Shop Drawings and Product Data
  - 1. Piping layouts in full detail.
  - 2. Location of pipe hangers and supports.
  - 3. Schedules of all pipe, fittings, special castings, couplings, expansion joints and other appurtenances.
  - 4. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.
  - 5. Brochures and technical data on coatings and linings and proposed method for application and repair.
- C. Samples
- D. Design Data
- E. Test Reports
  - 1. Copies of all field test reports, signed by Contractor and Owner's representative.
- F. Certificates

1. Copies of certification for all welders performing work in accordance with ANSI B31.1.
- G. Manufacturer's Installation (or application) instructions.
- H. Statement of Qualifications
- I. Manufacturers Field Report
- J. Project Record Document
- K. Operation and Maintenance Data in accordance with Section 01730.
- L. Warranties

#### 1.04 REFERENCE STANDARDS

- A. JEA Water and Wastewater Standards (January 2019 or latest edition)
- B. American National Standards Institute (ANSI)
  1. ANSI B16.5 - Pipe Flanges and Flanged Fittings
- C. American Welding Society (AWS)
  1. AWS B2.1 - Specification for Welding Procedure and Performance Qualifications
- D. American Water Works Association (AWWA)
- E. American Society of Mechanical Engineers (ASME)
- F. Underwriters Laboratories (UL)
- G. Factory Mutual (FM)
- H. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

- A. All materials shall be new and unused.
- B. Install piping to meet requirements of local codes.
- C. Provide manufacturer's certification that materials meet or exceed minimum requirements as specified. Reference to standards such as ASTM and ANSI shall apply to those versions in effect at the time of bid opening.
- D. Coordinate dimensions and drilling of flanges with flanges for valves, pumps and other equipment to be installed in piping systems. Bolt holes in flanges to straddle vertical centerline.
- E. Reject materials contaminated with gasoline, lubricating oil, liquid or gaseous fuel, aromatic compounds, paint solvent, paint thinner and acid solder.

- F. Pipe-joint compound, for pipe carrying flammable or toxic gas, must bear approval of UL or FM.
- G. Unless otherwise specified, pressures referred to in all Piping Sections are expressed in pounds per square inch gauge above atmospheric pressure, psig and all temperature are expressed in degrees Fahrenheit (F).

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. During loading, transportation and unloading, the Contractor shall take care to prevent damage to pipes and coating. The Contractor shall carefully load and unload each pipe under control at all times. The Contractor shall place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to ensure no injury to pipe, coating and lining.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Specific piping materials and appurtenances are specified in the respective Piping or System Sections.
- B. General installation materials shall be as specified below.
  - 1. PVC unions for joining PVC pipe; CPVC unions for joining CPVC pipe.
  - 2. Flanged Joints. Bolt and nuts shall be Grade B ASTM A307, bolt number and size same as flange standard; studs - same quality as machine bolts; 1/8-in thick rubber gaskets with cloth insertions; rust-resistant coatings.
  - 3. Plugs shall be standard plugs or caps which are suitable for permanent service.
  - 4. Flexible Connections shall be flanged spool type, 180 degree F maximum service, single filled arch with synthetic rubber tube and cover, steel-ring reinforced synthetic fiber carcass, with flanges drilled to 150 lb ANSI B16.5. Steel retaining rings, control rods and compression sleeves shall be provided where shown and as required for the working pressure of the system in which the joint is installed. All flexible joints shall be rated for the working pressure of the system in which they are installed.

### PART 3 EXECUTION

#### 3.01 GENERAL

- A. All dirt, scale, weld splatter, water and other foreign matter shall be removed from the inside and outside of all pipe and sub-assemblies prior to installing.
- B. All pipe joints and connections to equipment shall be made in such a manner as to produce a minimum of strain at the joint.
- C. The Contractor shall install piping in a neat manner with lines straight and parallel or at right angles to walls or column lines and with risers plumb. The Contractor shall run piping so as to avoid passing through ductwork or directly under electric light outlets and/or interference with other lines. All work shall be accomplished using recognized methods and procedures of pipe

fabrication and in accordance with the latest revision of applicable ANSI Standards, ASME Codes and Pipe Fabrication Institute Standards.

1. The Contractor shall use full length of pipe except where cut lengths are necessary. Do not spring or deform piping to make up joints.
2. Pipe shall be cut square, not upset, undersize or out of round. Ends shall be carefully reamed and cleaned before being installed.
  - a. Bending of pipe is not permitted. Use fittings for all changes in direction.
3. The Contractor shall not use bushings except where specifically approved by the Engineer.
4. The Contractor shall verify the locations and elevations of any existing piping and manholes before proceeding with work on any system. Any discrepancies between the information shown on the Drawings and the actual conditions found in the field shall be reported at once to the Engineer. No claim for extra payment will be considered if the above provision has not been complied with.
5. Where lines of lower service rating tie into services or equipment of higher service rating the isolation valve between the two shall conform to the higher rating.
6. Mitering of pipe to form elbow is not permitted.
7. All piping interiors shall be thoroughly cleaned after installation and kept clean by approved temporary closures on all openings until the system is put in service. Closures should be suitable to withstand the hydrostatic test.
8. End caps on pre-cleaned pipe shall not be removed until immediately before assembly. All open ends shall be capped immediately after completion of installation.

### 3.02 FLANGED JOINTS

- A. The Contractor shall make flanged joints with bolts; bolt studs with nut on each end; or studs with nuts where one flange is tapped. The Contractor shall use number and size of bolts conforming to same ANSI Standard as flanges. Before flanges pieces are assembled, remove rust resistant coating from machined surfaces, clean gaskets and smooth all burrs and other defects. The Contractor shall make up flanged joints tight, care being taken to prevent undue strain upon valves or other pieces of equipment.

### 3.03 SLEEVE COUPLINGS

- A. The Contractor shall install tierods, pipe clamps or bridles when sleeve type couplings or fittings are used in piping system where indicated, and at changes in direction or other places as necessary, to prevent joints from pulling apart under pressure. The Contractor shall use bridles and tierods at least 3/4-in in diameter, except where tierods replace flange bolts of smaller size, in which case fit with nut on each side of pair of flanges. Joint harnessing shall conform, as a minimum, to the requirements for the bolts and tie bolt lugs as set forth in AWWA Manual M11.

### 3.04 WALL SLEEVE SEALS

- A. The Contractor shall use expandable rubber segmented sealing device with corrosion-resistant fasteners to make watertight the annular space between pipe and sleeve. Determine the required inside diameter of each individual wall opening or sleeve to fit the pipe and seal it to assure a watertight joint as recommended by the Manufacturer, before ordering, fabricating or installing. Install pipe concentrically through wall sleeve. Install and tighten seal per manufacturer's instructions.

### 3.05 TESTING

- A. The Contractor shall test all pipelines for water/gas tightness as specified in the Piping or System sections. The Contractor shall furnish all labor, testing plugs or caps, pressure pumps, pipe connections, gauges and all other equipment required. Testing shall be performed in accordance with one or more of the testing procedures appended to this Section as specified in each Piping or System Section. All testing shall be performed in the presence of the Owner's Representative.
- B. The Contractor shall repair faulty joints or remove defective pipe and fittings and replace as approved by the Engineer and retest.

### 3.06 DISINFECTION

- A. After satisfactory testing and before being placed in service, all new water pipelines (including plant water) shall be chlorinated using the continuous feed method specified in AWWA C651. The procedure shall be approved by the Contractor and Engineer in advance.
- B. The location of the chlorination and sampling points will be determined by the Contractor in the field. Taps for chlorination and sampling shall be installed by the Contractor. The Contractor shall uncover and backfill the taps as required.
- C. The general procedure for chlorination shall be first to flush all dirty or discolored water from the lines and then introduce chlorine in approved dosages through a tap at one end, while water is being withdrawn at the other end of the line. The chlorine solution shall remain in the pipeline for 24 hours.
- D. Special disinfecting procedures shall be used in connections to existing mains and where the method outlined above is not practical.
- E. The Contractor shall make all arrangements necessary for the collection and examination of samples of water from disinfected water mains with the approval of the County Health Department. These samples shall be examined for compliance with the Department of Health and Rehabilitative Services requirements. Sampling shall be made daily and continuously until two successive examinations are found satisfactory. Should three examinations be found unsatisfactory, the line shall be flushed and disinfected again. The cost of all sampling, flushing, and disinfecting shall be included in the contract price and no additional charge shall be made to the Owner for this work.
- F. Water being flushed from structures or pipelines after disinfection with a chlorine residue of 2 mg/L or greater, shall be treated with a dechlorination solution, in a method approved by the Contractor and Engineer, prior to discharge.

### 3.07 HYDROSTATIC TEST

A. Hydrostatically test piping systems for structural integrity and leaks. The test shall be performed at ambient temperature unless otherwise specified.

B. Test Fluid

1. Water should be used as the test fluid whenever possible. In those systems where water cannot be used the test fluid may be either the one to be used in the system or the one agreed upon by the Engineer and the Contractor.

C. Test Equipment

1. Water - Of sufficient capacity to deliver the required test pressure.
2. Strainer - On inlet side of the pump to prevent foreign matter from entering the system.
3. Valves - Shall be provided on the suction and discharge side of the pump.
4. Heater - To allow heating of the test fluid when elevated temperatures are required for test.
5. Relief Valve - Set at a pressure to relieve at 20 to 25 percent above the required test pressure.
6. Pressure Gauge(s) - Capable of reaching 50 percent over the test pressure. These should be located at the pump discharge and any other place deemed convenient by the Contractor.
7. Pressure gauges and relief valves shall be checked for accuracy before use in test procedures.

D. Preparation for Test

1. Determine the fluid to be used for the test, and, if other than ambient temperature is required, what the test temperature will be.
2. When a fluid other than water is used for a test, the equipment used for the test shall be of a material compatible with the test fluid. Normally this would be equal to the piping material.
3. Vents shall be provided at the high points of the system and drains provided where means of venting or draining do not exist.
4. Remove or block off, all relief valves, rupture discs, alarms, control instruments, etc., that shall not be subjected to the test pressure.
5. All discs, balls, or pistons from check valves shall be removed if they interfere with filling of the system. Open all valves between inlet and outlet of the section to be tested.
6. Connect pump and provide temporary closures for all of the external openings in the system. Use caution to ensure that the closures are properly designed and strong enough to withstand the test pressure.
7. All joints, including welds, are to be left uninsulated and exposed for examination during test.

8. A joint previously tested in accordance with this Section may be covered or insulated.
9. Piping designed for vapor or gas shall be provided with additional temporary supports, if necessary, to support the weight of the test liquid.
10. Expansion joints shall be provided with temporary restraint for additional pressure under test or shall be isolated from the test.
11. Flanged joints, where blanks are inserted to isolate equipment during the test, need not be tested.

E. Test Pressure

1. The hydrostatic test pressure shall be 150 psig or 1.5 times the design pressure unless otherwise specified in the System Section.

F. Test Procedure

1. Allow the test fluid to enter the system. Open vents to allow displacement of all entrapped air. For all pipelines exceeding 500-ft in length, the maximum rate of filling shall be limited to that which produces a maximum nominal flow velocity of one foot per second in the pipe to be tested.
2. Close vents and restrict personnel in the test area to those involved in the test.
3. Raise the pressure slowly with the pump until the predetermined test pressure is reached. Maintain pressure for duration of time specified in System Section, keeping personnel at a safe distance.
4. Reduce the pressure about 20 percent and hold it at that point while the entire system is carefully inspected for leaks, cracks, or other signs of defects.
5. If defects are found, the pressure shall be released, the system drained, the defects corrected and the test repeated.
6. After a satisfactory test has been completed, the line shall be drained.

G. Flushing

1. Lines tested with water shall be completely drained.
2. Lines shall be flushed, after test.

H. Test Records

1. Records shall be maintained of all tests performed.
2. Test records shall include:
  - a. Date of Testing
  - b. Identification of Piping Tested
  - c. Test Fluid
  - d. Test Pressure

e. Signature of Contractor and Owner's Representative

3. If leaks are found, they shall be noted, on the record. After correction, retesting as specified for original test.
4. Records of test shall be maintained by the Contractor and copies furnished to the Engineer.

3.08 PNEUMATIC TEST

A. Scope: This procedure for a pneumatic test of piping systems shall be used when water, or other liquid, cannot be introduced into the line, or as a supplement to a hydrostatic test. Pneumatic tests shall only be allowed with prior approval by the Engineer. It shall not be used to test non-metallic (plastic pipe).

B. General

1. There is a hazard in using gases for test fluids because of their compressibility.
2. Gases shall never be used unless there is ample justification and always in a safe manner. See Paragraph 3.0.

C. Test Gases and Pressures

1. Compressed air shall normally be used. Other gases may be used when specified or directed by the Engineer.
2. Test pressures shall be 110 percent of the anticipated maximum operating pressure, but not exceeding 100 psig and not less than 5 psig at the highest point in the system.

D. Safety

1. All pneumatic tests shall be done under the supervision of Contractor and in the presence of the Engineer.
2. New Construction: The Engineer's permission shall be secured before testing.
3. Renovation Projects: The Owner's representative and the Engineer must be informed and their permission secured before testing.
4. Only those people actively participating in the test shall be allowed in the test area.
5. Safety glasses and hard-hats must be worn.

E. Equipment

1. Building supply air to deliver the required test pressure if available, or Contractor shall provide a compressor capable of the required test pressure.
2. Valves shall be provided on the discharge side of the pump.
3. Relief valve to relieve at 10 to 15 percent over the test pressure.

4. Pressure Gauge(s) capable of reaching 50 percent over the test pressure. A gauge shall be located on the pump discharge and other location as required.

F. Test Procedure

1. Increase the pressure in the line gradually, in steps, to the specified pressure. Checks shall be made at 25 psig and at 5 psig intervals until the test pressure is reached using sound, soap solution or a drop in indicated pressure.
2. When the specified pressure for the test is reached, shut off the valve in the supply line from the pump.
3. Maintain the test pressure long enough to visually inspect all joints or a minimum of 10 minutes. There shall be no drop in the test pressure in this time.
4. Leaks shall be repaired and the line retested. All leaks shall be noted on the Test Record form.
5. After satisfactory completion of the test, vent the line and allow it to return to atmospheric pressure. Connection can then be made to the supply line.

G. Test Records

1. Records shall be maintained of all tests performed.
2. Test records shall include:
  - a. Date of Testing
  - b. Identification of Piping Tested
  - c. Test Fluid
  - d. Test Pressure
  - e. Signatures of Contractor and Owner's Representative witnessing the test.
3. If leaks are found, they shall be noted on the record. After correction, retesting is required.
4. Test records shall be maintained by the Contractor and copies furnished to the Engineer.

END OF SECTION

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SECTION 15064  
PLASTIC PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install 1/8-in to 6-in non-buried plastic piping and appurtenances for water services (hose bibbs) as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Valves and appurtenances are included in Section 15100.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data required to establish compliance with this Section. Submittals shall include the following:
  - 1. Shop drawings including piping layouts and schedules shall be submitted to the Engineer and shall include dimensioning, fittings, locations of valves and appurtenances, joint details, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished.
  - 2. Shop drawing submittals for piping under this Section shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layout for each piping submittal.

1.04 REFERENCE STANDARDS

- A. ASTM International.
  - 1. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
  - 2. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
  - 3. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
  - 4. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
  - 5. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
  - 6. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.

7. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.
8. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
9. ASTM D3311 - Standard Specification for Drain, Waste and Vent (DWV) Plastic Fittings Patterns.
10. ASTM D5260 - Standard Classification for Chemical Resistance of Poly(Vinyl Chloride) (PVC) Homopolymer and Copolymer Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
11. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
12. ASTM F594 - Standard Specification for Stainless Steel Nuts.

B. Plastic Pipe Institute (PPI)

1. PPI Handbook of Polyethylene Pipe

C. Handbook of PVC Pipe Design and Construction, Uni-Bell PVC Pipe Association

D. American National Standard Institute (ANSI)

1. ANSI B16.5 Pipe Flanges and Flanged Fittings.

E. National Sanitation Foundation (NSF)

- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. All plastic pipe and fittings of each type shall be furnished by a single manufacturer who is experienced in the manufacture of the items to be furnished; however, it shall not be a requirement that the pipe and fittings be manufactured by the same manufacturer, provided that the pipe and fittings are compatible in both compounding and size. The pipe and fittings shall be designed, constructed and installed in accordance with the best practices and methods and shall be suitable for the intended service.

1.06 SYSTEM DESCRIPTION

- A. Piping shall be installed in those locations as shown on the Drawings.
- B. The equipment and materials specified herein are intended to be standard types of plastic pipe and fittings for use in transporting wastewater.
- C. Plastic piping systems shall be designed for the following conditions:

1. System: Water
2. Material: Schedule 80 PVC
3. Flow Velocity: Up to 10 fps
4. Temperature: 35 to 100 degrees F
5. Fluid: Water
6. Pressure: Atmosphere to 65 psig
7. Temperature: Ambient

## PART 2 PRODUCTS

### 2.01 MATERIALS

#### A. Poly (Vinyl Chloride) Pipe and Fittings - PVC

1. Pipe shall be manufactured from PVC compounds meeting ASTM D1784, Class 12454 in accordance with ASTM D1785, PVC 1120. The pipe shall have a minimum hydrostatic design stress of 2,000 psi at 73 degrees F and shall be suitable for field cutting and solvent welding. Pipe shall be of the sizes as shown on the Drawings and shall be Schedule 80 unless otherwise shown.
2. Fittings shall be the socket type for solvent welded joints conforming to ASTM D2467 or ASTM D2466 where Schedule 40 pipe is shown on the Drawings. Fittings shall be manufactured from PVC compound meeting ASTM D1784, Class 12454. Solvent cement shall be as specified in ASTM D2564.
3. Flange bolt spacing, number and dimensions shall conform to the requirements of ANSI B16.5. CPVC and PVC flanges shall be suitable for solvent cementing to the pipe and shall be suitable for a minimum pressure of 150 psi.
4. Bolts, nuts and washers for flanged joints shall be for corrosive service conditions and shall be Type 316 stainless steel. Anti-seize compound for stainless steel bolts and nuts shall be of a molybdenum disulfide base such as Molycoat-G or equal.

#### B. Fittings, specials, unions and flanges shall be of the same schedule number and manufactured of the same materials as the pipe. Whenever unions are called out on the Drawings, flanged connections may be substituted, provided that dimensional controls do not preclude use of flanges.

#### C. Sleeves for plastic pipe shall be as specified in Section 01180.

#### D. Expansion joints for PVC sizes 1/2-in to 6-in shall be telescoping type as manufactured by Plastinetics, Inc.; ASAHI/America or equal. Expansion in pipes smaller than 1/2-in shall be accommodated with expansion loops.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. The installation of plastic pipe shall be strictly in accordance with the manufacturer's technical data and printed instructions.
- B. Joints for PVC pipe shall be solvent cemented unless flanged or threaded are otherwise shown on the Drawings or are specified as other types herein. In making solvent cemented connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth to remove any shoulder or burrs created by cutting of the pipe. Solvent cement joints shall be made in accordance with ASTM D2855. Primer shall be used whenever recommended by the pipe, fitting, or cement manufacturer and in all cases for joints on pipe systems 4-in in diameter or larger. Making solvent cement joints shall not be performed and the work shall stop when the temperature, measured in the shade, is 40 degrees F and falling.
- C. Joints between PVC drain, waste and vent pipe and cast-iron soil pipe shall be made with approved mechanical compression joints designed for such use.
- D. Installation of valves and fittings shall be in accordance with manufacturer's instructions. Particular care shall be taken not to overstress threaded connections. In making solvent cement connections, the solvent cement or primer shall not be spilled on valves. Cement allowed to run from joints shall be cleaned from the pipe and fittings immediately.
- E. All piping shall have a sufficient number of unions to allow convenient removal of piping and shall be as approved by the Engineer. PVC pipe shall be installed with at least one expansion joint or loop near the center of each straight run of pipe which is 50-ft or longer with the maximum spacing between expansion joints or loops being 150-ft.
- F. Where plastic pipe passes through wall sleeves, the space between the pipe and sleeve shall be sealed with a mechanical sealing element as specified in Section 01180.
- G. All plastic pipe to metal pipe connections shall be made using flanged connections. Metal piping shall not be threaded into plastic fittings, valves, or couplings nor shall plastic piping be threaded into metal valves, fittings or couplings. Only socket to thread adaptors shall be used for threaded plastic pipe connections to other threaded devices.

### 3.02 FIELD TESTING AND FLUSHING

- A. Testing and flushing shall be performed per JEA Water and Wastewater Standards, January 2019 or latest edition.

END OF SECTION

SECTION 15067  
OZONE SYSTEM STAINLESS STEEL PIPING, TUBING AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install and test all stainless steel pipe and fittings as shown on the Drawings and as specified herein.
- B. The Contractor shall furnish all materials, equipment and incidentals required to install and test all stainless steel pipe and fittings for ozone service as shown in the Contract Drawings.
- C. Where the word "pipe" or "piping" is used, it shall refer to and/or include pipe, fittings, bends, elbows, wyes, tees, reducers, expanders, and connections for pipes, piping specialties and other connections, unless otherwise noted.
- D. Provide pipe supports, hangers and couplings as required to achieve a complete pipe system.
- E. The Work includes, but is not necessarily limited to:
  - 1. Furnishing and installing exterior, above grade, stainless steel pipe, fittings and specials with butt welded or flanged and plain ends for the Ozone System.

1.02 RELATED WORK

- A. Concrete work is included in Division 3.
- B. Ozone System equipment is included in various Sections of Division 13.
- C. Valves and appurtenances are included in Section 15100.
- D. Pipe hangers and supports are included in Section 15140.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, complete shop drawings to establish compliance with this Section. Submittals shall include, at a minimum, the following:
  - 1. Piping layouts and schedules, including dimensioning, fittings, expansion joints, locations of valves and appurtenances, joint details, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished. Shop drawings shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layouts for each pipe submittal. Not all dimensions will be checked by the Engineer, nor will detailed review be performed. Contractor shall be responsible for accurate field dimensioning of piping systems.
  - 2. Proposed cleaning method, including pre-cleaning, post-weld cleaning, chemicals to be used, or mechanical descaling method and final cleaning/passivation/pickling. Include the method and schedule for drying the pipe so that it is ready for service as part of the

proposed cleaning method. Include the name and qualifications of the firm that will be doing the cleaning. Include the name and qualifications of the independent firm that will be doing the inspection of cleaned pipe. Certifications that welders are qualified, in accordance with ANSI B31.3, Paragraph 127.5 for shop and project site welding of pipe work.

3. Submittal shall indicate which welds will be shop welded and field welded. All welds shall be performed prior to shipment to the site and treated in accordance with this section, unless submitted and approved for field welding.
4. Certifications that welders are qualified in accordance with ANSI B31.1 (2001), Paragraph 127.5 for shop and field welding of piping.

#### 1.04 REFERENCE STANDARDS

##### A. ASTM International

1. ASTM A182 F-316L - Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
2. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.
3. ASTM A262 - Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels.
4. ASTM A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
5. ASTM A276 - Stainless and Heat Resisting Steel Bars and Shapes.
6. ASTM A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
7. ASTM A403 - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
8. ASTM G93 - Standard Practice for Cleaning Methods and Cleanliness Levels for Material and Equipment Used in Oxygen-Enriched Environments.

##### B. American National Standards Institute (ANSI)

1. ANSI B16.1 - Gray– Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ANSI B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
3. ANSI B18.2 – Square, Hex, Heavy Hex, and Askew Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
4. ANSI B31.1/B31.3 - Power and Process Piping Package.

- 5. ANSI B36.19 - Stainless Steel Pipe.
- C. American Petroleum Institute (API)
- D. API 1104 - Standard for Welding Pipelines and Related Facilities. American Welding Society (AWS)
- E. Compressed Gas Association (CGA)
  - 1. CGA G-4.1 - Cleaning Equipment for Oxygen Service.
  - 2. CGA G-4.4 - Oxygen Pipeline Systems.
  - 3. CGA G-10.1 - Commodity Specification for Nitrogen.
- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

- A. All stainless steel pipe and fittings shall be furnished by a single manufacturer, who has a minimum of 5 years continuous and current experience in the manufacture of the items to be furnished. The pipe and fittings shall be designed, fabricated, and installed in accordance with the best practices and methods as outlined in the referenced standards and discussed herein and shall be suitable for the intended service.
- B. The stainless steel piping and fittings shall be manufactured by Douglas Brothers, Portland, ME; Felker Brothers, Marshfield, WI; or approved equal.
- C. All stainless steel tubing and fittings shall be furnished by Swagelok or approved equal.

#### 1.06 SYSTEM DESCRIPTION

- A. Piping shall be installed in those locations indicated and as required for the complete ozone system.
- B. The equipment and materials specified herein shall be standard types of stainless steel pipe and fittings for use in transporting gaseous oxygen (GOX), ozone-in-oxygen, ozone off-gas, ozone-in-water (side stream injection, sample lines, ozone pipeline contactor), and cooling water.
- C. Provide stainless steel piping for the following systems and conditions:
  - 1. System: Ozone-in-Oxygen
    - a. Material: Type 316L, Schedule 10S
    - b. Fluid: 0 to 12 percent by weight ozone-in-oxygen gas
    - c. Pressure: Atmospheric to 30 psig, 60 psig test
    - d. Temperature: Ambient to 100°F
  - 2. System: Ozone Off-Gas
    - a. Material: Type 316L, Schedule 40S
    - b. Fluid: 0 to 1 percent by weight ozone-in oxygen gas

- c. Pressure: Atmospheric to 21 psig
  - d. Temperature: Ambient to 100°F
- 3. System: Sidestream Liquid Conveyance (ozone gas in water)
  - a. Material: Type 316L, Schedule 40S
  - b. Fluid: Ozonated water (0.01 ppm to saturation, possible ozone gas)
  - c. Pressure: 70 psig, 120 psig test
  - d. Temperature: 50°F to 100°F

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Delivery, storage and handling shall be in compliance with Section 01600.
- B. Only piping that has been specifically cleaned and sealed for oxygen service shall be shipped and stored on site. This requirement shall not apply to ozone-in-water pipelines.
- C. Special care shall be taken to maintain this cleanliness during delivery, storage and handling.

#### 1.08 OZONE AND OXYGEN SERVICE

- A. All gaskets and associated appurtenances to be used with oxygen or ozone-in-oxygen shall be cleaned and certified for oxygen service before shipping to the plant site.
- B. All gaskets, welds and all associated appurtenances to be used with gaseous oxygen, ozone-in-oxygen, ozone off-gas, ozone-in-water (sidestream injection, sample lines, ozone pipeline contactor), and cooling water must be resistant to degradation and gas losses due to the use of these gases.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Pipe and fittings used for the gaseous oxygen, ozone-in-oxygen, ozone off-gas, ozone-in-water (side stream injection, sample lines, ozone pipeline contactor), and cooling water shall be ASTM A312, seamless or welded, austenitic Type 316L stainless steel pipe. Finish shall be No. 1 or better.
- B. Pipe and fittings shall be supplied with the wall thicknesses shown in Paragraph 1.06 C.
- C. Pipe shall be fabricated by die forming or rolling true to dimension and round within a tolerance of plus or minus 1/16-in. The two edges of sheet shall be brought to line so as not to leave a shoulder on the inside of the pipe. Ends of pipe and fittings shall be perpendicular to the longitudinal axis. Pipes shall be straight within maximum of 1/8-in deviation over 10-ft. All pieces shall be clearly marked with gauge and type of stainless steel.
- D. Fittings shall be fabricated of the same material and wall thicknesses as the pipe. Elbows shall be formed smooth. Branches shall be made with ASTM A403 tee fittings or for smaller diameter outlets forged ASTM A182 F-316L weld-on tees.

- E. Joints shall be welded, except where flanged or threaded joints are required. Sleeve type couplings shall be used, as needed, to allow for thermal expansion, disassembly of pipe or pipeline flexibility.
- F. All welding of pipe, fittings and subassemblies shall be completed in the factory to the greatest extent possible.
  - 1. All welding (factory or field) of pipe and fittings shall be performed by welders using procedures qualified in accordance with ASME B31.3 and ASME Section IX. Gas-Shielded Tungsten Arc Welding (GTAW) procedures shall be the standard welding procedures used for stainless steel pipe, tube and fittings installed under this Section. The procedure can be manual, semi-automatic or fully-automatic. All welding procedure specifications shall include an inert gas/mixed inert gas back-purge to minimize surface oxidation of the weld and heat affected zone (HAZ) on the interior of the pipe during welding. Purge plugs shall be used for back-purge during welding. Alternatives to purge plugs shall be submitted for approval by the ENGINEER.
  - 2. Filler wire shall be added to all welds to provide for a weld cross-section equal to or greater than the parent metal in thickness and in filler's stainless steel grade. Weld deposit shall be smooth with no more than 1/16-in reinforcement on both sides of the weld. No cracks or crevices shall be allowed. Butt welds shall have full penetration of the joint. Excessive weld deposits, slag, spatter and projections shall be removed by grinding. Accessible welds in shop-welded assemblies shall be cleaned and scrubbed with pickling solution and thoroughly rinsed after fabrication. All openings shall be covered after cleaning.
- G. Flanges shall be 316L slip-on type, class 150 raised face flanges conforming to ASTM A182 and A240 welded to the pipe end. Raised face type, weld-neck flanges shall be used at fittings where slip-on type flanges cannot be used. The raised faces shall be true and perpendicular to the axis of the pipe or fitting. Gaskets for flanged joints shall be PTFE for oxygen service, NSF 61 certified. Flange bolts and studs shall be of number and size in accordance with ANSI B16.1. Bolts and nuts shall conform to ANSI B18.2. Bolt studs and studs shall be of the same quality as machine bolts. All bolts, nuts and washers shall be of Type 316 stainless steel.
- H. Sleeve type couplings shall be of Type 316L stainless steel and shall be furnished with the pipe stop removed. Gaskets shall be PTFE for oxygen service. Couplings shall allow minimum 2 degrees angular deflection and minimum 3/8-in relative axial motion of adjoining pipe sections. All sleeve couplings shall be restrained with welded-on Type 316L stainless steel attachments for joint restraint, except where tie rods run from adjacent flanges. Furnish a minimum of two tie rods at all joint restraints. All bolts, nuts and washers shall be Type 316 stainless steel.
- I. Furnish tapped bosses on the pipe in the locations indicated in the Contract Documents and in other locations, as may be required, for the purposes of connecting small tubing and instruments to the pipe and as needed for cleaning and purging the assembled pipeline. Tapped bosses shall be of the same material as the pipe, welded to the pipe wall and shall have NPT threaded connections. PTFE thread tape shall be used on all threaded connections. For gaseous oxygen and ozone-in-oxygen piping, a thread sealant paste certified for use in oxygen service also shall be used.
- J. Furnish welded-on tabs or angle ring on pipe wherever vertical pipe is to be supported by a riser clamp, to support the weight of the pipe.

## 2.02 INSTRUMENTATION TUBING AND FITTINGS

- A. All instrument air header takeoffs and branch connections less than 2 inches shall be Type 316 stainless steel tubing, as manufactured by Swagelok or approved equal.
- B. All instrument shut-off valves and associated fittings shall be supplied in accordance with the piping specifications and all instrument installation details. Fittings shall be Swagelok Type 316 stainless steel and valves shall be Whitey Type 316 stainless steel.
- C. All process connections to instruments shall be annealed stainless steel tubing, Type 316.
- D. All tube racks shall be supported by stainless steel and installed as per manufacturer's installation instructions.

## PART 3 EXECUTION

### 3.01 INSTALLATION OF PIPE

- A. All pipe shall be protected from dirt, grease or other foreign material during installation to ensure that no foreign matter enters the piping. Stainless steel pipe and containment pipe shall be installed true to alignment and shall be supported in accordance with Section 15140. Fittings, in addition to those indicated, shall be provided at no extra cost, to provide a complete piping system. Due consideration shall be given to thermal expansion/contraction over a temperature range of 200°F.
- B. All buried piping for oxygen or ozone service shall be concrete encased.
- C. Interior pipe connections for equipment and valves shall be as specified in PART 2 of this Section.
- D. Cutting of pipe shall be done without damaging the pipe. Cut ends shall be smooth and perpendicular to the pipe axis.
- E. Excessive weld deposits, slag, spatter and projections shall be removed by grinding. All welds shall be cleaned and then scrubbed with pickling solution and thoroughly rinsed after installation. All openings shall be covered after cleaning.
- F. Completed welds shall be thoroughly cleaned and buffed using stainless steel deburring and finishing wheels.
- G. For ozone-in-oxygen piping systems, initially assemble the piping without installing pre-cleaned valves, filters, meters, or other in-line components. Install temporary pre-cleaned flanged spools in place of these components. Do not connect instrument tubing or install locally-mounted gauges. Install temporary caps at these connections. Valves, meters, filters, shall be installed and instruments connected after final inspection is successfully completed.

### 3.02 INSTALLATION OF TUBING

- A. Cuts made on tubing shall be reamed. Bends in tubing shall be made with a proper bending tool unless bends require the use of an elbow fitting. Stainless steel tubing shall be installed by pipe fitters skilled in the installation of stainless steel tubing. Parallel lines shall be held plumb by

adequate tubing supports. Waviness or sagging lines will not be accepted. Stainless steel tubing used for hydraulic service shall be flushed out with hydraulic fluid to ensure that the tubing is free of obstructions or foreign matter. Other stainless steel tubing shall be flushed clean with an appropriate fluid approved by the Engineer.

### 3.03 PRECLEANING

- A. Flush all pipe with water or other approved fluid to remove all dirt, and foreign material. Remove all debris from the pipe, flushing the lowest segment outlet last to assure debris removal.

### 3.04 FIELD PAINTING

- A. Pipe marking, as specified in Division 9, shall be part of the work of this Section to identify pipe contents, flow direction and other required pipe marking.

### 3.05 FIELD TESTING

- A. All pipelines shall be tested for compliance with Section 15050. Provide all necessary utilities, labor and equipment for flushing and testing and dispose all waste after the test including water.
- B. Submit detailed test procedures and method for Engineer's review at least 10 days before starting the test. In general, testing shall be conducted in accordance with AWWA C200. A minimum of 24-hour notice to the Engineer is required prior to conducting any and all pressure and leakage tests.
- C. After the piping is installed, five per cent of shop butt welds (minimum of four), as selected by Engineer, and all field butt welds shall be radiographed by an approved independent non-destructive testing (NDT) company in accordance with ANSI B31.3. If any of the joints is unacceptable, another equal number of joints shall be tested until all joints in the sample are acceptable. The NDT company shall submit a written test report to the Engineer, describing the radiography test procedure and results. The Contractor shall pay all costs for this NDT.
- D. Completed piping segments shall be given an initial air pressure test at 15 psig with a soapy solution to assure no leaks at joints. Final leak testing on a completed piping system with all fittings shall consist of monitoring the air pressure stability for at least 1-hour at the maximum system pressures specified herein. Leaks shall be repaired and retested as approved by the Engineer.
- E. After installation, all water piping shall be flushed clean and then subjected to hydrostatic test pressure for at least 2 hours at 150 psig. All leaks evident at the surface shall be repaired and leakage eliminated regardless of the total leakage rate.
- F. All repairs and retests, if required, shall be made at no additional cost to the Owner.

### 3.06 FINAL CLEANING

- A. Conduct final cleaning of piping furnished and installed under this Section including the ozone-in-oxygen, ozone off-gas, ozone-in-water (sidestream injection) systems after successful pressure testing has been performed. A cleaning firm with at least five years of experience in the cleaning of oxygen systems shall be used to conduct the final cleaning phase. Final cleaning

shall consist of in-place chemical cleaning in accordance with ASTM G93, CGA G-4.1 and the following steps:

1. Circulate an alkaline degreasing solution through the piping for a minimum of four hours to remove organic contamination, such as oils, greases and waxes. The cleaning solution shall be prepared using distilled or deionized water. The solution temperature shall be as recommended by the manufacturer of the cleaning agent; however, it shall be a minimum of 150°F. The solution may be reused until it becomes ineffective as determined by pH or contaminant analysis.
2. Rinse piping with potable water and properly dispose of used rinse water.
3. Circulate a phosphoric acid based cleaning solution through the piping for a minimum of four hours for the removal of oxides, light rust, light oils and fluxes. The solution shall be prepared using distilled or deionized water. The solution temperature shall be as recommended by the manufacturer of the cleaning agent. The solution may be reused until it becomes ineffective as determined by pH or contaminant analysis.
4. After acid cleaning, rinse piping thoroughly by circulating distilled or deionized water to remove all traces of the acid. Follow this procedure by rinsing with distilled or deionized water without allowing the pipe surfaces to dry between rinses. Dispose of used rinse water in a manner approved by the ENGINEER.
5. After rinsing, no puddles of rinse water should remain in the piping. After or instead of cleaning as above, 316L SS piping systems for conveying ozone-in-water shall be internally pickled with acid solution (typically a mixture of 10% nitric and 4% hydrofluoric acids above 120°F) to remove the oxide heat scale at the welds. This shall be carried out by a qualified acid cleaning Contractor. Effectiveness of post-weld pickling in removing weld-related heat scale shall be tested by visually inspecting welds accessible from a dead end or other access point. Acceptable welds shall be bright metal and slightly etched, with no visible discoloration and rinsed to remove pickling solution residue. This procedure can be completed in the shop provided all pipe welds exposed to ozone in water are pickled.
6. Piping systems that will convey gaseous oxygen or ozone-in-water shall be sealed with oil-free, dry nitrogen at a minimum pressure of 10 psig. Nitrogen shall be Grade M or better nitrogen as described in CGA G-10.1.
7. Dry rinsed piping systems that will convey ozone gas shall be continuously purged with oil-free dry nitrogen or oxygen to obtain a dewpoint of -80°F. Contractor shall coordinate this step with the testing and start-up of the ozone equipment. Contractor shall pay all costs of nitrogen or oxygen to achieve the required dewpoint. Ozone piping that will not be placed into service shall be sealed with oil-free, dry nitrogen at a minimum pressure of 10 psig. Nitrogen shall be Grade M or better nitrogen as described in CGA G-10.1.
8. The Contractor shall provide all temporary pumps, tanks, hoses, connections and equipment for the final cleaning operation. The Contractor shall be responsible for the proper disposal of all chemicals and waste products from the cleaning procedures.

### 3.07 FINAL INSPECTION

- A. Cleaned and pickled piping systems for gaseous oxygen, ozone-in-oxygen, cooling water, ozone sampling, side stream ozone (ozone gas and sidestream liquid conveyance), ozone off-gas, and ozone pipeline contactor piping systems shall be inspected by a qualified third-party inspector who has at least five years of experience in the past ten years inspecting liquid and gaseous oxygen piping systems in medical gas systems. The cost of such inspection shall be paid for by the Contractor.
- B. Remove all temporary spools in piping to allow unimpeded inspection. Temporary spools shall be packaged and remain the property of the Owner. To minimize potential for contamination, removal will occur no sooner than 24 hours prior to start of inspection. After removal of each spool, a temporary plastic seal shall be placed and maintained at each location until final inspection has been completed and the in-line component is ready for installation.
- C. The inspection shall consist of one or more of the following procedures in accordance with ASTM G93, CGA G-4.1 and the following:
  - 1. Direct visual inspection by natural light to detect contamination by oils, greases, preservatives, moisture, corrosion products, weld slag, heat scale, metal filings and chips, and other foreign matter.
  - 2. Direct visual inspection by ultraviolet (black) light to detect hydrocarbons, lint or dust.
  - 3. The wipe test to detect contaminants on visually inaccessible areas as aid in the above visual inspections.
  - 4. The water break test to detect oily residues not found by other means.
- D. If contamination of any type as specified above is detected by any of the above inspection methods, the affected piping shall be recleaned and reinspected at no additional cost to the Owner. The third-party inspector shall be the sole judge of whether the piping system has been cleaned for oxygen service in accordance with ASTM G93 and CGA G-4.1.
- E. A piping system that is not to be placed into immediate service shall be sealed with oil-free, dry nitrogen at a minimum pressure of 10 psig.

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SECTION 15072  
DUCTILE IRON PIPE AND FITTINGS (ABOVE GRADE)

PART 1 GENERAL

1.01 POTABLE WATER PIPING

- A. All above grade flanged ductile iron pipe, fittings, gaskets, nuts, bolts, interior and exterior lining/coating, marking, pressure testing, disinfection and all other requirements shall be as specified in the JEA Water and Wastewater Standards (January 2019 or latest), Potable Water Piping – Section 350.
- B. In addition to the requirements listed in JEA Water and Wastewater Standards (January 2019 or latest), finish painting for all above grade ductile iron pipe shall be as described in Specification 09902.

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SECTION 15100  
VALVES (ABOVE GRADE) AND APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required, and install complete and ready for operation, all valves and appurtenances as shown on the Drawings and/or specified herein.
- B. All components which come in contact with water or chemicals to be added to raw or finished water shall have ANSI/NSF 61 certification.

1.02 RELATED WORK

- A. Shop and Finish painting is included in Sections 09902.
- B. Instrumentation, not specified herein, is included in Division 13.
- C. Electrical work is included in Division 16.
- D. Valves are included in Section 351 JEA Water and Wastewater Standards (January 2019 or latest).
- E. Certain items similar to those specified in this Section may be specified to be furnished and installed with individual equipment or systems. In case of a conflict, those individual equipment or system requirements shall govern.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, materials required to establish compliance with this Section. The first submittal shall be the valve schedule described in Paragraph 1.09. Approval of the valve schedule submittal is required prior to Contractor submitting any of the equipment in this specification. Subsequent Equipment Submittals shall include at least the following:
  - 1. Valve tag number.
  - 2. The manufacturer and supplier.
  - 3. The address at which equipment will be fabricated or assembled.
  - 4. Drawings showing assembly details, materials of construction and dimensions.
  - 5. Descriptive literature, bulletins and/or catalogs of the equipment.
  - 6. The total weight of each item.
  - 7. A complete bill of materials.
  - 8. Additional submittal data, where noted with individual pieces of equipment.

B. Test Reports

1. Provide certified hydrostatic test data, per manufacturer's standard procedure or MSS-SP-61 for all valves.

C. Certificates

1. For each valve specified to be manufactured, tested and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with the appropriate standards, including certified results of required tests and certification of proper installation including a copy of ISO 9001 certification and ANSI/NSF 61 certification.

D. Manufacturer's Installation and Application Data

E. Operating and Maintenance Data

1. Operating and maintenance instructions shall be furnished to the Engineer as provided in Section 01730. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions and other information required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.04 REFERENCE STANDARDS

A. JEA Water & Wastewater Standards (January 2019 or latest)

B. ASTM International

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
3. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
4. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
5. ASTM A436 - Standard Specification for Austenitic Gray Iron Castings.
6. ASTM A536 - Standard Specification for Ductile Iron Castings.
7. ASTM B30 - Standard Specification for Copper-Base Alloys in Ingot Form.
8. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings

C. American Water Works Association (AWWA)

1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. AWWA C500 - Metal-Seated Gate Valves Supply Service
3. AWWA C504 - Rubber-Seated Butterfly Valves

4. AWWA C507 - Ball Valves, 6-in through 48-in (150mm through 1200mm)
  5. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-in (50mm through 24-in (600mm) NPS
  6. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service
  7. AWWA C511 - Reduced-Pressure Principle Backflow-Prevention Assembly
  8. AWWA C550 - Protective Epoxy Interior Coatings for Valves and Hydrants
  9. AWWA C800 - Underground Service Line Valves and Fittings
- D. American National Standards Institute (ANSI)
1. ANSI B1.20.1 - Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals).
  2. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings
  3. ANSI B16.10 - Face-to-Face and End-to-End Dimensions of Valves
  4. ANSI B16.104 - Butterfly Valves
- E. American Iron and Steel Institute (AISI)
- F. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS)
1. MSS-SP-61 - Pressure Testing of Steel Valves.
  2. MSS-SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
  3. MSS-SP-71 - Cast Iron Swing Check Valves, Flanges and Threaded Ends.
  4. MSS-SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Services.
  5. MSS-SP-82 - Valve Pressure Testing Methods
  6. MSS-SP-98 - Protective Coatings for the Interior of Valves, Hydrants and Fittings.
- G. National Electrical Manufacturers Association (NEMA)
- H. National Sanitation Foundation (NSF)
- I. Underwriters Laboratories (UL)
- J. Factory Mutual (FM)
- K. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

## 1.05 QUALITY ASSURANCE

### A. Qualifications

1. Valves and appurtenances shall be products of well-established firms who are fully experienced, minimum 10 years, reputable and qualified in the manufacture of the particular equipment to be furnished.
2. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with this Section as applicable.
3. All units of the same type shall be the product of one manufacturer.
4. The manufacturer shall be ISO 9001 certified.

### B. Certifications

1. The manufacturers shall furnish an affidavit of compliance with Standards referred to herein as specified in Paragraph 1.03C above. Refer to PART 3 for testing required for certain items in addition to that required by referenced standards.

### C. Inspection of the units may also be made by the Engineer or other representative of the Owner after delivery. The equipment shall be subject to rejection at any time due to failure to meet any of the specified requirements, even though submittal data may have been accepted previously. Equipment rejected after delivery shall be marked for identification and shall be removed from the job site at once.

## 1.06 SYSTEM DESCRIPTION

- A. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of water, wastewater, air, and chemicals as noted on the Drawings.
- B. Valves, appurtenances and miscellaneous items shall be installed as shown on the Drawings and as specified, so as to form complete workable systems.

## 1.07 DELIVERY, STORAGE AND HANDLING

- A. Reference is made to Section 01600 for additional information.
- B. Packing and Shipping
  1. Care shall be taken in loading, transporting and unloading to prevent injury to the valves, appurtenances, or coatings. Equipment shall not be dropped. All valves and appurtenances shall be examined before installation and no piece shall be installed which is found to be defective. Any damage to the coatings shall be repaired as acceptable to the Engineer.
  2. Prior to shipping, the ends of all valves shall be acceptably covered to prevent entry of foreign material. Covers shall remain in place until after installation and connecting piping is completed.
    - a. All valves 3-in and larger shall be shipped and stored on site until time of use with wood or plywood covers on each valve end.

- b. Valves smaller than 3-in shall be shipped and stored as above except that heavy cardboard covers may be used on the openings.
- c. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until the valve is installed and put into use.
- d. Any corrosion in evidence at the time of acceptance by the Owner shall be removed, or the valve shall be removed and replaced.

C. Storage and Protection

- 1. Special care shall be taken to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, to prevent deformation. See the individual piping sections and manufacturer's information for further requirements.

1.08 MAINTENANCE

- A. Special tools and the manufacturer's standard spare parts, if required for normal operation and maintenance, shall be supplied with the equipment as specified herein. Tools shall be packaged in a steel case, clearly and indelibly marked on the exterior to indicate equipment for which tools are intended.
- B. Provide one Operations and Maintenance manual for each type of valve and operator supplied under this specification in accordance with Section 01730.
- C. Included within the Operations and Maintenance manuals, provide a list of all spare and replacement parts with individual prices and location where they are available.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT - GENERAL

- A. Reference is made to Division 1 for additional requirements, including nameplates, provisions for temporary pressure gauges, protection against electrolysis and anchor bolts.
- B. The use of a manufacturer's name and/or model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- C. Valves and appurtenances shall be of the size shown on the Drawings or as noted and as far as possible equipment of the same type shall be identical and from one manufacturer.
- D. Valves and appurtenances shall have the name of the maker, nominal size, flow directional arrows, working pressure for which they are designed and standard referenced, cast in raised letters or via riveted stainless steel nameplate upon some appropriate part of the body.
- E. Unless otherwise noted, items shall have a minimum working pressure of 150 psi or be of the same working pressure as the pipe they connect to, whichever is higher and suitable for the pressures noted where they are installed.
- F. Joints, size and material - unless otherwise noted or required by the Engineer:
  - 1. Except where noted, all joints referred to herein shall be of the same type, nominal diameter, material and with a minimum rating equal to the pipe or fittings they are connected to.

2. Valves and appurtenances shall be of the same nominal diameter as the pipe or fittings they are connected to.
3. Unless otherwise noted on the drawings, valves and appurtenances shall be of the same material as the pipe or fittings they are connected to. Except for the discharge of the Finished Water Pumping Station and Raw Water Lines.
4. All valves exposed to view, or in vaults:
  - a. Plastic valves in chemical service - solvent cement, or flanged ends.
  - b. 3-inch and smaller - threaded ends- unless noted otherwise herein or on the Drawings.
  - c. 4-inch and larger - flanged ends.
- G. Provide all special adaptors as required to ensure compatibility between valves, appurtenances and adjacent pipe.
- H. No alternative materials will be considered for approval unless complete documentation is provided regarding their satisfactory long-term use in similar conditions; in addition, the consideration of any substitution will be considered only if the superiority of the proposed materials is the intent of the substitution, and only if sufficient evidence is provided to document that superiority.
- I. All valves and coatings shall be suitable for use with potable water and shall be NSF 61 approved.

## 2.02 VALVE ACTUATORS - GENERAL/MANUAL

- A. Geared actuators shall be suitable for all weather service, with mechanical shaft seals, shall be permanently greased, or shall have provisions for greasing. Actuators for submerged duty shall be so rated, with certification by manufacturer for submerged service.
- B. The valve manufacturer shall supply, mount and test all actuators on valves at the factory. The valves and their individual actuators shall be shipped as a unit.
- C. Unless otherwise noted on the Drawings, valves shall be manually actuated; non-buried valves shall have an operating wheel, handle or lever mounted on the operator; those with operating nuts shall have a non-rising stem with an AWWA 2-in nut; At least two tee handles shall be provided for all operating nuts. Unless otherwise noted, operation for all valves shall be CCW open.
- D. Manually actuated butterfly valves 6 inches and smaller for fluid service shall have a 10 position, spring retained ratcheting handle. Handle shall be fusion bonded epoxy coated steel or cast iron, hardware, spring and ratcheting plate shall be Type 316 stainless steel. Manually actuated butterfly valves for air service 6 inches and smaller shall have a memory stop handle with infinite throttling position capability. Memory stop plate and all hardware shall be Type 316 stainless steel.
- E. Except as otherwise shown on the Drawings or specified herein, all valves 3-in diameter or larger, with the valve hand wheel center line located 7-ft or more above the operating floor, shall be provided with chain wheel operators complete with chain guides and hot dipped galvanized steel chain, which loop within 4-ft of the operating floor. These requirements shall supersede positioning lever actuator requirements of manual butterfly valves 6 inch and smaller.

- F. All actuators shall be capable of moving the valve from the full open to full close position and in reverse and holding the valve at any position part way between full open or closed.
- G. Each operating device shall have cast on it the word "OPEN" and an arrow indicating the direction of operation.
- H. Floor boxes for operating nuts recessed in concrete shall be standard cast iron type, cast-in-place, with fastening top, and 316 stainless steel hardware.
- I. Stem guides shall be of the adjustable wall bracket type, bronze brushed, with maximum spacing of 10-ft as manufactured by Clow; Rodney Hunt or equal. Extended operating nuts and/or stems shall have universal joints and pin couplings, if longer than 10-ft and a rating of at least five times the maximum operating torque. Stem adaptors shall be provided.
- J. Where required by the installation, or as specified, provide the following: extended stem; floor stand and handwheel; position indicator and etched or cast arrow to show direction of rotation to open the valve; resilient, moisture-resistant seal around stem penetration of slab.
- K. Gear Actuators
  - 1. Unless otherwise noted, gear actuators shall be provided for the following: plug and ball valves larger than 3-in diameter; butterfly valves larger than 6 inch diameter; where specified and/or indicated on the Drawings; where manual operator effort is greater than 40 lbs rim pull.
  - 2. Actuators shall be capable of being removed from the valve without dismantling the valve or removing the valve from the line.
  - 3. Gear actuators for quarter turn valves shall be of the worm or helical worm gear type with output shaft perpendicular to valve shaft, having a removable hand wheel mounted on the output shaft. Where shown on the Drawings, a 2 inch cast iron operating nut shall be provided. Actuators shall conform to AWWA C504 except where more stringent requirements are provided hereinafter. Gearing shall be machine cut steel designed for smooth operation. Bearings shall be permanently lubricated, with bronze bearing bushings provided to take all thrusts and mechanical shaft seals to contain lubricants. Housings shall be sealed to exclude moisture and dirt, allow the reduction mechanisms to operate in lubricant and be constructed of cast iron, ASTM A126, Grade B, or of ductile iron, ASTM A536. Gear housing bodies for thermoplastic valves may be cast aluminum or fabricated steel to reduce weight. Gear actuators shall indicate valve position and have adjustable stops.
  - 4. Where indicated on the Drawings, gear actuators for butterfly valves shall be of the travelling nut type with output shaft perpendicular to valve shaft, having a removable hand wheel mounted on the output shaft. Unless noted they shall conform to AWWA C504. Stem shaft shall be machine cut alloy steel; nut and cross head shall be bronze, lever shall be ductile iron. Nut Actuators for valves 24-in and smaller shall be slotted lever design, actuators for valves greater than 24 inch shall be link and lever design. Mechanism shall be lubricated with water resistant extreme pressure NLGI No. 2 grease. Bevel gear reduction box shall be mounted on the actuator when required to meet specified manual operating effort requirements Gear actuators shall have mechanical, external indication of valve position and have adjustable threaded stops secured to the stem with spring pins. Stop shall

be capable of withstanding 450-ft-lb of input torque. Stop adjustment requiring shims are not acceptable.

5. Manual Input torque to produce required valve operating torque for worm and travelling nut gear operators shall not exceed 80 ft-lbs. In addition, hand wheel rim pull shall not exceed 20 lbs for valve sizes up to 12 inches, 40 lbs for valve size between 14 and 20 inches, 60 lbs for valve size 24 and greater. Minimum hand wheel size shall be 8 inches for up to 12 inch valve size, 12 inches for up to 16 inch valve size, 18 inches for up to 20 inch size.
  6. Gear actuators for multi turn valves shall be of the bevel or spiral bevel type with output shaft perpendicular to valve shaft, having a removable hand wheel mounted on the output shaft. Gearing shall be machine cut steel designed for smooth operation. Bearings shall be permanently grease lubricated, with dual anti-friction ball bearings on the output shaft and mechanical shaft seals to contain lubricants. The output flange of the primary gear reducer shall be designed to meet an appropriate MSS or ISO standard to allow mounting to the secondary gear reducer. The ring gear shall ride on ball bearings. The stem nut shall be bronze alloy, shouldered, and ride on needle bearings. Housing components shall be o-ring sealed to exclude moisture and dirt, constructed of cast iron, ASTM A126, Grade B, or of ductile iron, ASTM A536. Gear housing bodies for thermoplastic valves may be cast aluminum or fabricated steel to reduce weight. Manual operator input effort to the hand wheel shall be a maximum of 30 lbs for operating the valve from full open to full close, under any conditions. Maximum hand wheel size shall be 24-in diameter.
- L. Additional valve actuator requirements are included with the individual valve types and as noted in Paragraph 1.02 above.
- M. All position indication and direction of opening arrows shall be embossed, stamped, engraved, etched or raised castings. Decals or painted indications shall not be allowed.
- N. Unless otherwise noted, all valves larger than 3-in nominal diameter shall be provided with position indicators at the point of operation.

## 2.03 GATE VALVES

- A. All gate valves shall comply with requirements included in JEA's Water and Sewer Standards Manual, Section 351 – Water Valves & Appurtenances.

## 2.04 AWWA BUTTERFLY VALVES

### A. Manufacturers :

1. Dezurik, Pratt, Val-Matic, Mueller or Owner approved equal.

### B. Description:

1. Comply with AWWA C504, Class 150A or B.
2. Buried valves shall have mechanical joint ends with corrosion resistant alloy steel or stainless steel nuts and bolts.

3. Above ground valves shall be flanged in accordance with ANSI B16.1, Class 125.
4. Minimum Working Pressure: 150 psig.
5. Maximum Process Fluid Temperature: 85 deg. F.
6. Body Style: Rubber seated butterfly valve, AWWA Designation C504.
7. Shaft: "Stub Shaft" type or one piece extending full size through the disc bearings. Shaft diameters shall meet the requirements of AWWA C504 for Class 150B.
8. Bearings: Self-lubricating.
9. Shaft Seals/Packing:
  - a. self compensating V-type- primary means
  - b. multiple O-rings for up to 24-inch
  - c. pull down seals using a square braid of graphite fiber for over 24-inch
  - d. retained by bolted retainer plate or gland, clips not acceptable
  - e. retained by stuffing box with follower gland for over 24-inch
  - f. replacement without removal of valve from line.
  - g. Adjustment without disturbing actuator assembly for over 24-inch
10. Seats:
  - a. Mounting: On disc.
  - b. For body mounted seats, supply machined metal seating edges on disc. Seats mechanically retained and adjustable with common tools for valves larger than 24-inch.
  - c. For disc mounted seats, fasten with a segmented or one piece machined metal retaining ring, and self-locking bolts or set screws, fully adjustable with common tools. Machined metal seat ring installed in the valve body
  - d. Type: Resilient and replaceable. Field adjustable and replaceable.

C. Actuator:

1. Handwheel with horizontal stem except where noted on the drawings. Operator with handwheel and stem shall be top-mounted for the butterfly valve installed on the interconnect of the two clearwells as indicated on the Drawings.
2. Gear Actuators for Manual Valves: Comply with AWWA C504.

D. Materials:

1. Body: Cast iron, ASTM A126 or Ductile iron, ASTM A536.
2. Stem: ASTM A276 Type 316 stainless steel.
3. Disc: Ni-Resist, Type 1 or ductile iron, ASTM A536, Grade 65-45-12 with stainless steel seating edges or cast iron ASTM A-126.
4. Seats:
  - a. Elastomer: Neoprene.

- b. Retaining Ring: ASTM A276 Type 316 stainless steel.
  - c. Seat Ring: ASTM A276 Type 316 stainless steel.
- 5. Shaft: ASTM A276, type 304 stainless steel or high tensile steel with stainless steel shaft journals
- 6. Bearings:
  - a. Sleeve: Nylatron.
  - b. Thrust: Bronze ASTM 763, Alloy C99500.
- 7. Connecting Hardware: ASTM A276 Type 316 SS.

E. Finishes:

- 1. Manufacturers standard fusion bonded epoxy
- 2. All valve materials shall be NSF 61 compliant.

2.05 PLASTIC BALL CHECK VALVES (FOR SODIUM HYPOCHLORITE SERVICE)

- A. Plastic ball check valves shall be double-union style with socket ends, solid and completely spherical ball and capable of either horizontal or vertical mounting.
- B. Plastic ball check valves for sodium hypochlorite service shall be as manufactured by Asahi America, IPEX Industrial Piping Systems, or equal.
- C. Plastic ball check valves shall be constructed of a PVC body and a pressure rating of 230 psi. Seal material shall be FKM.

2.06 RUBBER FLAPPER SWING CHECK VALVES

- A. Rubber Flapper Check Valves: Tag Type RFCV
- B. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The seating surface shall be on a 45 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator or oil cushion device without special tools or removing the valve from the line.
- C. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. A threaded port shall be provided on the top access port with a mechanical, disc position indicator to indicate whether the valve is open or closed. The indicator shall have continuous contact with the disc under all operating conditions to assure accurate disc position indication.
- D. The disc shall be one-piece construction, precision molded with an O-ring sealing surface and reinforced with alloy steel. Non-slam closing characteristics shall be provided through a short 35-degree disc stroke and a disc accelerator to provide a cracking pressure of 0.3 psig.
- E. The disc accelerator shall be of one-piece construction and provide rapid closure of the valve in high head applications. The disc accelerator shall be field adjustable and replaceable without removal of the valve from the line.

- F. The valve body shall be ductile iron ASTM A536 Grade 65-45-12 or ASTM A126 class B gray iron.
- G. The disc shall be molded Buna-N (NBR), ASTM D2000-BG.
- H. The disc accelerator shall be Type 302 stainless steel.
- I. The valve shall be rated for a working pressure of 150 psig.
- J. A pre-wired limit switch shall be provided to indicate open/closed position to a remote location. The mechanical type limit switch shall be activated by the mechanical indicator. The switch shall be rated for NEMA 4 and shall have U.L. rated 5 amp, 125 VAC contacts. Limit switch shall be Model 802B Compact as Manufactured by Allen Bradley, or equal.
- K. Rubber flapper check valves shall be Surgebuster® Swing Check Valve by Val-Matic®, or equal by GA Industries LLC.

## 2.07 CHECK VALVES FOR OZONE SERVICE

### A. Check Valves for Ozone Contacting System

- 1. Check valves for the ozone contacting system shall match the existing check valves installed.
- 2. 4-inch check valves for the ozone contacting system (water service) shall be DR150WSSSSM by iFC Islip Flow Control Inc. The check valve shall be wafer style, Class 150, body material of CF8M stainless steel, disc material of Type 316 stainless steel with metal to metal seating.

### B. Check Valves for Gaseous Ozone-in-Oxygen

- 1. Check valves for gaseous ozone-in-oxygen shall match the existing check valves installed.
- 2. Check valves shall be F1KSSTF.500SS by CheckAll Valve. The check valve shall be Class 150 with Type 316 stainless steel body, Type 316 stainless steel spring, PTFE seat.
- 3. Valves for gaseous ozone-in-oxygen piping shall be cleaned, tested and packaged for oxygen service by the manufacturer in accordance with Section 13280 and ASTM G93.

## 2.08 PLASTIC BALL VALVES (FOR SODIUM HYPOCHLORITE SERVICE)

- A. Plastic ball valves in sodium hypochlorite service shall have the ball drilled to permit venting of pressure and gas from the confined ball cavity, when the valve is closed. The drilling shall vent to the upstream end of the valve. The drilling shall be 1/8-in opening, de-burred. An arrow shall be inscribed on the valve body to indicate direction of flow.
- B. Plastic ball valves for sodium hypochlorite service shall be as manufactured by Asahi America, IPEX Industrial Piping Systems, or equal.
- C. Plastic ball valves shall be of True Union design with a PVC body and a pressure rating of 230 psi. O-ring material shall be FKM with PTFE seats

## 2.09 MOTORIZED BUTTERFLY VALVES

### A. Motorized Butterfly Valves for Ozone Service

1. The motorized butterfly valves for the ozone contacting system shall match the existing butterfly valves and motorized actuators installed.
2. Butterfly valves shall be Series 40 by Bray with ANSI 150 flanges.
3. Motorized valve actuators shall be AQ 05.2/AC 01.2 by AUMA.

## 2.10 BALL VALVES

### A. All ball valves (excluding ball valves associated with the ozone system) shall comply with requirements included in JEA's Water and Sewer Standards Manual, Section 351 – Water Valves & Appurtenances.

### B. Manual Ball Valves for Ozone System

1. Valves shall be unibody or two-piece stainless steel full port; solid ball construction with bottom loading stems, and adjustable packing with manual locking lever actuator.
2. Body shall be ASTM A276, Type 316 or ASTM A351 GR CF8M stainless steel, flanged, Class 150, ANSI B16.5 as noted on drawings. Ball and stem shall be Type 316 stainless steel. Seats and seals shall be Teflon.
3. Valves for gaseous ozone-in-oxygen piping shall be cleaned, tested and packaged for oxygen service by the manufacturer in accordance with Section 13280 and ASTM G93.
4. Valves shall be WKM Dynaseal 310C, Jamesbury Series 9150 or equal.

### C. Motor Actuated Ball Valves for Ozone System

1. The motorized ball valves for the gaseous ozone-in-oxygen service shall match the existing ball valves and motorized actuators installed.
2. The ball valves shall be 87A-208-57 by Apollo Valves. The ball valve body and ball shall be CF8M or Type 316 stainless steel with PTFE seals and RPTFE seats.
3. The motorized actuators shall be P1 Series by Promotion Engineering. Features of the actuator shall include: voltage of 120VAC with on/off and Standard Proportional control options, non-spring return and NEMA 4X.

## 2.11 AIR RELEASE AND AIR/VACUUM RELIEF VALVES

- A. Pipeline air and vacuum valves shall be supplied with shutoff gate or ball valves with operator handle or lever removed. Valves shall be properly vented and piped to drain.
- B. Valve pressure rating shall be at least equal to attached pipe's rating.
- C. Ozone Off-gas Air Release Valves

1. The ozone off-gas air release valves shall match exiting off-gas air release valves. Refer to Contract Drawings for installation requirements.
2. The air release valve shall be sized to release 40 scfm of off-gas flow. The pressure at the valve inlet is 20 psig and the outlet pressure will be 1-2 psig.
3. The valves shall be provided with inlet and outlet reducers to be threaded to the valve and flanged to 2-inch stainless steel ball valves, see Contract Drawings. Valve body and cover shall be constructed of ASTM A351 Grade CF8M stainless steel. The orifice, float, linkage mechanism and all other components shall be type 316 stainless steel. The orifice button shall be constructed of ozone resistant material and shall provide tight closure. Valves shall be rated for minimum class 150 psig working pressure. Valves shall be manufactured and tested in accordance with AWWA Standard C512. Valves shall be Val-Matic wastewater air release valves to match existing.
4. Contractor shall provide and install inlet and outlet reducers and the (2) 2-inch flanged stainless steel ball valves. Coordinate exact size of the inlet and outlet reducers with the air release valve manufacturer. The air release valves shall be provided by the ozone contacting equipment supplier (refer to Section 13292) and installed by the Contractor.

D. Air Release Valves: Tag Type ARV

1. The air release valves shall be manufactured and tested in accordance with AWWA standard C512. The air/vacuum valves shall be certified to NSF/ANSI 61 standard.
2. The air release valve body, cover, and baffle shall be constructed of ASTM A536 Grade 65-45-12 cast ductile iron. The valve body shall provide a through flow area equal to the nominal valve size. The float, guide shafts, and bushings shall be constructed of Type 316 stainless steel. Floats shall be unconditionally guaranteed against failure including pressure surges. Resilient seats shall be Buna-N. Resilient seats shall provide drop tight shut off to the full valve pressure rating. If required by the valve manufacturer, the valve shall be equipped with a dual port throttling device to control the discharge of air from the valve and allow full vacuum through a separate port.
3. The 3-inch air release valve on the discharge header of the high service pumps shall be model VM45SV by Val-Matic, or equal by Crispin.

E. Air/Vacuum Relief Valves: Tag Type AVV

1. The air relief valves shall be fully automatic operated valves designed to exhaust air which is present in the pump column on pump startup and allow air to re-enter the column on pump shutdown or should negative pressure occur. The air/vacuum valves shall be suitable for pressures up to 400 psig for raw or finished water pump discharge service.
2. The air/vacuum valves shall be manufactured and tested in accordance with AWWA standard C512. The air/vacuum valves shall be certified to NSF/ANSI 61 standard.
3. The air/vacuum valve body, cover, and baffle shall be constructed of ASTM A536 Grade 65-45-12 cast ductile iron. The valve body shall provide a through flow area equal to the nominal valve size. The float, guide shafts, and bushings shall be constructed of Type 316 stainless steel. Floats shall be unconditionally guaranteed against failure including pressure

surges. Resilient seats shall be Buna-N. Resilient seats shall provide drop tight shut off to the full valve pressure rating. If required by the valve manufacturer, the valve shall be equipped with a dual port throttling device to control the discharge of air from the valve and allow full vacuum through a separate port.

4. The 2-inch air/vacuum valves on the well discharge header and on the large high service pumps shall be model VM-100SDISV-M by Val-Matic, or equal by Crispin.
5. The 1-inch air/vacuum valve on the well casing and on the small high service pumps shall be model VM-100SDISV-M by Val-Matic, or equal by Crispin.

## 2.12 FLAP GATES

- A. Flap gate body and cover shall be constructed of cast iron with a flanged-end. Pivot and attaching hardware shall be Type 304 stainless steel. Body seat shall be Nitrile conforming to ASTM D-2000, attached to the body. Cotter pins shall be Bronze conforming to ASTM B98 C655.
- B. Flap gates shall open whenever the upstream head exceeds 0.2 feet higher than the downstream head.
- C. Flap Gates shall be Series FG-SPR as Manufactured by Rodney Hunt-Fontaine, or equal.

## 2.13 DUCK BILL STYLE CHECK VALVE

- A. Duck bill style check valves shall be Series 35 Flanged Check Valve as manufactured by Tideflex Technologies or equal. Flange size drilling shall be ANSI 16.5 Class 150 Standards.

## 2.14 CORPORATION STOPS

- A. Corporation stops shall be of bronze or brass and shall be designed and manufactured in accordance with AWWA C800, except as modified herein.
- B. Corporation stops for use with service clamps shall have IPS threads. Where corporation stops are used with plastic pipe, a brass companion flange shall be provided on the outlet of each corporation stop.
- C. Stop and waste valves shall be similar to 150 psi-rated corporation stops as manufactured by Crane; Ford; McDonald or equal.

## 2.15 SURFACE PREPARATION AND SHOP COATINGS

- A. Notwithstanding any of these specified requirements, all coatings and lubricants in contact with potable water shall be certified as acceptable for use with that fluid.
- B. If not specified herein, coatings shall comply with the requirements of Section 09901. In case of a conflict, the requirements of this Section govern.
- C. If the manufacturer's requirement is not to require finished coating on any interior surfaces, then manufacturer shall so state and no interior finish coating will be required, if acceptable to the Engineer.

- D. The exterior surface of various parts of valves, operators, floor-stands and miscellaneous piping shall be thoroughly cleaned of all scale, dirt, grease or other foreign matter and thereafter one shop coat of an approved rust-inhibitive primer such as Inertol Primer No. 621 shall be applied in accordance with the instructions of the paint manufacturer or other primer compatible with the finish coat provided.
- E. Unless otherwise noted, interior ferrous surfaces of all valves shall be given a shop finish of an asphalt varnish conforming to AWWA C509, (except mounting faces/surfaces) or epoxy conforming to AWWA C550 with a minimum thickness of 6 mil.
- F. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating. Mounting surfaces shall be especially coated with a rust preventative.
- G. Special care shall be taken to protect uncoated items and plastic items, especially from environmental damage.

## 2.16 FACTORY INSPECTION AND TESTING

- A. Factory inspection, testing and correction of deficiencies shall be done in accordance with the referenced standards and as noted herein.
- B. See Division 1 for additional requirements. Also refer to PART 1, especially for required submission of test data to the Engineer.
- C. In addition to all tests required by the referenced standards, the following shall also be factory tested:
  - 1. Pressure regulating valves shall be factory tested at the specified pressures and flows.
  - 2. Butterfly valves shall be factory tested to demonstrate drop tight closure at the specified conditions.
  - 3. All types of air and vacuum valves.

## PART 3 EXECUTION

### 3.01 INSTALLATION - GENERAL

- A. All valves and appurtenances shall be installed per the manufacturer's instructions in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed.
- B. Install all brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings, or otherwise required. Before setting these items, check all Drawings and figures which have a direct bearing on their location. The Contractor shall be responsible for the proper location of valves and appurtenances during the construction of the work excluding skid mounted valves provided by the OSS.
- C. All materials shall be carefully inspected for defects in construction and materials. All debris and foreign material shall be cleaned out of openings, etc. All valve flange covers shall remain in place until connected piping is in place. All operating mechanisms shall be operated to check

their proper functioning and all nuts and bolts checked for tightness. Valves and other equipment which do not operate easily, or are otherwise defective, shall be repaired or replaced at no additional cost to the Owner.

- D. Where installation is covered by a referenced standard, installation shall be in accordance with that standard, except as herein modified, and the Contractor shall certify such. Also note additional requirements in other parts of this Section.
- E. Unless otherwise noted, joints for valves and appurtenances shall be made up utilizing the same procedures as specified under the applicable type connecting pipe joint and all valves and other items shall be installed in the proper position as recommended by the manufacturer. Contractor shall be responsible for verifying manufacturers' torquing requirements for all valves.

### 3.02 INSTALLATION OF MANUAL OPERATIONAL DEVICES

- A. Unless otherwise noted, all operational devices shall be installed with the units of the factory, as shown on the Drawings or as acceptable to the Engineer to allow accessibility to operate and maintain the item and to prevent interference with other piping, valves and appurtenances.
- B. For manually operated valves 3-in in diameter and smaller, valve operators and indicators shall be rotated to display toward normal operation locations.
- C. Floor boxes, valve boxes, extension stems and low floor stands shall be installed vertically centered over the operating nut, with couplings as required and the elevation of the box top shall be adjusted to conform to the elevation of the finished floor surface or grade at the completion of the Contract. Boxes and stem guides shall be adequately supported during concrete placement to maintain vertical alignment.

### 3.03 INSPECTION, TESTING AND CORRECTION OF DEFICIENCIES

- A. See also Division 1. Take care not to over pressure valves or appurtenances during pipe testing. If any unit proves to be defective, it shall be replaced or repaired to the satisfaction of the Engineer.
- B. Functional Test: Prior to plant startup, all items shall be inspected for proper alignment, quiet operation, proper connection and satisfactory performance. After installation, all manual valves shall be opened and closed in the presence of the Engineer to show the valve operates smoothly from full open to full close and without leakage. Pressure control and pressure relief valves shall be operated in the presence of the Engineer to show they perform their specified function at some time prior to placing the piping system in operation and as agreed during construction coordination meetings
- C. The various pipe lines in which the valves and appurtenances are to be installed are specified to be field tested. During these tests any defective valve or appurtenance shall be adjusted, removed and replaced, or otherwise made acceptable to the Engineer.
- D. Various regulating valves, strainers, or other appurtenances shall be tested to demonstrate their conformance with the specified operational capabilities and any deficiencies shall be corrected or the device replaced or otherwise made acceptable to the Engineer.

3.04 CLEANING

- A. All items including valve interiors shall be inspected before line closure, for the presence of debris. At the option of the Engineer, internal inspection of valve and appurtenances may be required any time that the likelihood of debris is a possibility. All pipes and valves shall be cleaned prior to installation, testing disinfection and final acceptance.

3.05 DISINFECTION

- A. Disinfection of valves and appurtenances on all potable water lines and where otherwise noted, shall be as noted in Paragraph 1.02B above.

END OF SECTION

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SECTION 15120  
PIPING SPECIALTIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install complete test, and make ready for operation all piping specialties required by the work of this Contract. Specific piping materials, systems and related installation and testing requirements shall be coordinated with the related sections in Divisions 2, 13 and 15. The items shall include the following:
1. Unions
  2. Flanged Joints
  3. Plugs and Caps
  4. Miscellaneous Adaptors
  5. Vents and Drains
  6. Line Strainers
  7. Service Clamps
  8. Cleanouts
  9. Quick Connect Couplings
  10. Mechanical Sleeve Seals
  11. Flexible Connectors
    - a. Sleeve Couplings
    - b. Split or Grooved Couplings
    - c. Flange Adapters
    - d. Pump and Equipment Flexible Connectors
    - e. Flexible Connectors
  12. Expansion Joints
    - a. Single- and Multiple-Arch Type
  13. Harnessing and Restraints
  14. Diaphragm Seals for Gauges
  15. Appurtenances and Miscellaneous Items
  16. Color Coding and Labeling

## 1.02 RELATED WORK

- A. Piping penetration are included in Section 01180
- B. Pipeline color coding and labeling is included in Section 09902.
- C. Piping materials and systems are included in other Sections of Division 15.
- D. Specialties and apparatus furnished with equipment and systems are included in individual Sections in Divisions 11.
- E. Valves are included in Section 15100.
- F. Pipe insulation is included in Section 15250.

## 1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, general submittals for piping, piping systems and pipeline appurtenances are listed below. It is not intended that all submittals listed below be provided for all piping materials and systems. Refer to individual System or Piping Sections for specific submittals.
- B. Shop Drawings and Product Data
  - 1. Piping layouts with specialties.
  - 2. Location of pipe hangers and supports.
  - 3. Large scale details of wall penetrations and fabricated fittings.
  - 4. Catalog cuts of specialties, joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.
  - 5. Catalog cuts of all pipeline appurtenances specified herein.
  - 6. Brochures and technical data on coatings and linings and proposed method for application and repair.
- C. Samples
- D. Design Data
- E. Test Reports
  - 1. Certified shop tests showing compliance with appropriate standard.
  - 2. Field test reports, signed by Contractor.
- F. Certificates
  - 1. Copies of certification for all welders performing work in accordance with ANSI B31.1.

- G. Manufacturers' Installation (or application) instructions.
- H. Statement of Qualifications
- I. Manufacturers Field Report
- J. Project Record Document
- K. Operation and Maintenance Data in accordance with Section 01730.
- L. Warranties

#### 1.04 REFERENCE STANDARDS

##### A. ASTM International

- 1. ASTM A36 - Standard Specification for Carbon Structural Steel.
- 2. ASTM A126 - Standard Specification for Gray Iron Casting for Valves, Flanges and Pipe Fittings.
- 3. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- 4. ASTM A536 - Standard Specification for Ductile Iron Castings
- 5. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

##### B. American National Standards Institute (ANSI)

- 1. ANSI A13.1 - Scheme for the Identification of Piping Systems.
- 2. ANSI B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form)
- 3. ANSI B18.2 - Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws and Lag Screws.
- 4. ANSI B31 - Code for Pressure Piping.

##### C. American Society of Mechanical Engineers (ASME)

- 1. ASME B2.1 - Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals).
- 2. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
- 3. ASME B16.5 - Pipe Flanges and Flange Fittings

##### D. American Water Works Association (AWWA)

- 1. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-in through 48-in (75mm Through 1200mm), for Water and Other Liquids.

2. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. AWWA C219 - Bolted Sleeve-Type Couplings for Plain-End Pipe
4. AWWA C606 - Grooved and Shouldered Joints.
5. AWWA Manual M11 - Steel Pipe - A Guide for Design and Installation.

E. Plumbing and Drainage Institute (PDI)

1. WH 201 - Water Hammer Arrestors

F. Underwriters Laboratories (UL)

G. Factory Mutual (FM)

- H. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. All materials shall be new and unused.
- B. Install piping to meet requirements of local codes.
- C. Provide manufacturer's certification that materials meet or exceed minimum requirements as specified.
- D. Coordinate dimensions and drilling of flanges with flanges for valves, pumps and other equipment to be installed in piping systems. Bolt holes in flanges to straddle vertical centerline.
- E. Reject materials contaminated with gasoline, lubricating oil, liquid or gaseous fuel, aromatic compounds, paint solvent, paint thinner and acid solder.
- F. Pipe-joint compound, for pipe carrying flammable or toxic gas, must bear approval of UL or FM.
- G. Unless otherwise specified, pressures referred to in all Piping Sections are expressed in pounds per square inch, gauge above atmospheric pressure, psig and all temperature are expressed in degrees Fahrenheit (F).

1.06 DELIVERY, STORAGE AND HANDLING

- A. During loading, transportation and unloading, take care to prevent damage to pipes and coating. Carefully load and unload each pipe under control at all times. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to ensure no injury to pipe and lining. Cover or cap all pipe ends while pipe is in storage, until it is made a part of the work.

## PART 2 PRODUCTS

### 2.01 MATERIALS AND EQUIPMENT

- A. Specific piping materials and appurtenances are specified in the respective Piping or System Sections. The use of a manufacturer's name and/or model number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Equipment shall be of the size shown on the Drawings or as noted and as far as possible equipment of the same type shall be identical and from one manufacturer.
- C. Equipment shall have the name of the maker, nominal size, flow directional arrows (if applicable), working pressure for which they are designed and standard referenced specifications cast in raised letters or indelibly marked upon some appropriate part of the body.
- D. Unless otherwise noted, items shall have a minimum working pressure of 150 psi or be of the same working pressure as the pipe they connect to, whichever is higher and suitable for the pressures noted where they are installed.

### 2.02 UNIONS

- A. PVC unions for joining PVC pipe; CPVC unions for joining CPVC pipe.

### 2.03 FLANGED JOINTS

- A. Flanged Joints. Bolt and nuts shall be Grade B ASTM A307, bolt number and size same as flange standard; studs - same quality as machine bolts; 1/8-in thick rubber gaskets with cloth insertions; rust-resistant coatings.

### 2.04 PLUGS AND CAPS

- A. Provide standard plug or cap as required for testing; plugs, caps suitable for permanent service.
- B. Plug or cap or otherwise cover all piping work in progress.

### 2.05 MISCELLANEOUS ADAPTORS

- A. Between different types of pipe and/or fittings special adapters may be required to provide proper connection. Some of these may be indicated on the Drawings or specified with individual types of pipe or equipment. However, it is the Contractor's responsibility to ensure proper connection between various types of pipe, to structures and between pipe and valves, gates, fittings and other appurtenances. Provide all adapters as required, whether specifically noted or not.
- B. As required, these adapters shall be suitable for direct bury, with proper dielectric insulation and as a minimum, if metallic (not stainless steel or galvanized), with two coats of Coal Tar Epoxy.

## 2.06 LINE STRAINERS

### A. "Y" Type Strainers

1. Manual strainers furnished for pipe diameters smaller than 2-in shall be "Y" type, capable of removing solids 0.01-in in diameter and larger. The strainer body shall be of semi-steel construction for steel pipe and brass or bronze for copper pipe and shall conform to the latest revision of ASTM A278, Class 30. Strainer elements, including woven wire mesh, shall be constructed of stainless steel.
2. The design of the strainer body shall be such that the cleanout plug and screen may be easily removed to permit inspection and cleaning without disassembly of the inlet and outlet piping. End connections shall be ANSI screwed pipe threads.
3. Sufficient spare screen shall be furnished for replacement of all "Y" type units at least once. The strainers shall be designed for a maximum operating pressure of 150 psig. They shall be as manufactured by GA Industries Inc., Pittsburg, PA or equal.

## 2.07 SERVICE CLAMPS

- A. Service clamps for outlet sizes up to 2-in shall have malleable or ductile iron bodies which extend at least 160 degrees around the circumference of the pipe and shall have neoprene gaskets cemented to the saddle body. Bodies shall be tapped for IPS. Clamps shall be of the double strap design. Service clamps shall be Style 91 by Dresser Industries, Inc.; Smith Blair; Mueller or equal.
- B. Service clamps for outlet sizes 4-in through 12-in where the outlet size is not greater than half the size of the main pipe shall have ductile iron bodies and a neoprene circular cross section O-ring gasket confined within the body. Outlet shall be AWWA C110 flange or AWWA C111 mechanical joint as required for the application. Straps shall be alloy steel, minimum 1/4-in by 1-1/2-in in cross section and fabricated with 3/4-in threaded ends. Service clamps shall be Fig. A-10920 or A-30920 by American Cast Iron Pipe Company or equal.

## 2.08 QUICK CONNECT COUPLINGS

- A. Couplings shall be polypropylene of the cam and groove type consisting of a male adapter. Male adapters shall be designed to receive a female coupler without requiring threading, bolting, or tools. Connections shall remain tight and leakproof under pressures up to 100 psig. Each adapter shall be furnished with a dust cap complete with a 18-in long security chain of corrosion resistant material. Couplings shall be by Civacon, a Division of Dover Corporation; Ever-tite or equal.
- B. Adapters shall be furnished in accordance with the Drawings, or as required by the installation.

## 2.09 MECHANICAL SLEEVE SEALS

- A. Mechanical sleeve seals shall be used to secure and seal the annular space around all new sleeved and core-drilled wall penetrations.
- B. A single seal shall be provided for all sleeve and cores in walls up to 14-in thick; dual sleeves shall be provided in larger walls.

- C. Galvanized steel wall sleeves and concrete core diameter shall be sized sufficiently larger to accommodate the modular elements, per the manufacturer's recommendations.
- D. Bolts and hardware shall be 316 stainless steel. Pressure plates shall be corrosion-resistant acetal resin.
- E. Mechanical sleeve seals shall consist of modular bolted, synthetic rubber sealing elements, Link Seal by Thunderline Corp. or equal.

## 2.10 FLEXIBLE CONNECTORS

### A. Sleeve Couplings

1. Provide plain end type ends to be joined by sleeve couplings as stipulated in AWWA C219.
  - a. Join welds on ends by couplings without pipe stops. Grind flush to permit slipping coupling in at least one direction to clear pipe joint.
  - b. Outside diameter and out-of-round tolerances shall be within limits specified by coupling manufacturer.
  - c. Provide lugs in accordance with ASTM A36.
  - d. Provide hardened steel washers in accordance with ASTM A325.
  - e. Plastic plugs shall be fitted in coupling to protect bolt holes.
  - f. Nuts and bolts
    - 1) Provide bolts and bolt-studs in accordance with ASTM A307 and ANSI B1.1 with hexagonal or square heads, coarse thread fit, threaded full length with ends chamfered or rounded.
    - 2) Project ends 1/4-in beyond surface of nuts.
    - 3) Hexagonal nuts with dimensions in accordance with ANSI B18.2 and coarse threads in accordance with ANSI B1.1.
2. Middle ring of each mechanical coupling shall have a thickness at least equal to that specified for size of pipe on which coupling is to be used and shall not be less than 10-in long for pipe 30-in and larger and not less than 7-in long for pipe under 30-in in diameter.
  - a. Omit pipe stop from inner surface of middle rings of couplings whenever necessary to permit removal of valves, flowmeters and other installed equipment.
  - b. Provide pipe stops in other couplings.
3. Clean and shop prime with manufacturer's standard rust inhibitive primer.
4. Furnish gaskets of a composition suitable for exposure to the fluid service.
5. Where shown on the Drawings, anchor sleeve-coupled joints with harness bolts. Weld harness lugs to steel pipe.
  - a. Joint harness bolts shall be of sufficient length, with harness lugs placed so that coupling can be slipped at least in one direction to clear joint. Provide harnesses of sufficient number and strength to withstand test pressure as recommended in AWWA M-11.
  - b. Each harness shall have a minimum of two 5/8-in diameter bolts.
6. Unless otherwise specified with the individual type of pipe, sleeve couplings (mechanical couplings) shall be Victaulic Depend-O-Lok E x E (unrestrained) or F x F ( self-

restrained); ITT (formerly Smith Blair) Style 411; Dresser Style 38, similar models by Baker or equal, with the pipe stop removed.

7. Similar insulation type couplings shall be provided at the face of buildings, between different type metals or where otherwise noted.
8. In addition to those locations noted on the Drawings, sleeve couplings shall be provided on all piping where it connects with a structure or buried directly under a structure at the structure's expansion joints. Special treatment will be required where pipe is encased in concrete, utilizing minimum 3-in thick styrofoam placed perpendicular to the horizontal centerline of the coupling.

## 2.11 HARNESSING AND RESTRAINT

- A. Where harnessed couplings or adapters are noted, they shall conform to AWWA Manual M11 except as modified by the Drawings or this Section.
- B. Unless otherwise noted, size and material for tie rods, clamps, plates and hex nuts shall be as shown on the Drawings, or, if not shown on the Drawings, shall be as required in AWWA Manual M11. Manufactured restraining clamp assemblies shall be as manufactured by Stellar Corporation, Columbus, OH, or equal.
- C. Restrained joints (such as welded, locking mechanical joints) shall be of the type specified with the individual type of pipe. If not specified, restrained (locking) mechanical joint pipe shall be of the manufacturer's standard design utilizing a locking device (ring or ears) integrally cast with the pipe.
- D. For up through 18-in diameter ductile iron pipe only, the following may be used as an alternative to other restraint system:
  1. The optional mechanical joint restraints shall be incorporated in the design of a follower gland. The gland shall be manufactured of ductile iron conforming to ASTM A536. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts as specified with the pipe.
  2. The restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability. The gripping surfaces shall be wedges designed to spread the bearing surfaces on the pipe. Twist-off nuts, sized same as tee-head bolts, shall be used to ensure proper actuating of restraining devices. When the nut is sheared off, standard hex nut shall remain.
  3. The mechanical joint restraint device for ductile iron pipe shall have a working pressure of at least 250 psi with a minimum safety factor of 2:1.
  4. The mechanical joint restraint devices shall be of the type listed below or equal.
  5. For Ductile Iron Pipe: EBAA Iron, Inc. Megalug 1100 series for up to 12-in only.
- E. The Contractor shall be responsible for anchorage including restraint as noted elsewhere in Division 15.

## 2.12 HARNESSSED FLANGE ADAPTER COUPLINGS (HFAC)

- A. Provide HFACs meeting the requirements of AWWA C.219 as applicable and with tie rods. Provide dismantling joints as shown on the Drawings and called out as HFAC. All connecting hardware shall be type 316 stainless steel. The spigots and flange adapters shall be ductile iron or steel meeting ASTM A283 Grade C, and shall be provided with a shop-coat primer compatible with the field applied coating as specified in Specification 09902. The HFAC shall be a complete assembly consisting of a spigot piece, flange adapter, tie rods and gaskets. The tie rod restraint system shall be capable of withstanding the full pressure thrust that the pipe system can develop at no more than 50% of the yield strength of the tie rod material. The design pressure rating of the HFACs shall be a minimum of 150 psig. HFACs shall be type DJ 400 Dismantling Joints by Romac Industries, Dismantling Joints by Viking Johnson, Style 131 Dismantling Joints by Dresser Industries, or equal.

## 2.13 DIAPHRAGM SEALS FOR GAUGES

- A. Diaphragm seals shall be installed for all pressure gauges and pressure switches, to protect pressure gauges and pressure switches from contact with the fluid in the pipeline. Gauges shall be furnished as part of a complete factory assembly, including gauge, snubber, diaphragm seal, liquid fill, bar stock isolation valve and threaded 316 stainless steel interconnecting piping.
- B. Diaphragm seals shall be minimum 2-1/2-in diameter, or as required for the connected pressure gauges. The diaphragm shall be "thread attached" to both piping and pressure switches or gauges. Furnish mineral oil fill between the diaphragm seal and the gauge.
  - 1. Diaphragm seals shall have an upper housing of cadmium plated carbon steel, with the lower housing of Type 316 stainless steel with Type 304 stainless steel bolts. Diaphragms shall be Teflon.
  - 2. Each diaphragm seal shall be connected to its respective piping or equipment with threaded red brass pipe and fittings. Pipe size and diaphragm tap size shall match the size of the gauge tap on the equipment, but shall not be less than 3/4-in, except for connections to plant water piping which shall be minimum 1/2-in. Furnish a ball valve shut-off valve between the pipeline or equipment and the diaphragm seal.
  - 3. Each diaphragm seal shall have a minimum 1/4-in NPT flush connection with ball valve and gauge tap to match the size of the gauge.
  - 4. Furnish pulsation dampeners adequate to prevent pulsation and/or vibration of the gauge indicator under all system operating conditions.
  - 5. Pump gauges shall connect to the diaphragm seal by a flexible Type 304 stainless steel capillary tube. Gauges shall be mounted on a support stand independent of the pump and piping, to minimize vibration of the gauges caused by vibration of the equipment or piping. Mount both the suction and discharge gauges at the same elevation. Furnish supports as specified in Section 15140, or attach gauges to the seal water assembly support (where applicable).
  - 6. Diaphragm seals shall be Type SG by Mansfield and Green; Ashcroft or equal.

- C. Where installed on chlorine lines, or lines leading to chlorine ejectors, seals shall be special chlorine-resistant type. All other materials shall be certified corrosion resistant for seal location and fluid.

## 2.14 APPURTENANCES AND MISCELLANEOUS ITEMS

- A. All gaskets, glands, bolts, nuts and other required hardware shall be provided for connection of piping and appurtenances. Bolts and nuts shall be high strength, Type 316 stainless steel if submerged, buried, or subject to splashing and cadmium plated otherwise, with tee-head and hexagon nut. All other hardware shall be of the size, type and number as required and recommended by the piping or appurtenance manufacturer and as specified herein.
- B. All gaskets for flanges shall be full face and suitable for 150 degrees F operating temperature, and the fluids carried. See also Division 1.
- C. Plugs, caps and similar accessories shall be of the same material as the pipe and of the locking type, unless otherwise noted.
- D. Unions shall be of the same material as the pipe, except for dielectric connections.
- E. Special protective tape shall be fabric reinforced petroleum tape by Denso Inc., Houston, TX or equal.

## 2.15 COLOR CODING AND LABELING

- A. General
  - 1. Provide a complete color coding system consisting of preprinted labels and banding by Brady; Seton or equal. Field painting shall be specified in Section 09902. Painting and coding shall comply with the requirements of the PROCESS PIPING SCHEDULE.
  - 2. Piping system identification shall comply with the requirements of ANSI A13.1.
  - 3. Contractor shall coordinate with the Owner for color selection of piping.
  - 4. Labels and Directional Arrows
    - a. Apply labels with directional arrows at connections to equipment, valves, branch fittings, at least one wall, floor, or ceiling boundary within a room and at intervals not greater than 36-ft.
    - b. At each label, arrows indicating direction of flow shall point away from label. If flow may be in both directions, use double headed arrows.
    - c. Lettering shall bear the full pipe system name as scheduled. Contractor shall coordinate with the owner for final pipe system name.
    - d. Lettering height shall be as follows:

| Outside Pipe Diameter | Minimum Letter Height |
|-----------------------|-----------------------|
| 3/4-in to 1-1/4-in    | 1/2-in                |
| 1-1/2-in to 2-in      | 3/4-in                |
| 2-1/2-in to 6-in      | 1-1/4-in              |
| 8-in to 10-in         | 2-1/2-in              |

|            |          |
|------------|----------|
| Over 10-in | 3-1/2-in |
|------------|----------|

- e. Two labels minimum each room, crawl space or compartment, unless otherwise approved.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. All dirt, scale, weld splatter, water and other foreign matter shall be removed from the inside and outside of all pipe and sub-assemblies prior to installing.
- B. All pipe joints and connections to equipment shall be made in such a manner as to produce a minimum of strain at the joint.
- C. Test Connections
  - 1. Provide 1/2-in female NPT test connection equipped with 1/2-in brass plug on all pump suction and discharge lines. Where indicated on the Drawings, test connections should be equipped with bar stock valve and gauge. Provide test connections at all steam traps. The connection shall be located on the discharge side of the trap between the trap and the first valve. It shall consist of a 1/2-in branch connection terminated with a gate valve.
- D. Installation of Expansion Joints and Flexible Connectors
  - 1. Piping systems shall be aligned prior to installation of expansion fittings. Alignment shall be provided by fitting a rigid pipe spool in place of the expansion joint. Prior to testing of the piping system, the pipe spool shall be replaced with the specified expansion or flexible fitting.
  - 2. In addition to the locations noted on the Drawings and in Part 2, expansion fittings and anchors shall be located and spaced as specified by the Expansion Joint Manufacturer's Association. The expansion joints/flexible connectors shall not be installed during times of temperature extreme or in a fully compressed or fully expanded condition.
- E. Installation of Sleeve Couplings
  - 1. Unless otherwise required by the manufacturer's instructions, prior to installation of sleeve couplings, the pipe ends shall be cleaned thoroughly for a distance of at least 12-in. Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6-in from the end, the middle ring shall be placed on the already installed pipe and shall be inserted into the middle ring flair and brought to proper position in relation to the pipe already installed. The gaskets and followers shall then be pressed evenly and firmly into the middle ring flares.
  - 2. After the bolts have been inserted and all nuts have been made up fingertight, diametrically opposite nuts shall be progressively and uniformly tightened all around the joint, preferably by use of a torque wrench of the appropriate size and torque for the bolts.
  - 3. The correct torque as indicated by a torque wrench shall not exceed 75 ft-lb for 5/8-in bolts and 90 ft-lb for 3/4-in bolts.

4. If a wrench other than a torque wrench is used, it should be no longer than 12-in so that when used by the average person the above torque values shall not be exceeded.
5. To prevent sleeve couplings from pulling apart under pressure, a suitable harnessing or flange clamp assembly shall be provided and installed where shown on the Drawings, directed by the Engineer or required elsewhere under Division 15 concerning anchorage.
6. Note the additional locations required for sleeve couplings in Part 2. Also note Contractor's responsibility for locating, providing and installing restraints.

F. Installation of Split Couplings

1. Prior to assembly of split couplings, grooves or shoulders of the pipe as well as other parts shall be thoroughly cleaned. The ends of the pipes and outside of the gaskets shall be moderately coated with manufacturer's recommended lubricant, petroleum jelly, cup grease, soft soap, or graphite paste and the gasket shall be slipped over one pipe end. Lubricant shall be compatible with potable water application. After the other pipe has been brought to the correct position, the gasket shall be centered properly over the pipe ends with the lips against the pipes. The housing sections then shall be placed.
2. Ensure that the joints are fully extended after the rings are in place and prior to tightening the bolts. After the bolts have been inserted, the nuts shall be tightened until the housing sections are firmly in contact, as required by the manufacturer, without excessive bolt tension or strain on the pipe.

G. Installation of Pipeline Appurtenances

1. All pipeline appurtenances shall be installed as required and in accordance with the manufacturer's recommendations, as acceptable to the Engineer.
2. Gauges, meters and similar in-line items shall be isolated from testing pressures in excess of the rated pressure of the assembly.
3. Use Teflon tape on all screwed fittings.

H. Installation of Unions

1. Use unions to allow dismantling of pipe, valves, and equipment.

I. Welding

1. Welding shall be in accordance with ANSI B31 and AWS B3.0.
2. Install welding fittings on all welded lines. Make changes in direction and intersection of lines with welding fittings. Do not miter pipes to form elbows or notch straight runs to form tees, or any similar construction. Do not employ welder who has not been fully qualified in above specified procedure and so certified by approved welding bureau or similar locally recognized testing authority.

J. Installation of Flanged Joints

1. Make flanged joints with bolts; bolt studs with nut on each end; or studs with nuts where one flange is tapped. Use number and size of bolts conforming to same ANSI Standard as flanges. Before flanges pieces are assembled, remove rust resistant coating from machined surfaces, clean gaskets and smooth all burrs and other defects. Make up flanged joints tight, care being taken to prevent undue strain upon valves or other pieces of equipment.

### 3.02 TESTING

- A. Test all pipelines for water/gas tightness as specified in the Piping or System Sections. Furnish all labor, testing plugs or caps, pressure pumps, pipe connections, gauges and all other equipment required. Testing shall be performed in accordance with one or more of the testing procedures appended to this Section as specified in each Piping or System Section. All testing shall be performed in the presence of the Engineer.
- B. Repair faulty joints or remove defective pipe and fittings and replace as approved by the Engineer. Retest.

### 3.03 DISINFECTION

- A. After satisfactory testing, all potable water shall be thoroughly disinfected with a solution of not less than 50 ppm of available chlorine. The disinfecting solution shall be allowed to remain in the system for a period of 3 hours after which time all valves and faucets shall be opened and the system shall be flushed with clean water.
- B. Water being flushed from structures or pipelines after disinfection with a chlorine residual of two mg/l or greater, shall be treated with a dechlorination solution, in a method approved by the Engineer, prior to discharge.

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SECTION 15140  
PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals and install a complete system of pipe hangers, supports, concrete inserts and anchor bolts including all metallic hanging and supporting devices for supporting non-buried piping as shown on the Drawings and as specified herein.
- B. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of the responsibility for providing them. Pipe supports indicated on the Drawings are shown only to convey the intent of the design for a particular location and are not intended to represent a complete system.

1.02 RELATED WORK

- A. Concrete is included in Division 3.
- B. Field painting is included in Division 9.
- C. Pipe and fittings are included in respective sections of Division 15.
- D. The project process piping schedule is included in Section 15120.
- E. Valves and appurtenances are included in Section 15100.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, complete sets of shop drawings of all items to be furnished under this Section. Submittals shall include complete layouts, schedules, location plans and complete total bill of materials for all pipe support systems.
- B. Submittals shall include a representative catalog cut for each different type of pipe hanger or support indicating the materials of construction, important dimensions and range of pipe sizes for which that hanger is suitable. Where standard hangers and/or supports are not suitable, submit detailed drawings showing materials and details of construction for each type of special hanger and/or support. Provide detailed information on anti-seize compound.
- C. Submittals shall include complete piping drawings as submitted for each piping submittal indicating type of hanger and/or support, location, magnitude of load transmitted to the structure and type of anchor, guide and other pipe supporting appurtenances including structural fasteners.
- D. Types and locations of pipe hangers and/or supports shall also be shown on the piping layouts for each piping submittal as specified in the respective Division 15 pipe sections. Service conditions for each piping system, including service temperatures, and operating and test pressures, are tabulated in the piping sections.
- E. Submit complete design data for pipe support systems to show conformance with this Section.

#### 1.04 REFERENCE STANDARDS

- A. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS):
  - 1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
  - 2. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.
- B. ASTM International:
  - 1. ASTM A36 - Standard Specification for Carbon Structural Steel.
  - 2. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- C. American National Standards Institute (ANSI):
  - 1. ANSI B31.1 - Power Piping.
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

- A. All hangers, supports and appurtenances shall conform to the latest applicable requirements of ANSI B31.1, except as supplemented or modified by the requirements of this Section.
- B. All hangers, supports and appurtenances shall be of approved standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for all supporting equipment, with the exception of springs, shall be five times the ultimate tensile strength of the material, assuming 10-ft of water-filled pipe being supported.
- C. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, submit certification stating that such requirements have been complied with.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. All supports and hangers shall be crated, delivered and uncrated so as to protect against any damage.
- B. All parts shall be properly protected so that no damage or deterioration shall occur during a prolonged delay from the time of shipment until installation is completed.
- C. Finished metal surfaces not galvanized, that are not of stainless steel construction, or that are not coated, shall be grease coated, to prevent rust and corrosion.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. All of the equipment specified herein is intended to support the various types of pipe and piping systems shown on the Drawings. It shall be the responsibility of the Contractor to develop final details and any details associated with special conditions not already covered to meet the system conditions (in particular system temperatures and pressures) specified in the respective Division 15 pipe sections.
- B. All pipe and tubing shall be supported as required to prevent significant stresses in the pipe or tubing material, valves, fittings and other pipe appurtenances and to support and secure the pipe in the intended position and alignment. All supports shall be designed to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces and all probable external forces such as equipment, pipe and personnel contact. Structural steel members required to brace any piping from excessive dislocation shall conform to the applicable requirements of Section 05500 and shall be furnished and installed under this Section.
- C. The Contractor may propose minor adjustments to the piping arrangements in order to simplify the supports, or in order to resolve minor conflicts in the work.
- D. Where flexible couplings are required at equipment, tanks, etc., the end opposite to the piece of equipment, tank, etc., shall be rigidly supported, to prevent transfer of force systems to the equipment. No fixed or restraining supports shall be installed between a flexible coupling and the piece of equipment.
- E. All pipe and appurtenances connected to the equipment shall be supported in a manner to prevent any strain from being imposed on the equipment or piping system.
- F. All rods, clamps, hangers, inserts, anchor bolts, brackets and components for interior pipe supports shall be furnished with galvanized finish, hot dipped or electro-galvanized coated, except where field welding is required, where cold-applied galvanizing may be used. Interior clamps on plastic pipe shall be plastic coated. All rods, clamps, hangers, inserts, anchor bolts, brackets and components for exterior pipe, submerged pipe and pipe within outdoor structures shall be of Type 316 stainless steel.
- G. Supports shall be sufficiently close together such that the sag of the pipe is within limits that will permit drainage and avoid excessive bending stresses from concentrated loads between supports.
- H. All uninsulated non-metallic piping such as PVC shall be protected from local stress concentrations at each support point. Protection shall be provided by galvanized steel protection shields or other method as approved by the Engineer. Where pipes are bottom supported 180 degrees, arc shields shall be furnished. Where 360-degree arc support is required, such as U bolts, protection shields shall be provided for the entire pipe circumference. Protection shields shall have an 18-gauge minimum thickness, not be less than 12-in in length and be securely fastened to pipe with stainless steel or galvanized metal straps not less than 1/2-in wide.

- I. All insulated pipe shall be furnished with a rigid foam insulating saddle at each pipe support location as specified under respective pipe insulation. Provide protection shields as specified in at each support location.
- J. All stainless steel piping shall be isolated from all ferrous materials, including galvanized steel by use of neoprene sheet material and protection shields, similar to above methods.
- K. Pipe supports shall be provided as follows:
  - 1. Ductile iron piping shall be supported at a maximum support spacing of 10-ft with a minimum of one support per pipe section at the joints.
  - 2. Insofar as is possible, floor supports shall be given preference. Typical concrete supports are shown on the drawings. Base elbow and base tees shall be used where possible.
  - 3. Support spacing for stainless steel piping 2-in and smaller diameter shall not exceed 5 ft.
  - 4. For all stainless steel piping, provide neoprene isolators between the pipe and support components.
  - 5. Supports for multiple PVC plastic piping shall be continuous wherever possible. Individually supported PVC pipes shall be supported as recommended by the manufacturer except that support-spacing shall not exceed 3-ft. Multiple, suspended, horizontal plastic PVC pipe runs, where possible, shall be supported by ladder type cable trays such as the Electray Ladder by Husky-Burndy; the Globetray by the Metal Products, a Division of United States Gypsum, or equal. Ladder shall be of galvanized steel construction. Rung spacing shall be 12-in. Tray width shall be approximately 6-in for single runs and 12-in for double runs. Ladder type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc., required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps or fasteners similar to Globe, Model M-CAC; Husky-Burndy, Model SCR or equal. Spacing between clamps shall not exceed 9-ft. The cable trays shall provide continuous support along the length of the pipe. Individual clamps, hangers and supports in contact with plastic PVC pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.
  - 6. All vertical pipes shall be supported at each floor or at intervals of not more than 12 ft by approved pipe collars, clamps, brackets, or wall rests and at all points necessary to insure rigid construction. All vertical pipes passing through pipe sleeves shall be secured using a pipe collar.
  - 7. Pipe supports shall not induce point loadings but shall distribute pipe loads evenly along the pipe circumference.
  - 8. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or as specified herein. No piping shall be supported from other piping or from metal stairs, ladders and walkways, unless specifically directed or authorized by the Engineer.
  - 9. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings and sleeve type couplings and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.

10. Effects of thermal expansion and contraction of the pipe shall be accounted for in the pipe support selection and installation.
- L. Unless otherwise specified herein, pipe hangers and supports shall be standard catalogued components, conforming to the requirements of MSS-SP-58 and -69; and shall be as manufactured by Grinnell Co., Inc., Providence, RI; Carpenter & Patterson, Inc., Woburn, MA; F&S Central, Brooklyn NY; Elcen Metal Products Co., Franklin Park, IL and Unistrut Northeast, Cambridge, MA or equal. Reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product and shall not be considered as proprietary.
- M. Required pipe supports for which the supports specified in this Section are not applicable shall be fabricated or constructed from standard structural steel shapes, concrete and anchor hardware similar to items previously specified herein and shall be subject to the approval of the Engineer.
- N. Expansion anchors shall be equal to Kwik-Bolt as manufactured by the McCulloch Industries, Minneapolis, MN or Wej-it by Wej-it Expansion Products, Inc., Bloomfield, CO. The length of expansion bolts shall be sufficient to place the wedge portion of the bolt a minimum of 1-in behind the steel reinforcement.
- O. Hanger rods shall be hot rolled steel, machine threaded and galvanized after fabrication. The strength of the rod shall be based on its root diameter. Hanger rods shall be attached to concrete structures using concrete inserts similar to F&S, Figures 180, 571 or 150; or continuous concrete inserts per F&S. Inserts shall be malleable iron, or steel with galvanized finish. Beam clamps, C clamps or welded beam attachments shall be used for attaching hanger rods to structural steel members. Where necessary and approved by the Engineer, expansion anchors shall be used for attaching to concrete structures.

## 2.02 SINGLE PIPE HANGERS

- A. Single pipes shall be supported by hangers suspended by hanger rods from structural steel members, concrete ceilings, bottom of trapeze hangers and wall mounted steel angle brackets.
- B. Except as otherwise specified herein, pipe hangers shall be steel, of the adjustable clevis type similar to Grinnell, Figure No. 65, 260 and 590 as required.
- C. Where pipes are near walls, beams, columns, etc., and located an excessive distance from ceilings or underside of beams, welded steel wall brackets similar to Carpenter and Patterson, Figure No. 69-68, 84 or 139 shall be used for hanging pipe. Where single pipes rest on top of bracket pipe supports, attachments shall meet requirements as specified under multiple pipe hangers.

## 2.03 SINGLE AND MULTIPLE PIPE SUPPORTS

- A. Single pipes located in a horizontal plane close to the floor shall be supported by one of the methods as shown on the Drawings and as specified herein.
- B. Pipes 3-in in diameter and larger shall be supported by adjustable stanchions similar to F&S, Figure 427. Stanchions shall provide at least 4-in adjustment and be flange mounted to floor.

- C. Pipes less than 3-in in diameter shall be held in position by supports fabricated from steel "C" channel, welded post base similar to Unistrut, Figure P2072A and pipe clamps similar to Unistrut, Figures P1109 thru P1126. Where required to assure adequate support, fabricate supports using two vertical members and post bases connected together by horizontal member of sufficient load capacity to support pipe. Wherever possible supports shall be fastened to nearby walls or other structural member to provide horizontal rigidity. More than one pipe may be supported from a common fabricated support.
- D. Where shown on the Drawings, pipe shall be supported using concrete anchor posts. Pipe shall be securely fastened to the posts using suitable metal straps as required and as approved.

#### 2.04 WALL SUPPORTED PIPES

- A. Single or multiple pipes located adjacent to walls, columns or other structural members, whenever deemed necessary, shall be supported using welded steel wall brackets similar to Carpenter and Patterson, Figure No. 69-78, 84, or 134; or "C" channel with steel brackets similar to Unistrut pipe clamps. All members shall be securely fastened to wall, column, etc., using double expansion shields or other method as approved by the Engineer. Additional wall bearing plates shall be provided where required.
- B. Pipe shall be attached to supports using methods specified herein to meet the intent of this Section.

#### 2.05 BASE ANCHOR SUPPORT

- A. Where pipes change direction from horizontal to vertical via a bend, a welded or cast base bend support shall be installed at the bend to carry the load. The base bend shall be fastened to the floor, pipe stanchion, or concrete pedestal using expansion anchors or other method as approved by the Engineer.
- B. Where shown on the Drawings, pipe bends shall be supported using concrete anchor posts. Pipes shall be securely fastened to the concrete supports with suitable metal bands as required and approved by the Engineer. A felt insert shall be used to isolate the piping from the poured concrete.

#### 2.06 VERTICAL PIPE SUPPORTS

- A. Where vertical pipes are not supported by a Unistrut system as specified in Paragraph 2.08 below, they shall be supported in one of the following methods.
  - 1. For pipes 1/4-in to 2-in in diameter, an extension hanger ring shall be provided with an extension rod and hanger flange. The rod diameter shall be as recommended by the manufacturer for the type of pipe to be supported. The hanger ring shall be steel or PVC clad depending on the supported pipe. The hanger ring shall be equal to Carpenter & Paterson, Figure No. 81 or 81CT. The anchor flange shall be galvanized malleable iron similar to Carpenter and Patterson, Figure No. 85.
  - 2. For pipes equal to or greater than 2-in in diameter extended pipe clamps similar to Carpenter and Patterson, Figure No. 267 may be used. The hanger shall be attached to concrete structures using double expansion shields, or to steel support members using welding lugs similar to Carpenter and Patterson, Figure No. 220.

3. Pipe riser clamps shall be used to support all vertical pipes extending through floor slabs. Riser clamps shall be steel similar to Carpenter and Patterson, Figure No. 126. Insulation shall be removed from insulated pipes prior to installing riser clamps. Insulation shall not be damaged by clamp installation.
4. Unless otherwise specified, shown, or specifically approved by the Engineer, vertical runs exceeding 12-ft shall be supported by base elbows/tees, clamps, brackets, wall rests and pipe collars, all located as required to ensure a rigid installation.

## 2.07 SPECIAL SUPPORTS

- A. Pipe supports shall be provided for closely spaced vertical piping systems required to provide a rigid installation. The interval of vertical support spacing shall be as specified, but in no case shall vertical interval exceed 10-ft. The support system shall consist of a framework suitably anchored to floors, ceilings or roofs.
- B. Vertical and horizontal supporting members shall be U shaped channels similar to Unistrut, Series P1000. Vertical piping shall be secured to the horizontal members by pipe clamps or pipe straps. All components shall be of steel.
- C. For piping 3-in and smaller, the framework shall be as manufactured by the Unistrut Corporation; Globe-Strut as manufactured by the Metal Products Division of U.S. Gypsum or equal. For piping larger than 3-in, the support frame shall be fabricated from structural steel shapes and secured through the use of expansion anchors.
- D. The assemblies shall be furnished complete with all nuts, bolts and fittings required for a complete assembly including end caps for all unistruts members.
- E. The design of each individual framing system shall be the responsibility of the Contractor. Shop drawings, as specified above shall be submitted and shall show all details of the installation, including dimensions and types of supports. In all instances the completed frame shall be adequately braced to provide a complete rigid structure when all the piping has been attached.
- F. Supports not otherwise described in this Section shall be fabricated or constructed from standard structural steel shapes in accordance with applicable provisions of Section 05500, or unistrut-type frame; have anchor hardware similar to items previously specified herein, shall meet the minimum requirements listed below and be subject to the approval of the Engineer.
  1. Pipe support systems shall meet all requirements of this Section and all related Sections.
  2. The pipe support system shall not impose loads on the supporting structures in excess of the loads for which the supporting structure is designed.

## 2.08 SURFACE PREPARATION AND SHOP PRIME PAINTING

- A. All surfaces shall be prepared and shop painted as part of the work of this Section. Surface preparation and shop painting shall be as specified in Section 09901.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Proceed with the installation of piping and supports only after any building structural work has been completed and new concrete has reached its 28-day compressive strength.
- B. The installation of pipe support systems shall in no way interfere with the operation of the overhead bridge cranes, monorails, access hatches, etc.
- C. The installed systems shall not interfere with maintenance and operational access to any equipment installed under this Section, or any other related Section.
- D. All pipes horizontal and vertical, requiring rigid support shall be supported from the building structure by approved methods. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or as specified herein. No piping shall be supported from metal stairs, ladders and walkways unless specifically directed or authorized by the Engineer.
- E. All pipe supports shall be designed with liberal strength and stiffness to support the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement and pressure forces, thermal expansion and contraction, vibrations and all probable externally applied forces. Prior to installation, all pipe supports shall be approved by the Engineer.
- F. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings and sleeve type couplings (within four pipe diameters) and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.
- G. Inserts for pipe hangers and supports shall be installed on forms before concrete is placed. Before setting these items, all Drawings and figures shall be checked which have a direct bearing on the pipe location. Responsibility for the proper location of pipe supports is included under this Section.
- H. Continuous metal inserts shall be embedded flush with the concrete surface.
- I. Apply anti-seize compound to all nuts and bolts. Supports installed without the approved compound shall be dismantled and correctly installed, at no additional cost to the Owner.

### 3.02 TESTING

- A. All pipe support systems shall be tested for compliance with this Section. After installation, each pipe support system shall be tested in conjunction with the respective piping pressure tests. If any part of the pipe support system proves to be defective or inadequate, it shall be repaired or augmented under this Section to the satisfaction of the Engineer.

END OF SECTION

SECTION 15400  
PLUMBING – GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, services and incidentals required and install and test a complete plumbing system as specified and shown on the following:
  - 1. Specifications
    - 15400 Plumbing - General Provisions
    - 15600 Fuel System
  - 2. Drawings
    - P-1 Plumbing Notes and Abbreviations
    - P-2 Standby Generator Fuel Piping Plan
    - PD-1 Fuel System Details
- B. More specifically the work shall include, but shall not be limited to, the following:
  - 1. All items included under the Scope of Work of other Plumbing Sections.
  - 2. Cutting, coring and rough patching in accordance with Section 01045.
  - 3. All parts necessary to make a complete Plumbing System ready for continuous operation.
  - 4. The absence of pipe supports and details on the Drawings shall not relieve the Construction Contractor of the responsibility for providing them.

1.02 RELATED WORK

- A. The following work related to, but not covered under the plumbing work will be done under other related Sections.
  - 1. All piping systems in the building other than the plumbing work specified in the Plumbing Sections.
  - 2. Yard piping for sanitary drains beyond 5-ft-0-in outside the building unless otherwise indicated.
  - 3. Source for potable and protected water services shall terminate as hereinafter specified.
  - 4. Valve tags are furnished under Division 1, but installed on Plumbing items under this Section.
  - 5. Excavating and backfilling is included under Division 2.
  - 6. Sump pit frames and covers not specified under the plumbing work will be included under Division 5.

7. Manholes, catch basins, gasoline trap and buried pipe encasement are included under Division 2.
8. Concrete is included under Division 3.
9. Painting is included under Division 9.
10. Portable fire extinguishers are included under Division 10.
11. Ductwork is included elsewhere in Division 15.
12. Electrical work is included under Division 16.

### 1.03 SUBMITTALS

- A. Inspection by the Engineer's representative or failure to inspect shall not relieve the Construction Contractor of responsibility to provide materials and perform the work in accordance with the documents.
- B. Submit, in accordance with Section 01300, shop drawings and product data to establish compliance with this Section. Submittals shall include the following:
  1. Shop drawings and technical literature covering details of all plumbing piping systems, equipment, fixtures and accessories being furnished under this Section prior to fabrication, assembly or shipment.
  2. Provide a recommended list of spare parts to be provided.
  3. Furnish no less than 60 days before start-up, a schedule of all exposed valves installed under this Section. The schedule shall include for each valve the location, type, a number, words to identify the valve function, and the normal operating position.
  4. Detailed layout drawings of all piping shall be provided. Drawings shall show the locations of piping appurtenances, specialties, and all valve banks.
  5. For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit.
  6. Provide manufacturers catalogs, literature, and engineering data on all hangers and supports. Load ratings, materials, and installation shall be in accordance with the recommendations of MSS SP-58 and MSS SP-69.
  7. All submittals shall contain a statement that Section 15400, 15600, and all other referenced Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Construction Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.
- C. Operation and Maintenance Data
  1. Operating and maintenance manuals shall be furnished to the Engineer as provided in 01730. The manuals shall be prepared specifically for this installation and shall include all

required cuts, drawings, equipment lists, descriptions, etc, that are required to assist operation and maintenance personnel unfamiliar with such equipment. The following information shall be considered a minimum. Where applicable, provide information required for specific pieces of equipment.

- a. Personnel familiar with the operation and maintenance of the specific information shall prepare manuals.
  - b. Equipment shall be identified with the Engineers Equipment Numbers and Identification as shown in the Schedules and on the Drawings.
2. Contents - Each volume shall contain the following minimum contents:
    - a. Installation including instructions for unpacking, installing, aligning, checking and testing. Foundation data, allowable piping loads, and electrical design shall be included.
    - b. Operating Instructions to provide pre-operational checks, start up and shut down, and description of all control modes. Include emergency procedures for all fault conditions and actions to be taken for all alarms. Procedures for long term storage shall be included.
    - c. Maintenance shall include preventive, and corrective. Schedules for test of other functions are to be included. Provide a list of tools required to service the equipment. Trouble shooting instructions to include a trouble-shooting guide shall be included.
  3. Spare Parts List
  4. Shop Drawing Data to include performance curves, data sheets, flow diagrams, wiring diagrams, and descriptive drawings.

- D. In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

#### 1.04 MANUFACTURERS SERVICES

- A. A representative of the manufacturer who has complete knowledge of proper operation and maintenance shall be provided for the number of 8 hour days as listed below to instruct representatives of the Owner and the Engineer on proper operation and maintenance. With the Owner's permission, this work may be conducted in conjunction with the inspection and the installation and test run as provided under Part 3. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no additional cost to the Owner.

#### 1.05 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
- B. American National Standards Institute (ANSI)
- C. American Water Works Association (AWWA)
- D. National Fire Protection Association (NFPA)

- E. National Electrical Manufacturers Association (NEMA)
- F. Plumbing and Drainage Institute (PDI)
- G. Cast Iron Soil Pipe Institute (CISP)
- H. Underwriters Laboratories (UL)
- I. Factory Mutual (FM)
- J. American Society of Plumbing Engineers Data Book (May be used as a design guide.)
- K. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.06 QUALITY ASSURANCE

- A. The Construction Contractor shall be fully responsible for the proper execution and performance of the work described herein. It shall be their responsibility to inspect all installation conditions and bring to the attention of the Engineer any conditions which may affect their work adversely. They shall report to the Engineer, prior to commencing any portion of this work, any conditions unsuitable for the installation of their portion of the work.
- B. All products and materials provided for potable water service application under the plumbing sections shall be certified “lead-free”, by an ANSI certified, third party independent organization. The term “lead-free” shall refer to the wetted surface of pipe, fittings, and fixtures in potable water systems that have a weighted average lead content less than or equal to 0.25 percent per the Safe Drinking Water Act (Sec. 1417) amended 1-4-2011 and other equivalent state regulations. Non lead-free materials can be purchased and installed in non-potable water systems.
- C. Mention herein or indication on the Drawings of equipment, materials, operation or methods shall require that each item mentioned or indicated be provided to make a complete system of plumbing ready for continuous operation.
- D. The location of all equipment, fixtures and piping shall be considered as approximate only and the right is reserved by the Engineer to change at any time, before the work is installed, the position of such equipment and piping to meet structural conditions and to provide proper headroom clearance or for other sufficient causes and such changes shall be made without additional expense to the Owner.
- E. Attention is called to the necessity for elimination of transmission of vibration from mechanical equipment to building structures. All equipment, therefore, shall be carefully selected and installed to meet this condition and isolators and water hammer arrestors shall be provided where required.
- F. Instruct such persons as designated by the Owner in the care and use of all plumbing equipment and piping systems installed.
- G. Comply with all the laws, ordinances, codes, rules and regulations of the State, local or other authorities having jurisdiction over any of the work specified herein.

- H. Obtain all required permits and pay all legal fees for the same and in general take complete charge and responsibility for all legal requirements pertaining to this Section of the work.
- I. Requirements set forth in this Section and indicated on the Drawings shall be followed when in excess of the required or minimum regulations.
- J. If any work is performed and subsequent changes are necessary to conform to the regulations, such change shall be made as part of this work at no additional cost to the Owner.
- K. All work shown on the Drawings is intended to be approximately correct to scale, but figured dimensions and detailed drawings shall be followed in every case. The Drawings shall be taken in a sense as diagrammatic. Size of pipes and general method of running them are shown, but it is not intended to show every offset and fitting nor every structural difficulty that may be encountered. To carry out the true intent and purpose of the Drawings all necessary parts to make complete working systems ready for use shall be furnished without extra charge.
- L. Refer to the Structural and Architectural Drawings which indicate the type of construction in which the work shall be installed. Locations shown on the Plumbing Drawings shall be checked against the general and detailed drawings of the construction proper. All measurements must be taken at the building.
- M. All equipment of a given type included in this Section shall be furnished by or through a single manufacturer or as specified on the schedules.
- N. Inspection by the Engineer's representative or failure to inspect shall not relieve the Construction Contractor of responsibility to provide materials and perform the work in accordance with the documents.
- O. The piping manufacturer shall furnish an affidavit of compliance certifying that all materials used and work performed complies with the specified requirements. The Construction Contractor shall provide copies of mill test confirming the type of material used in the various components.
- P. The Owner and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.
- Q. An authorized representative of the manufacturer shall perform the initial startup of the equipment. The Owner and Engineer shall witness startup. The use of local sales representatives to perform this work is not acceptable, unless the manufacturer provides documented evidence that the sales representative has been specifically trained for this work.
- R. All rotating parts of equipment shall be statically and dynamically balanced at the factory.

#### 1.07 ENGINEERING SERVICES

- A. When engineering services are specified to be provided by the Construction Contractor, the Construction Contractor shall retain a licensed professional engineer to perform the work. The engineer shall be licensed at the time the work is done and in the state in which the project is located. If the state issues discipline specific licenses, the engineer shall be licensed in the applicable discipline. In addition, the engineer shall be experienced in the type of work being provided.

- B. All work is to be done according to the applicable regulations for professional engineers, to include signing, sealing and dating documents. When submittals are required by a professional engineer, in addition to state required signing and sealing, a copy of the current wallet card or wall certificate indicating the date of expiration shall be included with the submittal.

#### 1.08 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery.
- B. Delivery schedule of all equipment shall be coordinated with the Construction Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner by the manufacturer.
- C. All materials shall be suitably packed for shipment and long term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.
- D. All equipment shipped that is exposed such as on a flatbed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.
- E. Instructions for the servicing and startup of equipment in long term or prolonged storage shall accompany each item.
- F. All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

#### 1.09 COORDINATION

- A. The Drawings indicate the extent and general arrangement of the systems. If any departures from the drawings or specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted as soon as practical for review. No such departures shall be made without the prior written concurrence of the Engineer.
- B. The Construction Contractor shall coordinate the location and placement of all concrete inserts and welding attachments with the structural engineer.
- C. The Construction Contractor shall assume full responsibility for coordination of the Plumbing systems, including; scheduling, and verification that all structures, piping and the mounting of equipment are compatible.
- D. The Construction Contractor shall start up each piece of equipment and system and shall make all adjustments so that the system is placed in proper operating condition.

#### 1.10 ELECTRICAL EQUIPMENT

- A. Electric motors in NEMA frame sizes shall conform to the requirements in Section 16150, unless otherwise specified herein.

- B. Electrical equipment which is furnished under this Section shall meet the requirements specified in Division 16:
  - 1. Disconnect switches, motor starters and combination motor starters (starters with disconnecting means and short circuit protection) shall be as specified in Section 16191.
  - 2. Cord-connected controls for hazardous areas shall be provided with intrinsically safe relays, which shall be as specified in Section 16191.
  - 3. Raceways, boxes, fittings and supports shall be as specified in Section 16110.
  - 4. Wires and cables shall be as specified in Section 16120.
- C. Electrical enclosures, panels and components shall be suitable for the environment and electrical classification for the space they are located in. The type of enclosure for the various spaces shall be as specified in Division 16. Refer to the electrical drawings for the space classifications.

#### 1.11 SUPPORTS

- A. All components shall be provided with lugs, brackets or field supplied devices to allow the components to be firmly attached to the structure. The lugs, brackets or field supplied devices shall be sized to withstand the seismic and wind loads for the area and type of application.

### PART 2 PRODUCTS (NOT USED)

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. All the items specified in Section 15600 under PART 2 shall be installed according to the applicable manufacturer's recommendations, the details shown on the Drawings and as specified herein and in other related Sections.
- B. The Construction Contractor shall start up each piece of equipment and system and shall make all adjustments so that the system is placed in proper operating condition.
- C. The Construction Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Construction Contractor's risk.
- D. All work shall be installed in accordance with the manufacturer's printed instructions and shall be rigid, plumb and true to line, with all parts in perfect working order. Maintain protective covers on all units until final cleanup time and at that time remove covers and clean and polish all surfaces.

#### 3.02 VALVE TAGS

- A. The work of this Section shall also include the installation of valve tags furnished by the Construction Contractor. All valves provided under this Section shall be tagged.

3.03 PROTECTION

- A. Materials, fixtures and equipment shall be properly protected at all times and all pipe openings shall be temporarily closed so as to prevent obstruction and damage.

3.04 COORDINATION SKETCHES

- A. It shall be the responsibility of the subcontractor to have employed a competent coordinator of mechanical systems and as such to provide all coordination of drawings or sketches as may be required or deemed necessary by the Engineer to obtain the required ceiling heights and eliminate conflicts with all piping, ducts and electrical installation.

END OF SECTION

SECTION 15600  
FUEL SYSTEM

PART 1 GENERAL

1.01 SCOPE

- A. The work of this section includes all labor, materials and equipment required for the installation and testing of the fuel and fuel piping systems complete and ready for operation.
  - 1. The system will include a 5000 gallon above ground fuel storage tank as indicated on the drawings, a complete fuel piping system for the tank and generator, fuel storage tank monitoring systems, concrete pad, and all accessories as indicated for each tank and fuel piping system. The system will convey diesel fuel between the generator and the fuel storage tank.
  - 2. Refer to Section 15400 for additional requirements.

1.02 RELATED WORK

- A. Related work specified in other sections:
  - 1. JEA Water and Sewer Standards Manual Section 472 Emergency Generator (less than 750 KW).
  - 2. Section 16216 - Diesel Engine Driven Generator (Self-Contained With Weatherproof Sound Attenuated Enclosure).
  - 3. Concrete work is included in Division 3.
  - 4. Field painting is included in Division 9.
  - 5. Electrical and Instrumentation work, except as otherwise specified herein, is included in Division 16.

1.03 REQUIREMENTS OF REGULATORY AGENCIES

- A. All work shall conform to the applicable requirements of the city, county, state and federal codes. Where the requirements of such agencies are more stringent than specified herein, abide by such requirements and consider this specification as supplementary to those requirements.
- B. The tank systems including coating and sealants must be accepted by the US Environmental Protection Agency. All work shall conform to the applicable requirements of the following: Federal Register and the Federal Resource Conservation Recovery Act law (RCRA).
- C. All work shall conform to the applicable requirements of the following: National Fire Protection Association (NFPA) 30 - Flammable and Combustible Liquids Code, NFPA 321 - Basic Classification of Flammable and Combustible Liquids, and NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
- D. All work shall conform to the applicable requirements of the following: Department of Environmental Protection, the Florida Building Code, and Local Ordinances.

- E. The tank shall meet the current requirements of Underwriters Laboratories (UL) Standard 142 and UL 2085 and all requirements of the Florida Administrative Code 62-762. All components of the fuel distribution system shall be UL listed, unless otherwise specified, or approved by the Engineer.
- F. The tank and fuel systems shall be designed and fabricated according to best practices and methods available to date.
- G. Electrical Components, Devices, and Accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

#### 1.04 QUALIFICATIONS

- A. Installer shall have had supervisory experience with five similar fuel systems in the past three years and shall hold a valid pollution control contracting license if required by the State of Florida, Department of Environmental Protection or the local jurisdiction. A copy of the license shall be submitted to the Engineer and to the local authorities, prior to proceeding with construction. Written confirmation from the applicable authorities shall be provided to verify that a pollution control contracting license is not required.
- B. Tank installers shall be certified in writing by the tank manufacturer as being qualified to install the equipment. A copy of the certificate shall be submitted, prior to proceeding with construction.

#### 1.05 SUBMITTALS

- A. Complete shop drawings shall be submitted, including certification of shop test to the Engineer for review, in accordance with Section 01300.
  - 1. The shop drawings shall include sufficient information to demonstrate compliance with the specified tank design standards, including copies of applicable sections of the specified design standards, manufacturer's catalog data and descriptive literature for the tank, fully dimensioned shop layout drawing (1/4" = 1' scale or larger) showing all piping, manholes, valves, equipment connections, tank outline dimensions, platform and stair dimensions, nozzle locations and foundation requirements, recommended tank installation and test procedures.
  - 2. The shop drawings for pipe, fittings, and each item listed in the Specifications shall include manufacturer's catalog data and descriptive literature, fully dimensioned shop layout drawing (1/4" = 1' scale or larger) showing all piping, manholes, valves, equipment connections, nozzle locations and installation clearance requirements.
  - 3. Submit all manufacturer's recommended installation and test procedures for all equipment including tanks, piping, etc.
  - 4. Submit manufacturer's Test Reports (vessel fabrication, coating integrity and tank leakage, etc) for each tank and specific service application.
  - 5. Submit manufacturer's warranty for each tank, all fuel components, containment piping and specific service application.

6. Operation and Maintenance Manuals shall be submitted in accordance with Section 01730.

#### 1.06 ENGINEERING SERVICES

- A. When engineering services are specified to be provided by the Contractor, the Contractor shall retain a licensed professional engineer to perform the work. The engineer shall be licensed at the time the work is done and in the state in which the project is located. If the state issues discipline specific licenses, the engineer shall be licensed in the applicable discipline. In addition, the engineer shall be experienced in the type of work being provided.
- B. All work is to be done according to the applicable regulations for professional engineers, to include signing, sealing and dating documents. When submittals are required by a professional engineer, in addition to state required signing and sealing, a copy of the current wallet card or wall certificate indicating the date of expiration shall be included with the submittal.

#### 1.07 PRODUCT HANDLING

- A. Deliver materials and equipment to project site in manufacturer's original, unopened containers with labels intact and legible. Labels shall indicate manufacturer's name and model number. Store equipment in dry protected area. All damaged items shall be replaced with new at no additional cost to Owner.
- B. Piping shall be supplied to the site with sealed end caps which shall remain in place until installation. Tanks shall be delivered to the site with all openings sealed which shall remain in place until installation. The tanks shall be properly supported during transportation to the site and during installation in accordance with the manufacturer's instructions.

### PART 2 PRODUCTS

#### 2.01 ABOVEGROUND FUEL OIL STORAGE TANK AND ACCESSORIES

- A. Rectangular Steel Storage Tank
  1. Steel primary and steel secondary tanks shall be listed by UL as an aboveground tank for flammable and combustible liquids and manufactured in accordance with UL 142 and UL Standard 2085 with a two-hour fire rating.
  2. The steel primary tank shall be fabricated from minimum 3/16-inch thick steel plate.
  3. The tank shall be insulated for fire resistance and protected against ballistic and impact penetration.
  4. Emergency Vent: as required by NFPA 30 with no size reduction allowed for insulation.
  5. Normal Vent: independent of the emergency vent as required by NFPA 30.
  6. Steel Tank Openings: threaded and located in the top of tank.
  7. Steel Tank shall be provided with two (2) lugs for connecting ground conductors for lightning protection in accordance with NFPA 780.
  8. Steel tank shall be pressure tested at the tank factory at 4 psi per UL 142.

9. Secondary steel tank shall be painted with a primer coat and finish coat of an industrial epoxy coating. The coating shall be impervious to diesel fuel, weather resistant, and UV protected.
10. Secondary containment shall be capable of unobstructed liquid and vapor monitoring. Containment space shall be vacuum or pressure tested pursuant to industry standard.
11. The interstitial space between inner and outer tanks shall be filled with light weight thermal insulation or reinforced concrete.
12. Leak detection shall be facilitated by a polyethylene membrane around the primary tank or porous fill material.
13. Integral steel supports shall be provided for the tank.
14. The tank shall have appropriate warning signs as required by the local and state jurisdictions.
15. Steel tank shall have an integral seven gallon UL listed spill containment system, as a part of the tank, with internal reservoir and normally closed UL listed drain port. Spill containment system shall be provided with water tight gaskets at all openings. This includes containment housing cover, fill port cover, drain valve, and stick port cover.
16. The tank shall be placed on reinforced concrete pad made to manufacturer's specifications.
17. Hurricane Restraints and Flood Restraints shall be designed and installed per the requirements of the Florida Building Code with Amendments. Design services shall be provided by a licensed Engineer as described in Paragraph 1.06. Signed and sealed calculations shall be submitted for record purposes.
18. The tank design shall have been in manufacturing production and commercial use for a minimum of five (5) years.
19. The tank shall be Envirovault as manufactured by Phoenix Products, Convault, or AMPS .
20. Tank size shall be 5000 gallons.
21. The fuel tanks shall be left 90 percent full of diesel fuel at the conclusion of the contract as part of the Contractor Scope of Services. Refer to Paragraph 3.05.D.

B. Tank Accessories

1. A mechanical level gauge system shall be provided to indicate the liquid level within the tank. The level gauge shall have a direct reading indicator mounted on top of the tank. The tank shall include all openings required for the level gauge system. Gauge shall be Krueger At-A-Glance Type D Direct Reading Gauge.
2. A mechanical leak gauge system shall be provided to indicate leaks in the annular/interstitial space of the double wall above ground fuel tank. The leak gauge shall have a direct reading indicator mounted on top of the tank. The tank shall include all openings required for the leak gauge system. Gauge shall be Krueger Type D Leak Detection Gauge.

3. Provide stairs with 24" x 24" platform at the top, to provide access to the top of the tank. Stairs shall have handrails on both sides and at all platform sides. Stairs shall be galvanized steel construction and painted with one coat of epoxy corrosion resistant paint, color to be selected by the Owner. Refer to the Drawings for required location of stairs for each tank.
4. The tank fabricator shall provide ports and accessories with the tank as shown on the drawings and listed below.
5. All ports shall be steel pipe with male threaded fittings.
6. All ports except for those with capped accessories shall be provided with threaded caps.
7. The following equipment shall be furnished along with the necessary piping and fittings required to provide a complete diesel fuel piping system.
  - a. Vent piping shall be 3-inches.
  - b. Vent cap shall be 3-inches and shall be constructed of aluminum with removable brass screen, EBW Model 800-203-01.
  - c. A single poppet foot valve, EBW model 75-105-01 shall be installed inside the aboveground tank at the fuel intake line at a location 6" above the bottom of the tank.

#### C. Fuel Level/Leak Monitoring Equipment

1. General
  - a. Furnish a complete electrical monitoring system and associated equipment including but not limited to tank alarm, tank level detection and real time monitoring, tank leak detection, and associated modules for the entire fuel level/leak detection system shown on the drawings and specified herein. The system shall be the Greenleaf Solar Gauge EFG-8000-I with EFC-420.1 4-20mA data converter. The system shall include provisions for remote monitoring of the alarm conditions, tank level detection, and tank leak detection including all required terminals, switches, and transmitters.
  - b. The control unit shall be housed in a NEMA 4 equivalent plastic steel enclosure. All probes and sensors shall be rated for outdoor service.
  - c. The control unit shall be solar powered with battery back-up.
  - d. A minimum of four (4) programmable relay outputs shall be provided. At least one output shall be designated as a common system alarm/fault. The tank level shall be provided with a 4-20 mA outputs for level monitoring each tank at a remote monitoring PLC. Tank manufacturer shall coordinate with the Instrumentation System Supplier to provide all required signals for the Instrumentation System. Refer to instrumentation drawings for additional signal requirements.
  - e. The supplier shall be responsible for coordinating and providing all necessary components for a fully functional fuel level and leak detection monitoring system. Any additional components required for a complete system shall be included whether specifically noted or not.
  - f. Provide complete piping and electrical schematic diagrams for the entire system in the shop drawing submittals.
2. Tank Level Detection
  - a. All necessary tank level detection probes shall be provided. The system shall include provisions for remote monitoring of the level detection system including all required terminals, switches, transmitters, and local wiring.

3. Double Wall Interstitial Leak Sensing
  - a. Double wall interstitial leak sensing shall be capable of detecting the presence of any liquid in the annulus of the aboveground storage tanks.
4. Tank Alarm Horn and Light
  - a. A local audible electronic horn and flashing amber light alarm system shall be furnished to indicate a trouble condition. Horn and light shall be NEMA 4 suitable for outdoor installations.

## 2.02 PIPE AND FITTINGS AND FUEL SYSTEM ACCESSORIES

- A. Fuel, vent, and level gauge piping shall be Schedule 40, Type 316 stainless steel welded in conformance with ASTM A-312 and ASTM A-774 stainless steel socket and butt-weld fittings.
- B. Flexible piping at tank and equipment connections shall be constructed of a seamless flexible plastic liner with corrosion resistant type 316 stainless steel wire braid reinforced cover, stainless steel collars, and stainless steel fittings.
- C. Provide all piping, valves, unions, filters, strainers, and other accessories as shown on the Drawings and/or as required for a complete system.
  1. Fire safe ball valves shall be three-piece design with stainless steel body and end caps, stainless steel ball and stem, reinforced Teflon seats and seals, and socket welded ends. Valves shall be of fire safe design and shall utilize secondary metal seating surfaces to ensure shut-off if the primary seats are destroyed by fire. Fire safe ball valves shall be Contromatics or Jamesbury.
  2. An anti-siphon valve, EBW model 605-300-01 shall be installed at the aboveground tank in the fuel intake line, at a location approximately 6" above the top of the tank, or as required by the valve manufacturer. Valve shall be suitable for the final elevations of the aboveground tank and generator as installed.
  3. Unions shall be Type 316 stainless steel with fully ground faces. Where threaded unions are required, all threaded connections shall utilize Hercules Chemical Company Inc. multipurpose heavy Teflon "Tape Dope" and "Megaloc and/or Real-tuff."
  4. Manual strainers shall be "Y" type, capable of removing solids 0.01-inch diameter and larger. The strainer body shall be Type 316 stainless steel construction and shall conform to the latest revision of ASTM A278 (1993), Class 30. Strainer elements, including woven wire mesh, shall be constructed of stainless steel. The design of the strainer body shall be such that the cleanout plug, and screen may be easily removed to permit inspection and cleaning without disassembly of the inlet and outlet piping. End connections shall be ANSI screwed pipe threads. Provide three spare screen elements for each strainer furnished. The strainers shall be designed for a maximum operating pressure of 150 psig. They shall be as manufactured by GA Industries Inc., Pittsburgh, PA or approved equal.
  5. Refer to Section 16216 for fuel filter and oil water separator.
- D. All piping and supports that are installed outdoors shall be designed and installed to meet wind loadings as required by the Florida Building Code, all other applicable codes, and the requirements of this specification. Design services shall be provided by a licensed Engineer as

described in Paragraph 1.06. Signed and sealed calculations shall be submitted for record purposes.

- E. All piping and tank supports, including hangers, brackets, fasteners, and miscellaneous metals shall be Type 316 Stainless Steel.
- F. Joint compound for steel pipe threaded connections shall be a non-hardening, non-solvent joint sealer.
- G. Fire Suppression Kit:
  - 1. Contractor shall furnish a packaged fire suppression kit including 10 lb. extinguisher with vinyl jacket.
- H. Provide a Core Engineered Solutions Spill Kit, Model EP-SKL-2, Or Equal, including socks, pillows, wipers, mat pads, labels, Emergency Response Guidebook, and instruction manual.
- I. Finish painting shall be provided as specified in Division 9 - Finishes and as specified herein.
  - 1. Tank exterior shall be factory painted prior to shipment. Painting shall be two coats of epoxy powder coating suitable for outdoor corrosive environment and approved by Owner.
  - 2. All non-stainless steel pipe fittings and nipples on the tank shall have a suitable primer and finish coat of epoxy powder coating suitable for outdoor corrosive environment and approved by Owner.
  - 3. All colors to be selected by the Owner.
  - 4. The Contractor shall provide minor field touch-up painting of fuel tank after completed installation. Surface preparation shall be in accordance with factory paint system. Any major defects or damage shall be inspected and repaired by the Manufacturer.
  - 5. One quart of paint and a brush shall be provided to the Owner for field touchup painting.

## PART 3 EXECUTION

### 3.01 INSTALLATION

#### A. General

- 1. Equipment shall be installed in accordance with the manufacturer's recommendations.
- 2. All materials and equipment shall be new and free from defects or damage and shall be installed in accordance with the approved recommendations of the manufacturer to conform to the contract documents. The installation shall be accomplished by workmen skilled in this type of work. Equipment shall be erected in a neat manner, shall be aligned, leveled and adjusted to provide satisfactory operation. Installation shall be such that connection and disconnection of piping and accessories can be readily made and so that all parts are easily accessible for inspection, operation, maintenance and repair. Minor deviations from indicated arrangements to provide proper access may be made.

3. Tank installers shall be certified in writing by the tank manufacturer as being qualified to install the equipment. A copy of the certificate shall be submitted to the local authorities prior to proceeding with construction.
4. Fuel storage tanks shall be grounded.
5. The Contractor shall install all warning and safety signs required by the local Fire Marshal and as specified herein.

B. Fuel Piping

1. All pipes shall be cut accurately to measurements established at the site and shall be worked into place without forcing or bending.
2. Piping shall be installed to minimize the quantity of piping joints. Provide unions and/or flexible connections at all equipment connections.
3. Joints shall be fabricated in accordance with standard industry practices and manufacturer's instructions. All joints shall be welded except where flanged or threaded connections to equipment or valves are required.
4. Aboveground steel piping shall be grounded. Where fittings cause a break in the electrical continuity of the system approval jumpers shall be provided.
5. Refer to Part 2 for requirements for piping mounted outdoors, and for wind restraint requirements.

C. Flexible Fuel Piping

1. Provide flexible piping connectors at all day tank connections, all generator connections, all storage tank connections and all equipment connections.
2. Flexible connections shall be a minimum of 12-inches long or as required for equipment removal or maintenance. Protect flexible connectors where physical damage may occur due to adjacent equipment, other piping, wiring, or where subject to possible damage from operating personnel.

D. Leak and Level Sensor Installation

1. Install all level and leak sensing equipment, monitoring panel interface modules and all wiring, conduit, junction boxes, sealing fittings and other material required for a complete operating system.
2. Install all monitoring equipment in accordance with the manufacturer's instructions including compliance with hazardous locations as defined in the National Electrical Code as locally amended and local codes having jurisdiction.
3. Provide instrument identification (tagging), calibration and manufacturer services.

### 3.02 CLEANING

- A. At the conclusion of the work thoroughly clean all pipelines to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period.
- B. If defective piping or joints are discovered at this time, they shall be repaired or replaced by the Contractor at no cost to the Owner.

### 3.03 PERMITS

- A. Contractor shall contact the local public health department, DEP, and the local building department for necessary inspections and to obtain required operating permits in the Owner's name.
- B. The entire system including the tanks, piping, equipment, and leak detection system shall be inspected and approved by DEP.
- C. Contractor shall obtain written approval of the installation from the local fire official of jurisdiction.

### 3.04 PROTECTIVE COATINGS

- A. Finish painting shall be provided as specified in Division 9 - Finishes and as specified herein.

### 3.05 TESTING

- A. Piping shall be tested in strict accordance with the manufacturer's testing requirements. Piping system shall be tested upon completion of the roughing-in before setting equipment. Piping shall be subjected to an air test of 10 psig maximum. The entire system shall be pressure tested with fuel at 25 psig and proved tight at this pressure for a period of four (4) hours. Defective work or material shall be replaced and retested. The system shall be test plugged or capped prior to testing to prevent test pressure from reaching any equipment or storage tank.
- B. Storage tanks and piping shall be precision tested by a state qualified tester.
- C. Storage tanks shall be pressure tested at 5 psi and all fittings soaped for a period of at least 12 hours prior to placing tanks. Tanks under test pressure shall not be left unattended.
- D. Contractor shall provide fuel for any required testing and retesting. If the fuel subsequently becomes contaminated, Contractor shall dispose of the fuel at no cost to the Owner and in accordance with all DEP regulations. Upon completion of the testing and prior final acceptance of the system, the Contractor shall fill the tanks to 90% of capacity.

END OF SECTION

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SECTION 16000  
ELECTRICAL – GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install complete and make operational, electrical and process instrumentation systems at the JEA Greenland Water Treatment Plant and Well No. 3 as shown on the Drawings and as specified herein.
- B. The work shall include furnishing, installing and testing the equipment and materials specified in other Sections of the Division 16 Specifications and shown on the Drawings.
- C. The work shall include furnishing and installing the following:
  - 1. Electrical service from the Power Company for Well No. 3.
  - 2. Conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions of these specifications.
  - 3. Conduit, wiring and terminations for all field-mounted instruments furnished under other Divisions of these specifications, including process instrumentation primary elements, transmitters, local indicators and control panels. Lightning and surge protection equipment wiring at process instrumentation transmitters. Install vendor furnished cables specified under other Divisions of these specifications.
  - 4. A complete raceway system for the Data Highway Cables and specialty cable systems. Install the Data Highway Cables and other specialty cable systems furnished under Division 13 in accordance with the system manufacturers' installation instructions. Review the raceway layout, prior to installation, with the computer system supplier and the cable manufacturer to ensure raceway compatibility with the systems and materials being furnished. Where redundant cables are furnished, install cables in separate raceways.
  - 5. Conduit, wiring and terminations for variable frequency drives, harmonic filters, transformers and power factor correction capacitors furnished under other Divisions of these specifications.
  - 6. Power wiring for all heating, ventilating, and air conditioning (HVAC) equipment furnished under other Divisions of these Specifications, including power wiring for 120V unit heater motors, thermostats, fan motors, dampers and other HVAC inline unit wiring shown on the Drawings.
  - 7. Furnish and install precast manholes, precast handholes and light pole bases.
  - 8. Furnish and install manhole and handhole frames and covers.
  - 9. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Section shall be furnished at no extra cost.

10. Modifications to existing control systems including installation of auxiliary motor starter contacts, relays, switches, etc., as required to provide the control functions or inputs as shown on the Drawings. Obtain the existing equipment shop drawings from the OWNER before attempting to make any modifications to the existing equipment wiring. Verify all existing wiring and connections for correctness. If record drawings are not available, trace all circuits in the field and develop the wiring diagrams necessary for completion of the work. Document all changes made to the wiring diagrams and return a marked-up set of Record Drawings to the OWNER after the work is complete.
  11. Coordinate the sequence of demolition with the sequence of construction to maintain plant operation in each area. Remove and demolish equipment and materials in such a sequence that the existing and proposed plant will function properly with no disruption of treatment.
  12. Modifications to existing motor control centers, switchboards, panelboards and motor controllers including installation of circuit breakers, etc., or disconnection of circuits as required to provide the power supplies to new and existing equipment to maintain the plant in operation.
  13. Provide Short Circuit, System Protective Device Coordination Analysis and Arch Fault Analysis in accordance with Section 16015.
  14. Perform testing of the electrical equipment in accordance with the requirements of the individual specification sections and in accordance with Section 16950.
  15. Set the electrical protective devices in accordance with NETA standards and in accordance with the protective coordination study.
- D. Each bidder or their authorized representatives shall, before preparing their proposal, visit all areas of the existing site, buildings and structures in which work under this Division is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the site, buildings and structures and noted the locations and conditions under which the work will be performed and that he/she takes full responsibility for a complete knowledge of all factors governing his/her work.
- E. Provide all electrical demolition work associated with the removal of equipment from the existing facilities, including disconnecting and removing all electrical wiring and conduit to equipment being removed under other sections. Survey the existing electrical systems with representatives from other trades prior to performing any demolition work. Identify all conduit and equipment to be removed with tags or paint.
- F. Buildings or structures scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition. Disconnect all electrical power, communications, alarm and signaling systems. Remove only specific electrical equipment noted for removal and turn over to the OWNER. All other miscellaneous electrical materials, equipment, etc, will be demolished and removed from the site as specified in Division 2.
- G. Provide all electrical relocation work associated with the relocation of equipment for the existing and new facilities, including disconnecting all existing wiring and conduits and providing new wiring and conduit to the relocated equipment.

- H. All power interruptions to electrical equipment shall be at the OWNER's convenience with 72 hours (minimum) notice. Each interruption shall have prior approval.
- I. The CONSTRUCTION CONTRACTOR shall maintain the existing plant in operation at all times. Temporary power connections as required shall be provided by the CONSTRUCTION CONTRACTOR at no additional expense to the OWNER. All temporary wiring shall be in accordance with the NEC. Any temporary equipment feeders (120V, 480V) shall be installed in conduit. The CONSTRUCTION CONTRACTOR shall provide to the ENGINEER details, methods, materials etc. prior to making temporary connections. Furnish and install all equipment and materials including control equipment, motor starters, branch and feeder circuit breakers, panelboards, transformers, etc., for temporary power.
- J. Field verify all existing underground electrical conduit, concrete duct banks, manhole, pull boxes, etc. and mechanical piping. The CONSTRUCTION CONTRACTOR shall include in his bid all costs associated with relocation or removal of underground equipment as required for construction of the new facilities.
- K. The CONSTRUCTION CONTRACTOR shall prepare and furnish electrical and instrumentation conduit layout shop drawings for yard electrical, within and under all roads, buildings and structures to the ENGINEER for approval prior to commencing work. Layouts shall include but not be limited to equipment, pull boxes, manholes, conduit routing, dimensioning, methods and locations of supports, reinforcing, encasement, materials, conduit sizing, equipment access, potential conflicts, building and yard lighting, and all other pertinent technical specifications for all electrical and instrumentation conduits and equipment to be furnished. All layouts shall be drawn to scale on 24-in by 36-in sheets. Refer to the SUBMITTALS paragraph within this specification for additional requirements.
- L. The work shall include complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.
- M. A single manufacturer shall provide switchgear, motor control centers, transformers, disconnect switches, panelboards, etc. This manufacturer shall also provide the Electrical Systems Analysis as specified herein.
- N. CONSTRUCTION CONTRACTOR shall provide their own temporary power for miscellaneous power (drills, pumps, etc.). No facility circuits shall be used unless approved in writing by the ENGINEER. Any temporary added shall be removed at job completion.
- O. Complete coordination with other contractors. CONSTRUCTION CONTRACTOR shall coordinate with all other contractors' equipment submittals and obtain all relevant submittals.
- P. Mount control panels, transmitters, process instruments, operator stations, etc. furnished under other Divisions of these specifications.
- Q. Concrete electrical duct encasement, including but not limited to excavation, concrete, conduit, reinforcement, backfilling, grading and seeding is included in Division 16. All work shall be done in accordance with Divisions 2 and 3 of these specifications.

- R. Excavation, bedding material, forms, concrete and backfill for underground raceways; forms and concrete for electrical equipment furnished herein is included in Division 16. All work shall be done in accordance with Divisions 2 and 3 of these specifications.

#### 1.02 RELATED WORK

- A. Excavation and backfilling, including gravel or sand bedding for underground electrical work is specified in Division 2.
- B. Cast in place concrete work, including concrete encasements for electrical duct banks, equipment pads, light pole bases and reinforcing steel, is specified in Division 3.

#### 1.03 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Section 01300, shop drawings for equipment, materials and other items furnished under Division 16.
- B. Shop drawings shall be submitted for the following equipment:
  - 1. Raceways, Boxes, Fittings and Hangers.
  - 2. Wires and Cables.
  - 3. Low Voltage Cable Systems.
  - 4. Miscellaneous Equipment (as specified in Section 16191).
  - 5. Variable Frequency Drives.
  - 6. Panelboards.
  - 7. Lighting Fixtures and Lamps.
  - 8. Switches, Receptacles and Covers.
  - 9. Precast Manholes and Handholes, Frames and Covers.
  - 10. Grounding Hardware and Connections.
  - 11. Diesel Engine Driven Generator.
- C. Submittals shall be required for the following items:
  - 1. Concealed and Buried Conduit Layouts.
  - 2. Preliminary Short Circuit Study.
  - 3. Final Electrical Systems Analysis.
  - 4. Electrical System Testing and Settings Reports.
  - 5. Manufacturer's Service Reports.

- D. The manufacturers name and product designation or catalog numbers shall be submitted for the following material utilized:
  - 1. Testing Equipment.
  - 2. Ground System Resistance Test Equipment.
- E. Check shop drawings for accuracy and contract requirements prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to the Specifications and the Drawings. This statement shall also list all exceptions to the Specifications and the Drawings. Shop drawings not so checked and noted shall be returned.
- F. The ENGINEER's check shall be for conformance with the design concept of the project and compliance with the Specifications and the Drawings. Errors and omissions on approved shop drawings shall not relieve the CONSTRUCTION CONTRACTOR from the responsibility of providing materials and workmanship required by the Specifications and the Drawings.
- G. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.
- H. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "APPROVED AS NOTED - CONFIRM", "APPROVED AS NOTED - RESUBMIT" or "NOT APPROVED".
- I. In addition to manufacturer's equipment shop drawings, submit electrical installation working drawings containing the following:
  - 1. Concealed and buried conduit layouts, shown on floor plans drawn at not less than 1/4-in = 1-ft-0-in scale. The layouts shall include locations of process equipment, motor control centers, transformers, panelboards, control panels and equipment, motors, switches, motor starters, large junction or pull boxes, instruments and any other electrical devices connected to concealed or buried conduits.
  - 2. Plans shall be drawn on high quality paper, size 36-in by 24-in and shall be presented in a neat, professional manner.
  - 3. Concrete floors and/or walls containing concealed conduits shall not be poured until conduit layouts are approved.
- J. Operation and Maintenance Data
  - 1. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Section 01730. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists, etc., to instruct operating and maintenance personnel unfamiliar with such equipment.
  - 2. Manuals shall include the following as a minimum:
    - a. A comprehensive index.
    - b. A complete "As-Built" set of approved shop drawings.
    - c. A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.

- d. A table listing of the "as left" settings for all timing relays and alarm and trip setpoints.
- e. System schematic drawings "As-Built", illustrating all components, piping and electric connections of the systems supplied under this Section.
- f. Detailed service, maintenance and operation instructions for each item supplied.
- g. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
- h. The operating instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.
- i. Complete parts list with stock numbers, including spare parts.

#### 1.04 REFERENCE STANDARDS

- A. Electric equipment, materials and installation shall comply with the latest edition of National Electrical Code (NEC) and with the latest edition of the following codes and standards:
  1. National Electrical Safety Code (NESC)
  2. Occupational Safety and Health Administration (OSHA)
  3. National Fire Protection Association (NFPA)
  4. National Electrical Manufacturers Association (NEMA)
  5. American National Standards Institute (ANSI)
  6. Insulated Cable Engineers Association (ICEA)
  7. Instrument Society of America (ISA)
  8. Underwriters Laboratories (UL)
  9. Factory Mutual (FM)
  10. International Electrical Testing Association (NETA)
  11. Institute of Electrical and Electronic Engineers (IEEE)
- B. All electrical equipment and materials shall be listed by Underwriter's Laboratories, Inc., and shall bear the appropriate UL listing mark or classification marking. Equipment, materials, etc. utilized not bearing a UL certification shall be field or factory UL certified prior to equipment acceptance and use.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 PRIORITY OF THE CONTRACT DOCUMENTS

- A. If, during the performance of the work, the CONSTRUCTION CONTRACTOR finds a conflict, error or discrepancy between or among one or more of the Sections or between or among one or more Sections and the Drawings, furnish the higher performance requirements. The higher performance requirement shall be considered the equipment, material, device or

installation method which represents the most stringent option, the highest quality or the largest quantity.

- B. In all cases, figured dimensions shall govern over scaled dimensions, but work not dimensioned shall be as directed by the ENGINEER and work not particularly shown, identified, sized, or located shall be the same as similar work that is shown or specified.
- C. Detailed Drawings shall govern over general drawings, larger scale Drawings take precedence over smaller scale Drawings, Change Order Drawings shall govern over Contract Drawings and Contract Drawings shall govern over Shop Drawings.
- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the CONSTRUCTION CONTRACTOR, unless otherwise directed by the ENGINEER.
- E. In accordance with the intent of the Contract Documents, the CONSTRUCTION CONTRACTOR accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the CONSTRUCTION CONTRACTOR's responsibility to comply with all Laws and Regulations at all times.

#### 1.06 ENCLOSURE TYPES

- A. Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:
  - 1. NEMA 1 for dry, non-process indoor locations.
  - 2. NEMA 12 for "DUST" locations.
  - 3. NEMA 4X for outdoor locations, rooms below grade (including basements and buried vaults), "DAMP" and "WET" and "PROCESS" locations.
  - 4. NEMA 4X for "CORROSIVE" locations.
  - 5. NEMA 7 (and listed for use in the area classifications shown) for "Class I Division 1 Group D", "Class I Division 2 Group D" and "Class II Division 1" hazardous locations shown on the Drawings.

#### 1.07 SERVICE AND METERING (WELL NO. 3)

- A. The power company serving this project is JEA. Service will be obtained at 480/277 Volts, 3 Phase, 4 Wire, wye-grounded, 60 Hz to the service entrance equipment as shown on the Drawings. Pay all fees and charges as required to obtain temporary and permanent service. Coordinate with JEA to provide and meet requirements for these services. The CONSTRUCTION CONTRACTOR shall pay for costs associated with obtaining the permanent service from Power Company via bid allowance. Upon activation of permanent service, the

OWNER shall pay monthly power company charges for permanent service. Monthly power company charges for temporary power service shall not be payable via bid allowance. CONSTRUCTION CONTRACTOR will coordinate with Power Company for both temporary and permanent service.

- B. Furnish and install the primary conduits as required and secondary service conduit, wire, connectors, etc. to extend the service to the service entrance location.
- C. The power company will be responsible for the following work:
  - 1. Furnishing and installing primary cables.
  - 2. Furnishing and installing transformer.
  - 3. Termination of underground primary cables within primary distribution system.
  - 4. Termination of underground primary cables at the transformer.
  - 5. Termination of underground secondary cables at the transformer.
- D. The CONSTRUCTION CONTRACTOR shall be responsible for the following work:
  - 1. Make all arrangements with the power company for obtaining electrical service.
  - 2. Furnishing and installing the primary conduits.
  - 3. Furnishing and installing the transformer pad and grounding.
  - 4. Furnishing secondary conduits and cables.

#### 1.08 HAZARDOUS AREAS

- A. Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NEC Articles 500, 501, 502, 503, 504 and 510.
- B. Equipment and materials installed in hazardous areas shall be UL listed for the appropriate hazardous area classification.

#### 1.09 CODES, INSPECTION AND FEES

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

#### 1.10 ELECTRICAL SYSTEMS ANALYSIS

- A. Provide the electrical system analyses in accordance with Section 16015.
  - 1. Provide a preliminary short circuit and coordination analysis prior to the initial submittal of the electrical service switchgear submittal to confirm the equipment being provided new and the existing equipment are appropriately rated for the short circuit duty available and to

ensure that the protective devices being provided properly coordinate among themselves and with the existing installed equipment.

2. Provide a final short circuit, protective devices coordination and arc flash analysis to be used for setting the protective devices and for providing the appropriate safety arc flash labeling on all equipment, existing and new. In addition, the final analysis report will be used by the OWNER as a bench mark for setting and testing protective devices in the future.

#### 1.11 ELECTRICAL SYSTEM TESTING AND SETTINGS

- A. Test and provide settings for systems and equipment furnished under Division 16 in accordance with Section 16950 "Electrical Testing and Settings" and the individual equipment sections for additional specific testing requirements. If the testing results are not within acceptable limits repair or replace all defective work and equipment at no additional cost to the OWNER.
- B. Make adjustments to the systems furnished under Division 16 in accordance with the equipment manufacturers requirements/recommendations and the system coordination study specified in Section 16015.

#### 1.12 INTERPRETATION OF DRAWINGS

- A. The Drawings are not intended to show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.
- B. Install each 3 phase circuit in a separate conduit unless otherwise shown on the Drawings.
- C. Unless otherwise approved by the ENGINEER, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.
- D. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation.
- E. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation. Any adjustments required in the field shall be provided at no additional cost to the OWNER and coordinated and approved by the ENGINEER.
- F. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the CONSTRUCTION CONTRACTOR and approved by the ENGINEER during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the ENGINEER and furnish all labor and materials necessary to complete the work in an approved manner.
- G. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of the approved equipment at no additional cost to the OWNER.
- H. Redesign of electrical or mechanical work, which is required due to the CONSTRUCTION CONTRACTOR's use of an alternate item, arrangement of equipment and/or layout other than

specified herein, shall be done by the CONSTRUCTION CONTRACTOR at his/her own expense. Redesign and detailed plans shall be submitted to the ENGINEER for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.

- I. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by ½-inch spacers to provide a clearance between wall and equipment.
- J. All floor mounted electrical equipment shall be placed on 4-inch thick (¾-inch, 45-degree chamfer at all exposed edges) concrete pads, provide reinforcement, anchors, etc.
- K. The CONSTRUCTION CONTRACTOR shall harmonize the work of the different trades so that interferences between conduits, piping, equipment, architectural and structural work will be avoided. All necessary offsets shall be furnished so as to take up a minimum space and all such offsets, fittings, etc., required to accomplish this shall be furnished and installed by the CONSTRUCTION CONTRACTOR without additional expense to the OWNER. In case interference develops, the ENGINEER is to decide which equipment, piping, etc., must be relocated, regardless of which was installed first.
- L. Raceways and conductors for the fire alarm and lightning protection systems are not shown on the Drawings. Provide raceways and conductors as required by the system manufacturer for a complete and operating system. Raceways shall be installed concealed in all finished spaces and may be installed exposed or conducted in process spaces.
- M. Raceways and conductors for lighting, switches, receptacles and other miscellaneous low voltage power and signal systems as specified are not shown on the Drawings. Raceways and conductors shall be provided as required for a complete and operating system. Homeruns, as shown on the Drawings, are to assist the CONSTRUCTION CONTRACTOR in identifying raceways to be run exposed and raceways to be run concealed. Raceways shall be installed concealed in all finished spaces and may be installed exposed or concealed in all process spaces. Raceways installed exposed shall be near the ceiling or along walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes hoists, monorails, equipment hatches, doors, windows, etc. Raceways installed concealed shall be run in the center of concrete floor slabs, above suspended ceilings, or in partitions as required.

#### 1.13 PHASE BALANCING

- A. The Drawings do not attempt to balance the electrical loads across the phases. Circuits on motor control centers and panelboards shall be field connected to result in evenly balanced loads across all phases.
- B. Field balancing of circuits shall not alter the conductor color coding requirements as specified in Section 16120.

#### 1.14 SIZE OF EQUIPMENT

- A. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.

- B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

#### 1.15 RECORD DRAWINGS

- A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings".
- B. Record Drawings shall accurately show the installed condition of the following items:
  - 1. One-line Diagram(s).
  - 2. Equipment elevations (front views).
  - 3. Raceways and pullboxes.
  - 4. Conductor sizes and conduit fills.
  - 5. Panel Schedule(s).
  - 6. Control Wiring Diagram(s).
  - 7. Lighting Fixture Schedule(s).
  - 8. Lighting fixture, receptacle and switch outlet locations.
  - 9. Underground raceway and duct bank routing.
  - 10. Plan view, sizes and locations of switchgear, distribution transformers, substations, motor control centers and panelboards.
- C. Submit a schedule of control wiring raceways and wire numbers, including the following information:
  - 1. Circuit origin, destination and wire numbers.
  - 2. Field wiring terminal strip names and numbers.
- D. In addition to the schedule, provide point-to-point connection diagrams showing the same information submitted in the schedule of control wiring raceways including all designations and wire numbers.
- E. Submit the record drawings, schedule of control wiring raceways and wire numbers and the point-to-point connection diagrams to the ENGINEER. The schedule of control wiring raceways and wire numbers and the point-to-point connection diagrams shall be computer generated (i.e., no hand-written or drawn schedules, drawings, or diagrams will be accepted).

#### 1.16 EQUIPMENT INTERCONNECTIONS

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

#### 1.17 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be new, except where specifically identified on the Drawings to be re-used.
- B. Material and equipment of the same type shall be the product of one manufacturer and shall be UL listed.
- C. Warrant all equipment furnished under Division 16 in accordance with Section 01740. Refer to individual equipment sections for additional warranty items.

#### 1.18 EQUIPMENT IDENTIFICATION

- A. Identify equipment (disconnect switches, separately mounted motor starters, control stations, etc.) furnished under Division 16 with the name of the equipment it serves. Motor control centers, control panels, panelboards, transformers, switchboards, switchgear, junction or terminal boxes, transfer switches, etc., shall have nameplate designations as shown on the Drawings.
- B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high white letters on a black background.
- C. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using an epoxy or similar permanent waterproof adhesive. Two sided foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate, the nameplate shall be permanently fastened to the adjacent mounting surface. Cemented nameplates shall not be drilled.
- D. All voltages (e.g. 208 volts, 480 volts, etc.) within pull boxes, junction boxes etc. shall be identified on the front exterior cover. Signs shall be red background with white engraved lettering, lettering shall be a minimum of 1" high.
- E. All receptacles, wall switches, lighting fixtures, photo cells, emergency lights, exit lights, etc. shall be identified with the panel and circuit to which it is connected. Identification shall be with machine generated labels with 1/4" high letters.

#### 1.19 DEMOLITION

- A. Remove electrical work associated with equipment scheduled for demolition except those portions indicated to remain or be reused.
- B. Remove unused exposed conduit and wiring back to point of concealment including abandoned conduit above accessible ceiling finishes. Remove unused wiring in concealed conduits back to source (or nearest point of usage).

- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide stainless steel blank covers for abandoned outlets which are not removed.
- D. Disconnect and remove abandoned panelboards, transformers, disconnect switches, control stations, distribution equipment, etc.
- E. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers and other accessories.
- F. Disconnect electrical circuits in the way of demolition work and re-establish circuits to remaining outlets, fixtures, equipment, etc. Disconnect electrical systems in walls, floors and ceilings scheduled for removal.
- G. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- H. New lighting shall be in place or safe lighting levels maintained for plant operation during the construction period.
- I. Repair adjacent construction and finishes damaged during demolition and extension work.
- J. Where electrical systems pass through the demolition areas to serve other portions of the premises, they shall remain or be suitably relocated and the system restored to normal operation.
- K. Coordinate outages in systems with the OWNER. Where duration of proposed outage cannot be allowed by the OWNER, provide temporary connections as required to maintain service.
- L. Removal and relocation of existing conduit, wire and equipment have not been detailed on the Drawings. Survey the affected areas before submitting bid proposal.
- M. Trace out existing wiring that is to be relocated, or removed and perform the relocation or removal work as required for a complete operating and safe system.
- N. Continuous service is required on all circuits and outlets affected by these changes, except where the OWNER will permit an outage for a specific time. Obtain OWNER's consent before removing any circuit from continuous service.
- O. Remove exposed conduits, wireways, outlet boxes, pull boxes and hangers made obsolete by the alterations, unless specifically designated to remain. Patch surfaces and provide stainless steel blank covers for abandoned outlets which are removed.
- P. All equipment, materials, controls, motor starters, branch and feeder breakers, panelboards, transformers, wiring, raceways, etc., furnished and installed to temporarily keep circuits energized shall be removed when the permanent installation is fully operational.
- Q. Electrical Removal
  - 1. All existing electrical equipment and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to maintain the integrity of the grounding systems.

2. Conduits and wires shall be abandoned or removed where shown. All wires in abandoned conduits shall be removed, salvaged and stored. Abandoned conduits concealed in floor or ceiling slabs or in walls, shall be cut flush with the slab or wall at the point of entrance. The conduits shall be suitably plugged and the area repaired in a flush, smooth and approved manner. Exposed conduits and their supports shall be disassembled and removed from the site. Repair all areas of work to prevent rust spots on exposed surfaces.
3. Wall switches, receptacles, and other miscellaneous electrical equipment, shall be removed and disposed of off the site as required. Care shall be taken in removing all equipment so as to minimize damage to architectural and structural members. Any damage incurred shall be repaired.

#### 1.20 DISPOSITION OF REMOVED MATERIALS AND EQUIPMENT

- A. In general, it is intended that material and equipment indicated to be removed and disposed of by the CONSTRUCTION CONTRACTOR shall, upon removal, become the CONSTRUCTION CONTRACTOR's property and shall be disposed of off the site by the CONSTRUCTION CONTRACTOR, unless otherwise directed by the OWNER. Any fees or charges incurred for disposal of such equipment or materials shall be paid by the CONSTRUCTION CONTRACTOR. A receipt showing acceptable disposal of any legally regulated materials or equipment shall be given to the OWNER.
- B. Ballasts in each existing lighting fixture shall be assumed to contain PCB's unless specifically marked with a label indicating "No PCBs". Remove ballasts from each lighting fixture and pack them in accordance with EPA PCB regulations. Ship ballasts in approved containers to an EPA approved recycling facility and pay all shipping, packaging and recycle costs.

#### 1.21 SAFETY REQUIREMENTS

- A. The CONSTRUCTION CONTRACTOR shall make every effort to keep all employees and/or subcontractors aware of the danger inherent in working in dangerous proximity to the existing power lines. The minimum recommended precautionary measures are as follows:
  1. Make sure that all persons responsible for operating cranes, draglines and other mobile equipment have a copy of, and are familiar with the State Department of Commerce Regulations for Use of Cranes, Draglines and Similar Equipment Near Power Lines, as well as the U.S. Department of Labor OSHA Regulations, before commencing operation of said equipment.
  2. Make sure that all cranes, draglines and other mobile equipment have attached to them the black and yellow Department of Commerce warning signs required by the said Regulations of State Department of Commerce.
  3. Warn all employees on the ground, new and old employees alike, of the danger of holding on to or touching a cable or other piece of equipment or machinery that is located or working close to any overhead power line.
  4. If, during the course of construction, it becomes necessary for the CONSTRUCTION CONTRACTOR, or subcontractor, and their employees, to operate cranes, draglines, or their mobile equipment, in dangerous proximity of any overhead power lines, or in such a manner that such equipment might come close to any overhead power lines, the

CONSTRUCTION CONTRACTOR shall give the Power Company or overhead power line owner prior notice of such proposed operation.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 SLEEVES AND FORMS FOR OPENINGS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.
- B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.
- C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the ENGINEER may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.
- D. Seal all openings, sleeves, penetration and slots as specified in Section 16110.

### 3.02 CUTTING AND PATCHING

- A. Cutting and patching shall be done in a thoroughly workmanlike manner and be in compliance with modifications and repair to concrete as specified in Section 01045. Sawcut concrete and masonry prior to breaking out sections.
- B. Core drill holes in existing concrete floors and walls as required.
- C. Install work at such time as to require the minimum amount of cutting and patching.
- D. Do not cut joists, beams, girders, columns or any other structural members.
- E. Cut opening only large enough to allow easy installation of the conduit.
- F. Patching to be of the same kind and quality of material as was removed.
- G. The completed patching work shall restore the surface to its original appearance or better.
- H. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.
- I. Remove rubble and excess patching materials from the premises.
- J. When existing conduits are cut at the floor line or wall line, they shall be filled with grout of suitable patching material.

### 3.03 INSTALLATION

- A. Any work not installed according to the Drawings and this Division or without approval by the ENGINEER shall be subject to change as directed by the ENGINEER. No extra compensation will be allowed for making these changes.
- B. Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. Electrical equipment shall not be stored out-of-doors. Electrical equipment shall be stored in dry permanent shelters. If an apparatus has been damaged, such damage shall be repaired at no additional cost. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the OWNER, the damaged unit(s) or systems shall remain on site and returned to the manufacturer after the replacement unit(s) or systems have been delivered to the site. Under no circumstances will electrical equipment damaged by water be rehabilitated or repaired, new equipment shall be supplied and all cost associated with replacement shall be borne by the CONSTRUCTION CONTRACTOR.
- C. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the ENGINEER's discretion.
- D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted per the field painting requirements Section 09902, at no additional cost to the OWNER.

### 3.04 MANUFACTURERS SERVICE

- A. Provide manufacturer's services for testing and start-up of the following equipment:
  - 1. Variable Frequency Drives (   4   days   2   trips minimum)
  - 2. Diesel Engine Driven Generator (   4   days   2   trips minimum)
- B. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturers warranty repairs.
- C. The manufacturers of the above listed equipment shall provide experienced Field Service Engineer to accomplish the following tasks:
  - 1. The equipment shall be visually inspected upon completion of installation and prior to energization to assure that wiring is correct, interconnection complete and the installation is in compliance with the manufacturer's criteria. Documentation shall be reviewed to assure that all Drawings, operation and maintenance manuals, parts list and other data required to check out and sustain equipment operation is available on-site. Documentation shall be red-lined to reflect any changes or modifications made during the installation so that the "as-built" equipment configuration will be correctly defined. Spare parts shall be inventoried to assure correct type and quantity.
  - 2. The Field Service Engineers shall provide engineering support during the energization and check-out of each major equipment assembly. They shall perform any calibration or adjustment required for the equipment to meet the manufacturer's performance specifications.

3. Upon satisfactory completion of equipment test, they shall provide engineering support of system tests to be performed in accordance with manufacturer's test specifications.
4. A final report shall be written and submitted to the CONSTRUCTION CONTRACTOR within fourteen days from completion of final system testing. The report shall document the inspection and test activity, define any open problems and recommend remedial action. The reports after review by the CONSTRUCTION CONTRACTOR shall be submitted to the ENGINEER.

### 3.05 TRAINING

- A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment specified under Division 16.
  1. Variable Frequency Drives (\_\_\_1\_\_\_ days \_\_\_1\_\_\_ trips minimum)
  2. Diesel Engine Driven Generator (\_\_\_1\_\_\_ days \_\_\_1\_\_\_ trips minimum)
- B. The cost of training programs to be conducted with OWNER's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.
- C. Provide detailed O&M manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.
- D. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance including trouble-shooting of each system.
- E. All training schedules shall be coordinated with and at the convenience of the OWNER. Shift training may be required to correspond to the OWNER's working schedule. The training shall be conducted with record "as-built" drawings sufficient for a class of eight personnel.
- F. Within 120 days of contract award to the CONSTRUCTION CONTRACTOR, submit an overview of the proposed training plan. This overview shall include, for each course proposed:
  1. An overview of the training plan.
  2. Course title and objectives.
  3. Prerequisite training and experience of attendees.
  4. Recommended types of attendees.
  5. Course Content - A topical outline.
  6. Course Duration.
  7. Course Location - Training center or jobsite.
  8. Course Format - Lecture, laboratory demonstration, etc.
  9. Schedule of training courses including dates, duration and locations of each class.

10. Resumes of the instructors who will actually implement the plan.
- G. The ENGINEER will review the training plan submittal with the OWNER.

END OF SECTION

SECTION 16015  
ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Provide both a preliminary and a final short circuit, selective coordination and arc flash study of the complete electrical distribution system as specified herein and as shown on the Drawings. The study shall include motor starting/running calculations.
- B. Provide both a preliminary and final harmonic study of the complete electrical distribution system as specified herein and as shown on the Drawings.
- C. Obtain and pay for the services of the independent engineering specialty firm, subject to the approval of the ENGINEER, to provide a complete fault current, device evaluation, protective devices selective coordination, arc flash study, harmonic study and motor starting study. The selective coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and including the largest feeder circuit breaker and motor starter in the all low voltage motor control centers and power distribution panelboards. The study shall also include variable frequency drives, harmonic filters, Uninterruptible Power Supplies (UPS), power factor correction equipment, transformers and protective devices associated with emergency and standby generators, and the associated paralleling equipment and distribution switchgear. The arc flash study shall begin with the utility company's feeder protective device and include all of the electrical distribution equipment down to and including low voltage motor control centers and power distribution panelboards and lighting panels. All information required to perform the study shall be obtained by the entity performing the study.
- D. Submit the preliminary short circuit, selective coordination and motor starting/running study prior to submittal of motor control centers, and 480 Volt panelboards shop drawings. The aforementioned shop drawings will not be reviewed until the preliminary power system study is approved by the ENGINEER. No exceptions will be allowed. The preliminary study shall include but not limited to:
  - 1. Short circuit, and protective device coordination and motor starting studies shall be performed on nationally recognized computer software such as SKM System Analysis, EDSA, ETAP, or approved equal.
  - 2. Obtain and verify with the utility company all information needed to conduct the study. Obtain and verify with the OWNER ratings of existing electrical equipment that shall be included in the study.
  - 3. Current transformers' ratio and burden calculations shall be based on a 10 percent maximum ratio error per ANSI C57.13. Identify current transformers that will not allow the protective devices to operate within acceptable ANSI error margins and recommend corrective action.
  - 4. The preliminary study shall verify equipment is being applied within their design ratings and electrical protective devices will coordinate.

5. Recommend changes and/or additions to equipment as required providing adequate protection and coordination based on the actual equipment supplied and the results of the short circuit and protective device selective coordination studies. Submit any such changes and additions as a part of the study. Field settings of devices, adjustments, and minor modifications to equipment that are required to accomplish conformance with the approved short circuit and protective device selective coordination studies shall be carried out by the CONSTRUCTION CONTRACTOR at no additional cost to the OWNER.
- E. After release of electrical equipment by the manufacturer, but prior to energizing the electrical equipment, submit the final short circuit and selective coordination study including all calculations, tabulations, protective devices coordination graphs, etc. as specified herein.
1. Provide a complete short circuit study and protective device selective coordination study for both the utility power distribution system and the emergency/standby power distribution system under the scope of this study. The study shall include but shall not be limited to:
    - a. Full compliance with applicable ANSI and IEEE Standards.
    - b. Performed on nationally recognized computer software such as EDSA, SKM System Analysis, ETAP, or equal.
  2. Provide a report summarizing the selective coordination and motor starting/running study including: one-line diagram of the system, relay and breaker setting tabulation, coordination curves, relay curves, circuit breaker curves, motor starting/running curves, protective device coordination and short circuit calculation, all prepared by the specialty firm.
  3. Recommend changes and/or additions to equipment as required providing adequate protection and coordination based on the actual equipment supplied and the results of the short circuit and protective device selective coordination studies. Submit any such changes and additions as a part of the study. Field settings of devices, adjustments and minor modifications to equipment that are required to accomplish conformance with the approved short circuit and protective device selective coordination studies shall be carried out by the CONSTRUCTION CONTRACTOR at no additional cost to the OWNER.

#### 1.02 RELATED WORK

- A. Section 16950 "Electrical Systems Testing and Setting".
- B. Motors are included under other Divisions and are specified in Section 16150.

#### 1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, the following:
  1. The number of years the specialty firm has been in the business of performing coordination studies.
  2. Identification of each of the three qualifying projects for each of the past three years including:
    - a. A brief description of each study.
    - b. Name of owner of installation on which study was performed with address, telephone number, and contact person.

- c. Date of study.
  - d. Any other information indicating the firm's experiences and ability to perform the work and business status.
- B. Preliminary Short Circuit and Coordination Study Report shall include but not limited to:
  - 1. The coordination study report shall be bound in a standard 8-1/2-in by 11-in size report.
  - 2. Electrical distribution system one-line diagram. One line diagrams shall be legible on printed paper and shall not exceed 11-in x 17-in in size unless required to clearly illustrate the system and related data.
  - 3. Provide detailed "Input Data" report that identifies all input parameters associated with the equipment depicted on the system one line diagrams including but not limited to Utility data, conductor sizes and lengths, protective device sizes and rating, transformer sizes and ratings, motor types and sizes, etc.
  - 4. Provide current transformers' ratio and burden calculations to confirm that the current transformers will not saturate prior to operation of the protective relays and confirming the current transformers used with differential protection will not saturate under any fault condition.
  - 5. Tabulation of each protective device, its short circuit rating, the available fault current available at the device and an indication whether or not the device is adequately rated for the available fault current and voltage at which it is applied.
  - 6. Preliminary graphic time-current curves showing how the protective devices proposed by the equipment suppliers will coordinate as being applied. TCC's shall be produced and printed in color to assist the reviewing engineer in the graphical analysis of the protective device coordination. Each device on a TCC shall be a different color and where devices are shown on multiple TCCs the color for the device shall be constant on each TCC that the devices are shown on.
- C. Final Short Circuit and Selective Coordination Study Report shall include but not limited to:
  - 1. The coordination study report shall be bound in a standard 8-1/2-in by 11-in size report. The selection of all protective relays types, current transformers, fuse types and ratings shall be the responsibility of the manufacturer and shall be based on the preliminary coordination study, which shall be submitted prior to the equipment shop drawings in accordance with Section 01300. The complete study shall be approved by the ENGINEER before any equipment is shipped. The report shall include the following sections and information:
  - 2. An executive summary outlining the distribution system, the information received from the power company, assumptions made to complete the report, statement of the adequacy of the distribution equipment to safely clear any fault currents, the adequacy of the distribution equipment to close in on a fault, identify any problem areas with recommendations for resolving the problem.

3. Electrical distribution system one-line diagram. One line diagrams shall be legible on printed paper and shall not exceed 11-in x 17-in in size unless required to clearly illustrate the system and related data.
  4. Provide detailed "Input Data" report that identifies all input parameters associated with the equipment depicted on the system one line diagrams including but not limited to Utility data, conductor sizes and lengths, protective device sizes and rating, transformer sizes and ratings, motor types and sizes, etc.
  5. Provide current transformers' ratio and burden calculations to confirm that the current transformers will not saturate prior to operation of the protective relays and to confirm the current transformers used with differential protection will not saturate under any fault condition.
  6. Transformer differential protection calculations including current transformer mismatch relay setting and charts. Provide differential current transformer wiring schematics including polarity and wiring connections based on the winding configuration of the actual power transformers being supplied.
  7. Tabulation of all protective devices, circuit breakers, fuses, current transformers, etc. The tabulation shall indicate the device, manufacturer, catalog number, recommended setting, etc.
  8. Industry standard graphic time current, protective relay and protective device curves, showing equipment and material damage curves, relay, circuit breaker, fuse curves, available fault currents at the equipment, transformer inrush currents, etc., for each piece of equipment. TCC's shall be produced and printed in color to assist the reviewing engineer in the graphical analysis of the protective device coordination. Each device on a TCC shall be a different color and where devices are shown on multiple TCCs the color for the device shall be constant on each TCC that the devices are shown on.
  9. Tabulation of each protective device, its short circuit rating the available fault current available at the device and an indication whether or not the device is adequately rated for the available fault current and voltage at which it is applied.
  10. Calculations and required documentation including copies of correspondence with involved entities such as utility fault contribution coordination.
- D. Preliminary Arc Flash Study Report shall include but not limited to:
1. The Arc Flash study report shall be bound in a standard 8-1/2-in by 11-in size report.
  2. An executive summary outlining the distribution system, the information received from the power company, assumptions made to complete the report and recommendations to reduce the arc flash values.
  3. Recommendations to reduce the arc flash incident energy levels.
- E. The Final Arc Flash Study report shall be bound in a standard 8-1/2-in by 11-in size report. The report shall include the following sections and information:

1. An executive summary outlining the distribution system, the information received from the power company, assumptions made to complete the report and recommendations to reduce the arc flash values.
  2. Provide a detailed bus label for each fault location. Each label shall include a listing of the protective device settings and incident energy at several different working distances.
  3. Provide a NFPA 70 E work permit form for each fault location.
  4. Provide labels for each fault location.
    - a. Labels shall be indoor/outdoor rated weather resistant vinyl or polyester with a UV resistant overlamine. The label shall have a minimum thickness of 5 mil. Labels shall be backed with pressure sensitive permanent cold temperature adhesive rated for a minimum 5-year life in the environment in which they are installed.
    - b. The label shall match any pre-existing facility or OWNER specified formatting. The CONSTRUCTION CONTRACTOR shall be responsible for obtaining this formatting information prior to submitting label templates.
    - c. A single label for equipment is acceptable where equipment is continuous. In the event of split busses or equipment not arranged in a continuous fashion, multiple labels shall be provided.
    - d. Line side labels for equipment main breakers shall be included in addition to load side labels.
    - e. Labels shall be DANGER/WARNING type conforming to the NFPA 70E and ANSI Z534.4 standards. Labels are required to have the minimum information specified by these standards printed on them. Labels shall be legible and standard throughout the plant.
    - f. Labels templates shall be provided to the ENGINEER and OWNER for final approval and shall be printed and affixed by the CONSTRUCTION CONTRACTOR. CONSTRUCTION CONTRACTOR shall be responsible for all work required to print and affix the labels to the equipment. Labels shall be affixed in accordance with the direction of the OWNER.
  5. PPE Table – Provide a PPE table that defines the Personnel Protective Equipment classes and clothing descriptions identified in the reports and labels.
- F. Preliminary Harmonic Study Report shall include but not limited to:
1. The harmonic study report shall be bound in a standard 8-1/2-in by 11-in size report.
  2. Electrical distribution system one-line diagram.
  3. Provide the minimum available fault current available from the utility and show the calculations of plant load vs. available fault current to determine the appropriate THD threshold as defined in IEEE 519.
  4. Provide the harmonic parameters assumed for use in the study for the harmonic generating equipment, i.e., VFD units, UPS units, static inverters, Ozone units, etc.

G. Final Harmonic Study Report shall include but not limited to:

1. The harmonic study report shall be bound in a standard 8-1/2-in by 11-in size report. The selection of the harmonic mitigation equipment shall be the responsibility of the manufacturer and shall be based on the preliminary harmonic study, which shall be submitted prior to the equipment shop drawings in accordance with Section 01300. The complete study shall be approved by the ENGINEER before any equipment is shipped. The report shall include the following sections and information:
  - a. An executive summary outlining the distribution system, the information received from the power company, assumptions made to complete the report, document harmonic profile for all harmonic producing equipment.
  - b. Electrical distribution system one-line diagram.
  - c. Recommended parameters for harmonic mitigation equipment, if required. Recommendations shall detail the projected effects of the mitigation effects and shall prove them via a revised harmonic study.
  - d. Calculations and documentation indicated.

H. Submittal of Digital Data and System Model

1. Following final approval of any of the above mentioned studies, the CONSTRUCTION CONTRACTOR shall provide a digital copy of all reports submitted as part of the project. Reports shall not be password protected and shall be free manipulated by the ENGINEER or OWNER.
2. Following final approval of any of the above studies, the CONSTRUCTION CONTRACTOR shall provide the complete digital system model and system library used to build the model and complete the studies. All files needed to accurately recreate the study completed by the CONSTRUCTION CONTRACTOR must be furnished and a backup of the system library used to define all system components must be provided.

1.04 REFERENCED STANDARDS

A. Institute of Electrical and Electronic Engineers, Inc. (IEEE):

1. Plants
2. Standard 241, Recommended Practice for Electrical Power Systems in Commercial Buildings
3. Standard 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Systems
4. Standard 399, Recommended Practice for Industrial and Commercial Power System Analysis
5. IEEE Std. 519- Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems, 1992
6. IEEE Std. 1584- IEEE Guide for Arc Flash Hazard Calculations, 2002
7. NFPA 70E 2012

8. IEEE Std. 242-2001

B. American National Standards Institute (ANSI):

1. Standard C37.90, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
2. Standard C37.91, IEEE Guide for Protective Relay Applications to Power Transformers
3. Standard C37.95, IEEE Guide for Protective Relaying of Utility-Consumer Interconnections
4. Standard C37.96, IEEE Guide for AC Motor Protection
5. Standard C57.12.59, IEEE Guide for Dry-Type Transformer Through-Fault Current Duration
6. Standard C57.13, IEEE Standard Requirements for Instrumentation Transformers
7. Standard C57.109, IEEE Guide for Liquid-Immersed Transformer Through-Fault-Current Duration

1.05 QUALITY ASSURANCE

A. Independent Engineering Specialty Firm's Experience

1. Specialty firm shall have been in the business of the type of work specified, for at least the past five years.
2. The specialty firm shall have a minimum of three projects of equal or greater size, service, with the type of equipment specified for each of the past three years.

B. Specialty firm shall be incorporated in the State, Commonwealth or District, in which the equipment will finally reside and shall have a licensed, in the same jurisdiction, professional engineer as a full time employee, to supervise and seal the report.

C. The specialty firm shall be an independent organization, which can function as an unbiased authority, professionally independent of the manufacturers, suppliers and installers of equipment or systems evaluated by the specialty firm.

D. All electrical studies shall be stamped and signed by a professional electrical engineer. The engineer shall be registered in the State, Commonwealth or District in which the equipment will finally reside.

1.06 SHORT CIRCUIT STUDY

- A. Perform a short circuit study in accordance with ANSI Standards C37.010 and C37.13 to check the adequacy and to verify the correct application of circuit protective devices and other system components within the construction package. The study shall address the case when the system is being powered from the utility source as well as from the on-site generating facilities, normal and alternate (bus tie closed) modes of operation. Minimum and maximum possible fault conditions shall be covered in the study. It shall be the responsibility of the CONSTRUCTION

CONTRACTOR performing the study to determine the operating parameters of the system and to derive the worst case fault conditions. Assumptions of plant operation shall not be allowed.

- B. Consider the fault contribution of all motors operating during the maximum demand condition of the motors.
- C. Calculate short-circuit momentary duties and interrupting duties on the basis of an assumed bolted 3 phase short circuit at each high and medium voltage switchgear bus and controller, low voltage switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard and other significant locations throughout the systems. The short circuit tabulations shall include X/R ratios, asymmetry factors, KVA and symmetrical fault-current. Provide a ground fault current study for the same system areas. Include in tabulations fault impedance, X/R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault-currents.
- D. The studies shall include representation of the site power system, the base quantities selected, impedance source data, calculation methods and tabulations, one-line diagrams, conclusions and recommendations.
- E. Provide the following:
  - 1. The available fault current at each bus within the limits of the study shall be identified and listed.
  - 2. The momentary and interrupting rating of all elements of the distribution system shall be listed. The maximum available fault current available at each element shall be calculated.
  - 3. Determine the adequacy of the electrical protective devices to withstand the maximum available fault at the terminals of the equipment. Provide an equipment list, the equipment rating (both momentary and withstand), the maximum available fault rating and the adequacy of the equipment to withstand the fault. The results shall be tabulated in the form of a PASS/FAIL device evaluation table Equipment that does not have adequate ratings shall be identified immediately and brought to the attention of the ENGINEER.
  - 4. The short circuit portion of the report shall include:
    - a. Executive summary describing the distribution system, the procedures used to develop the study, utility related information furnished by the utility company including the name and telephone number of the individual supplying the information, identify all assumptions made in the preparation of the study, identify any problem areas and provide a definitive statement concerning the adequacy of the distribution system to interrupt and withstand the maximum possible fault current.
    - b. Computer printout of the input data.
    - c. Computer printouts for the three phase and ground fault studies. Printouts shall indicate the fault current available at each major equipment, distribution bus within the high, medium and low voltage distribution systems.
    - d. Table listing all the electrical distribution and utilization equipment (including VFDs), the equipment interrupting and withstand ratings, the available fault current at the terminals of the equipment and the ability of the equipment to interrupt and/or withstand the fault.
    - e. The short circuit study shall be prepared using approved computer software and must include complete fault calculations as specified herein for each proposed and ultimate

source combination. Source combinations may include present and future Power Company supply circuits, large motors, or generators.

F. Automatic Load Transfer

1. Provide a detailed study demonstrating the interrupting capacity of automatic transfer bus ties and switches, as well as the fault withstand capabilities. The following shall be considered:
  - a. X/R ratio fault-current of circuit at point of transfer.
  - b. X/R ratio and fault-current rating of the transfer device.
  - c. Length of time fault may persist prior to protective device opening.
  - d. Magnetic stress withstand rating.
  - e. I<sup>2</sup>t withstand rating.
  - f. Transfer device maximum interrupting duty compared to load interrupting duty.

1.07 PROTECTIVE DEVICE COORDINATION

- A. Provide a protective device time-current coordination study in accordance with ANSI/IEEE Std. 242, with coordination plots of protective devices plus tabulated data, including ratings and settings selected. In the study, balance shall be achieved between the competing objectives of protection and continuity of service for the system specified, taking into account the basic factors of sensitivity, selectivity and speed.
- B. Provide separate plots for each mode of operation: (1) "double-ended mode" (double-ended substation with bus tie open); (2) "singled ended mode" (single incoming utility feeder energized all switchgears single ended with bus ties closed); (3) "stand-by mode" (on-site generation solely providing power to the system); (4) "peak shaving modes" (a.) (double-ended substation with bus tie open with on-site generation paralleled) and (b) (single-ended with bus ties closed with on-site generation paralleled). Show maximum and minimum fault values in each case. Multiple power sources shown in one plot is not acceptable.
- C. Each primary protective device required for a delta-to-wye-connected transformer shall be selected so the characteristic or operating band is within the transformer parameters, which, where feasible, shall include a parameter equivalent to 58 percent of the ANSI C37.91 withstand curve to afford protection for secondary line-to-ground faults. Separate low voltage power circuit breakers from each other and the associated primary protective device, by a 16 percent current margin for coordination and protection in the event of line-to-line faults. Separate the protective relays by a 0.3-second time margin for the maximum 3 phase fault conditions to assure proper selectivity. The protective device characteristics or operating bands shall be terminated to reflect the actual symmetrical and asymmetrical fault-currents sensed by the device. Provide the coordination plots for 3 phase and phase-to-ground faults on a system basis. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center and/or power distribution panelboard. Include all adjustable setting ground fault protective devices.
- D. Select relay types (i.e., inverse, very inverse, extremely inverse, over current with or without voltage restraint, timers, etc.), current transformer ratings and types, fuse, residually or zero sequence connected ground faults protection, etc., that will allow the system to be protected to within the equipment fault ratings and provide the maximum possible coordination between the protective devices.

E. Multifunction Solid State Relays

1. Where multifunction solid state relays are already installed, it shall be the responsibility of the CONSTRUCTION CONTRACTOR to obtain the current and complete list of software setpoints programmed into the device. These setpoints shall be evaluated for potential impacts on the protective device coordination.
2. Where multifunction solid state relays are being install, it shall be the responsibility of the CONSTRUCTION CONTRACTOR to provide all setpoints needed for the specified operation of the relay. These settings include but are not limited to:
  - a. The complete pickup settings of all protective elements specified by the designer and shall not be limited to only the overcurrent pickup settings. Settings for protective elements such as reverse power, synchronization, frequency and voltage control, etc. shall be provided in full.
  - b. Differential pickup and zone settings necessary for the relay to operate as specified and designed and to protect the zone it is intended for. Zone of protection calculations and balance equations shall be completed entirely by the CONSTRUCTION CONTRACTOR based on the equipment as furnished and designed.
  - c. The complete protective relay logic map and logic equations. The relay logic is responsible for translating the pickups of the protective elements into relay output events and device trips. All logic necessary to create the specified output of the relay based on the specified protective elements shall be furnished with the protective device coordination report.
  - d. Any and all miscellaneous settings necessary for the relay to communicate with the installation systems and the mirroring of data to other installation systems as specified or designed.
3. CONSTRUCTION CONTRACTOR shall be responsible for the programming of relays prior to the field testing and start up requirements of this contract. CONSTRUCTION CONTRACTOR shall be responsible for all time needed to complete the relay settings in order to furnish a completely functional system as specified and required by the approved protection device settings.

F. Arc Flash Mitigation and Reduction Modes

1. Where devices are furnished with alternative trip settings intended to mitigate arc flash hazards, the CONSTRUCTION CONTRACTOR shall coordinate these alternative pickup settings and provide representation of their tripping characteristics via TCC's. The alternative pickup settings shall be coordinate with the associated load and shall be set to provide the fastest device response time while avoiding nuisance trips during normal plant operation.

G. Generator Protective Devices

1. The study shall address all of the protective devices provided for generator protection.
2. Protective relays requiring settings shall be included.
3. The Electrical Contractor shall obtain all necessary generator information to perform this study.

H. Motor Protection and Coordination

1. Provide a complete and independent set of current-time characteristic curves for all motors 50 HP and above indicating coordination between the protective relays and the thermal and starting characteristics of the motor.
  2. The CONSTRUCTION CONTRACTOR shall obtain from the motor supplier the necessary information to perform the study. Certified curves for "Safe Time vs. Current at 100% Voltage" and "Accelerating Time vs. Current at 100% Voltage" are necessary and shall become part of the final report.
- I. Call discrepancies to the attention of the ENGINEER in the conclusions and recommendations of the report.
- J. The Time current Characteristic Curves shall include:
1. The coordination plots shall graphically indicate the coordination proposed for the several systems centered on full-scale log forms. The coordination plots shall include complete titles, representative one-line diagrams and legends, associated upstream power system relays, fuse or system characteristics, significant motor starting characteristics, significant generator characteristics, complete parameters for power, and substation transformers, complete operating bands for low voltage circuit breaker trip devices, fuses, and the associated system load protective devices. The coordination plots shall define the types of protective devices selected, together with the proposed coil taps, time-dial settings and pick-up settings required. The short-time region shall indicate the relay instantaneous elements, the magnetizing inrush, and ANSI transformer damage curves, the low voltage circuit breaker and instantaneous trip devices, fuse manufacturing tolerance bands, and significant symmetrical and asymmetrical fault-currents.
  2. No more than six devices shall be shown on one coordination plot. Of these six curves, two (the largest upstream device and the smallest downstream device) shall repeat curves shown on other coordination plots in order to provide cross-reference. Give each curve in the study a study-unique number or letter identifier to permit cross-reference between plots.
  3. The coordinating time interval between primary and back-up protective devices shall be as per Table 15-3, Section 15.6, IEEE Std. 242-2001.
  4. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings. A tabulation shall include settings for every overcurrent protective device, timer, power system relays (e.g., ANSI 25, 27, 32, 67, 87, etc.), circuit breaker, recommended fuse and current transformer ratings, etc. Include C.T. ratio, burden and all other calculations required for the determination of settings. Provide recommended settings for all protective devices furnished under Division 16 and furnished with those furnished with Variable Frequency Drives and associated transformers, generators and associated paralleling and distribution switchgear.

## 1.08 ARC FLASH

- A. Provide an arc flash study that utilizes the fault current values calculated in the short circuit study and the minimum clear times of the upstream protective device selected in the coordination study to calculate the incident energy at each fault location.
- B. The Arc Flash study shall be in accordance with the procedure outlined in NFPA 70E.
- C. Calculate the incident energy levels at each faulted bus for each mode of operation: (1) "double-ended mode" (double-ended substation with bus tie open); (2) "singled ended mode" (single incoming utility feeder energized all switchgears single ended with bus ties closed); (3) "stand-by mode" (on-site generation solely providing power to the system; (4) "peak shaving modes" (a.) (double-ended substation with bus tie open with on-site generation paralleled) and (b) (single-ended with bus ties closed with on-site generation paralleled). Determine arc flash incident energy values for both maximum and minimum fault values in each case.
- D. Extent of Study
  - 1. The arc flash study shall include analysis for all equipment that would normally be serviced while energized and cannot be easily shut down during maintenance periods. The CONSTRUCTION CONTRACTOR shall coordinate with the OWNER to ensure that all equipment that is expected to be analyzed is included in the study. The extent of the analysis includes but is not limited to:
    - a. Switchgear, MCC's and distribution equipment.
    - b. Low voltage lighting panels, even those covered by certain calculation exceptions must be modeled and provided with a unique device label.
    - c. Low voltage control equipment such as 120-600V control panels.
- E. Arc Flash Labels
  - 1. The arc flash study shall produce a single set of label templates that shall not be printed until the final arc flash study has been approved.
  - 2. A single set of labels shall be printed and affixed to the equipment analyzed if the equipment is continuous. Double ended equipment shall have individual labels for each side of the gear. Equipment that is not continuous shall have a single label placed on each piece of continuous gear.
  - 3. Where applicable, LINE and LOAD labels shall be produced for equipment. Examples of equipment that require these labels include the main breakers of switchgear and MCC's. In these cases, the LINE side breakers shall be affixed to indicate the hazard associated with the line side of the equipment and the LOAD label shall be affixed to indicate the hazard associated with the rest of the gear.
  - 4. Labels shall be affixed where they are clearly identifiable with the equipment they depict. Labels shall not obscure any other signage on the equipment unless they are used to completely cover a previous arc flash label.
  - 5. Labels shall meet the following requirements:
    - a. Labels shall be indoor/outdoor rated weather resistant vinyl or polyester with a UV resistant overlamine. The label shall have a minimum thickness of 5 mil. Labels

- shall be backed with pressure sensitive permanent cold temperature adhesive rated for a minimum 5-year life in the environment in which they are installed.
- b. All lettering shall be black and printed via thermal transfer. Backgrounds shall be orange for hazard risk categories 1-4 and red for “Dangerous” areas.
  - c. Where subjected to degrading or corrosive environments, the labels shall be provided with a tinted fiber glass cover.
  - d. The label shall match any pre-existing facility or OWNER specified formatting. The CONSTRUCTION CONTRACTOR shall be responsible for obtaining this formatting information prior to submitting label templates.
  - e. A single label for equipment is acceptable where equipment is continuous. In the event of split busses or equipment not arranged in a continuous fashion, multiple labels shall be provided.
  - f. Line side labels for equipment main breakers shall be included in addition to load side labels.
  - g. Labels shall be DANGER/WARNING type conforming to the NFPA 70E and ANSI Z534.4 standards. Labels are required to have the minimum information specified by these standards printed on them. Labels shall be legible and standard throughout the plant.
  - h. Labels templates shall be provided to the ENGINEER and OWNER for final approval and shall be printed and affixed by the CONSTRUCTION CONTRACTOR. CONSTRUCTION CONTRACTOR shall be responsible for all work required to print and affix the labels to the equipment. Labels shall be affixed in accordance with the direction of the OWNER.
6. CONSTRUCTION CONTRACTOR shall produce all arc flash labels and coordinate affixing them onto all equipment.

F. Arc Flash Mitigation and Reduction Devices

1. Where devices are furnished with alternative trip settings intended to mitigate arc flash hazards, the CONSTRUCTION CONTRACTOR shall provide an alternative arc flash lookup table associated with these alternative settings.
2. Labels shall have only the worst case hazard risk category (without the arc flash reduction settings) depicted. Multiple labels for different device settings shall not be accepted.
3. Devices such as differential protection relays which limit incident energy by limiting the magnitude of the available fault and/or minimizing the fault clearing time may be used to calculate hazard risk categories. The use of these devices in the calculations shall only be permitted where permitted by the standards and code guidelines used to complete the arc flash analysis. If not explicitly stated by the standard as an acceptable method for calculating arc flash hazard, it shall not be permitted.

G. Arc Flash Hazard Mitigation

1. Acceptable hazard risk categories shall be coordinated by the CONSTRUCTION CONTRACTOR between the OWNER and ENGINEER. Where there are no guidelines determining acceptable arc flash levels, the CONSTRUCTION CONTRACTOR shall actively attempt to reduce all hazard risk categories greater than 2. CONSTRUCTION CONTRACTOR shall list all areas greater than category 2 in the conclusion of the report and shall give reasons for the high incident energy.

2. The CONSTRUCTION CONTRACTOR shall be responsible for proposing and evaluating arc flash mitigation measure including but not limited to:
  - a. Adjustment of protective devices in an attempt to better balance the system coordination and the incident energy available to an arcing fault.
  - b. Equipment that could be used to physically remove the operator from the arc flash hazard boundary (mimic panels, remote switching/racking).
  - c. Equipment that could be used to limit the amount of incident energy or reduce the protective device pickup time (maintenance mode bypass, differential relaying).
3. Proposing and evaluating these arc flash mitigation measures shall include evaluating the cost and implementation of the options as well as reevaluating and reporting the hazard risk category associated with their installation.

#### 1.09 MOTOR STARTING/RUNNING

- A. Provide a motor starting study for all electric motors rated above 100 HP to determine voltage dip or power inrush limitations at selected locations due to starting of motors. Include in the study problems created by reclosing of Power Company feeders in 20 cycles with a dead time of 15 cycles. Provide relay protection on breakers as the study recommends.
- B. The motor starting/running study shall provide a voltage profile for the complete electrical distribution system. At a minimum, the voltage profile shall include voltage values at the utility service point, each switchgear/switchboard bus, each motor control center and at the terminals of each motor identified in Paragraph 1.08A.
- C. A complete voltage profile shall be provided for each of the following operating conditions:
  1. All tie circuit breakers open with electrical distribution system operating double-ended.
    - a. One profile for all equipment running (steady state condition).
    - b. One profile for each motor starting scenario as identified in Paragraph 1.08A.
  2. All tie circuit breakers closed with the electrical distribution system operating single-ended.
    - a. One profile for all equipment running (steady state condition).
    - b. One profile for each motor starting scenario as identified in Paragraph 1.08A.
- D. The CONSTRUCTION CONTRACTOR shall obtain from the motor supplier the necessary information to perform the study. Certified curves for "Safe Time vs. Current at 100% Voltage" and "Accelerating Time vs. Current at 100% Voltage" are absolutely necessary and shall become part of the final report.
- E. Multifunction Solid State Motor Protection/Management Relays
  1. Following a starting study, the CONSTRUCTION CONTRACTOR shall produce all settings necessary for the programming of any and all motor protection and/or management relays. Generation of these settings shall take into account the motor starting parameters assessed during the motor starting study and shall incorporate all parameters coordinated with the motor manufacturer.

2. CONSTRUCTION CONTRACTOR shall develop all settings necessary to safely start and run any motor evaluated in the study and controlled by a motor protection/management relay. Settings generated shall include but shall not be limited to:
  - a. Starting parameters including start and stall times, torque settings and transition timing where applicable.
  - b. Motor protection settings coordinated with the motor manufacturer such as the number of starts per hour, safe stall times, overcurrent protection and mechanical jams.
  - c. Logic required for the motor to start, transition and run as specified and designed.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 QUALITY ASSURANCE

- A. Adjust relay and protective device settings according to values established by coordination study. Setting shall be made in accordance with Section 16950.
- B. Make minor modifications to equipment as required to accomplish conformance with the short circuit and protective device coordination studies.
- C. Notify Consulting ENGINEER in writing of any required major equipment modifications.

END OF SECTION

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SECTION 16110  
RACEWAYS, BOXES, FITTINGS AND SUPPORTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Refer to Section 16600 for additional requirements.

1.03 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Section 01300, the manufacturers' names and product designation or catalog numbers with cut-sheets of all materials specified. Indicate in the submittal, the areas where specific materials are used.

PART 2 PRODUCTS

2.01 MATERIALS

A. Rigid Aluminum Conduit

1. Rigid aluminum conduit shall be 6063 alloy and shall be as manufactured by New Jersey Aluminum Corp.; Reynolds Aluminum International Services Inc.; Alumax Extrusions, Inc; VAW of America, Inc. or equal.
2. Rigid aluminum conduit shall be for use under the provisions of NEC Article 344.

B. Electrical Metallic Tubing

1. Electrical metallic tubing shall be hot-dipped galvanized steel as manufactured by the Allied Tube and Conduit Corp.; Triangle PWC Inc.; Wheatland Tube Co.; Bridgeport or equal.
2. Electrical metallic tubing shall be for use under the provisions of NEC Article 358.

C. Rigid Nonmetallic Conduit

1. PVC conduit shall be rigid polyvinyl chloride schedule 80 as manufactured by Carlon; An Indian Head Co.; Cantex; Queen City Plastics or equal.
2. PVC conduit used in underground concrete encased duct banks shall be rigid polyvinyl chloride schedule 40 as manufactured by Carlon; An Indian Head Co.; Cantex; Queen City Plastics or equal.
3. PVC conduit shall be for use under the provisions of NEC Article 352.

D. Liquidtight Flexible Metal Conduit, Couplings and Fittings

1. Liquidtight flexible metal conduit shall be Sealtite, Type UA, manufactured by the Anaconda Metal Hose Div.; Anaconda American Brass Co.; American Flexible Conduit Co., Inc.; Universal Metal Hose Co. or equal.
2. Fittings used with liquidtight flexible metal conduit shall be of the 3-piece screw-in type malleable iron as manufactured by the O.Z. Gedney Co. or equal.
3. Liquidtight flexible metal conduit shall be for use under the provisions of NEC Article 350.

E. Flexible Metallic Tubing

1. Flexible metallic tubing shall be for use under the provisions of NEC Article 360.
2. Flexible metallic tubing shall be hot-dipped galvanized steel strips shaped into interlocking convolutions firmly joined to one another assuring a complete lock similar to Tristeel as manufactured by Triangle - PWC, Inc. or equal.
3. Flexible metallic tubing shall be used only indoors for connection to lighting fixtures in NEMA 1 administration and office areas.
4. Furnish and install insulated bushings at terminations for conductor protection.

F. Flexible Couplings

1. Flexible couplings shall be type ECGJH as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Killark Electric Manufacturing Co. or equal.

G. Boxes and Fittings

1. Pressed steel switch and outlet boxes shall be hot-dipped galvanized with hot-dipped galvanized tile rings as manufactured by the Raco Manufacturing Co.; Adalet Co.; O.Z. Manufacturing Co. or equal.
2. NEMA 1 and NEMA 12, junction boxes, pull boxes etc., shall be sheet steel unless otherwise shown on the Drawings. Boxes shall be galvanized and have continuously welded seams. Welds shall be ground smooth and galvanized. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies and covers shall not be less than 14-gauge metal. Covers shall be gasketed and fastened with stainless steel screws. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets (refer to Section 16191 for additional requirements). Boxes shall be as manufactured by Hoffman Engineering Co.; Lee Products Co.; ASCO Electrical Products Co., Inc., or equal. All boxes shall be shop primed and painted by the box manufacturer.
3. NEMA 4X stainless steel, junction boxes and pull boxes shall be 316 stainless steel with 316 stainless steel hardware and gasketed covers. Boxes shall have continuously welded seams and welds shall be ground smooth. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies and covers shall not be less than 14-gauge metal. Covers shall be gasketed and fastened with stainless steel screws. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets (refer to Section 16191 for additional requirements.) Boxes shall be as manufactured by Hoffman Engineering Co.; Lee Products Co.; ASCO Electrical Products Co., Inc., or equal.

4. Explosion-proof boxes shall be designed for Class 1, Group D, Division 1 hazardous locations. They shall be cast aluminum, with stainless steel hinged covers and stainless steel hardware and bolts; Type EJB-N4 as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Adalet-PLM or equal.
5. Cast aluminum boxes and fittings shall be copper free aluminum with cast aluminum covers and stainless steel screws as manufactured by the Killark Electric Co.; Crouse-Hinds Co.; Appleton Electric Co.; or equal.
6. Cast aluminum device boxes shall be Type FD. All cast aluminum boxes and fittings shall be copper-free aluminum with cast aluminum covers and stainless steel screws as manufactured by the Killark Electric Co.; Crouse-Hinds Co.; L. E. Mason Co. or equal.
7. Cast aluminum fittings (C's, T's, LB's, etc.) shall be of the mogul design (with rollers) as manufactured by Appleton Electric Co.
8. Multi-Outlet Assembly
  - a. Multi-Outlet Assembly shall only be used where specifically indicated on the drawings. The assembly enclosures shall consist of two piece, all steel or anodized aluminum raceways which shall allow for field installation of wiring and standard receptacles.
  - b. Multi outlet assemblies shall be UL Listed as a Multi-outlet assembly.
  - c. Raceway bases and removable covers shall be .040-in steel, minimum of 2-1/8-in high by 1-5/8-in deep. Entrance fittings shall be sized for 3/4-in conduit.
  - d. Raceways shall include all fittings, couplings, etc, for the complete installation of a finished system.
  - e. Device covers shall be the 1702 Series by Walker, similar by Isoduct; Wiremold or equal.
  - f. The multi-outlet assembly shall be the 1700 Series by Walker, similar by Isoduct; Wiremold or equal.
9. Pedestal boxes for laboratory bench receptacles shall be cast aluminum, polished finish, single face with 1/2-in NPT tapped inlet, single gang: J.A. Pink Catalog No. 800-A; double gang: J.A. Pink Catalog No. 801-A, similar by Hubbell or equal.
10. Floor boxes shall be of the adjustable single gang, concrete tight type for installation in concrete fill, Walker 800 Series, similar by Hubbell; Thomas & Betts Co. or equal.
11. Conduit hubs shall be of the grounding type as manufactured by Myers Electric Products, Inc. or equal.
12. Conduit wall seals for new concrete walls below grade shall be O.Z./Gedney Co., Type WSK; Spring City Electrical Manufacturing Co., Type WDP or equal.
13. Conduit wall seals for cored holes shall be Type CSML as manufactured by the O.Z./Gedney Co. or equal.
14. Conduit wall and floor seals for sleeved openings shall be Type CSMI as manufactured by the O.Z./Gedney Co. or equal.
15. Combination expansion-deflection fittings embedded in concrete shall be Type XD as manufactured by the Crouse-Hinds Co.; O.Z./Gedney Co.; Spring City Electrical Mfg. Co. or equal.

16. Combination expansion-deflection fittings installed exposed shall be Type XJ as manufactured by Crouse-Hinds Co.; O.Z. Gedney Co.; Spring City Electrical Mfg. Co. or equal.
17. Explosion proof fittings shall be as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; O.Z./Gedney Co. or equal.
18. Conduit sealing bushings shall be O.Z./Gedney, Type CSB or equal.
19. Elbows and couplings shall be aluminum.
20. Electrical metallic tubing fittings shall be of the steel, raintight, concrete-tight, insulated throat (connectors), compression type as manufactured by the Appleton Electric Co.; Crouse-Hinds Co. or equal.

#### H. Conduit Mounting Equipment

1. In dry indoor non-process areas, hangers, rods, backplates, beam clamps, channel, fasteners, anchors, nuts, washers, etc., shall be hot-dipped galvanized steel.
2. 316 Stainless steel channel with 316 stainless steel hardware (hangers, rods, backplates, beam clamps, fasteners, anchors, nuts, washers, etc.) shall be used in process areas, as shown on the drawings, in areas designated "WET", "DAMP" and "CORROSIVE" on the Drawings and in outdoor locations. All channel and hardware shall be resistant to the chemicals present in the area in which it is used.
3. Expansion anchors (minimum 3/8" diameter) shall be equal to Kwik-Bolt as manufactured by the McCulloch Industries, Minneapolis, MI; Wej-it by Wej-it Expansion Products, Inc., Bloomfield, CO; or Kwik-Bolt II as manufactured by the Hilti Fastening Systems, Inc, Tulsa, OK. The length of expansion bolts shall be sufficient to place the wedge portion of the bolt a minimum of 1-in behind the steel reinforcement. Apply anti-seize compound to all nuts and bolts. Supports installed without the approved compound shall be dismantled and correctly installed, at no cost to the OWNER.

#### I. Wall and Floor Slab Opening Seals

1. Wall and floor slab openings shall be sealed with "FLAME-SAFE" as manufactured by the Thomas & Betts Corp.; Pro Set Systems; Neer Mfg. Co.; Specified Technologies, Inc. or equal.

#### J. Cold Galvanizing Compound

1. Cold galvanizing compound shall be 95% zinc rich paint as manufactured by ZRC Products Company, a Division of Norfolk Corp. or equal.

### PART 3 EXECUTION

#### 3.01 RACEWAY APPLICATIONS

- A. Except where otherwise shown on the Drawings, or specified, all wiring shall be in rigid aluminum conduit.

- B. Schedule 80 PVC conduit shall be used where shown on the Drawings and in chemical rooms, chlorinator rooms and chlorine storage areas or areas designated "CORROSIVE" on the Drawings.
- C. PVC conduit shall be used for underground work. Schedule 80 PVC shall be used underground where concrete encasement is not called for. Schedule 40 PVC shall be used when encased in concrete. All elbows associated with underground PVC conduit shall be rigid aluminum.
- D. Electrical metallic tubing and fittings may be used only in NEMA 1 administration and office areas. Electrical metallic tubing and fittings shall not be embedded in concrete, installed outdoors, in process areas, shops, maintenance areas, electrical rooms, etc.
- E. All conduit of a given type shall be the product of one manufacturer.

### 3.02 BOX APPLICATIONS

- A. Unless otherwise specified herein or shown on the Drawings, all boxes shall be metal.
- B. Exposed switch, receptacle and lighting outlet boxes and conduit fittings shall be cast aluminum.
- C. Concealed switch, receptacle and lighting outlet boxes shall be pressed steel. Welded seamed boxes will not be permitted.
- D. Terminal boxes, junction boxes and pull boxes shall have NEMA ratings suitable for the location in which they are installed, as specified in Section 16000.

### 3.03 FITTINGS APPLICATIONS

- A. Combination expansion-deflection fittings shall be used where conduits cross structure expansion joints. Refer to Structural Drawings for expansion joint locations. Provide bonding jumpers around fittings.
- B. Conduit wall seals shall be used where underground conduits penetrate walls or at other locations shown on the Drawings.
- C. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather and at other locations shown on the Drawings.

### 3.04 INSTALLATION

- A. No conduit smaller than 3/4-inch electrical trade size shall be used, nor shall any have more than the equivalent of three 90-degree bends in any one run. Pull boxes shall be provided as required or directed.
- B. No wire shall be pulled until the conduit system is complete in all details; in the case of concealed work, until all rough plastering or masonry has been completed; in the case of exposed work, until the conduit system has been completed in every detail.
- C. The ends of all conduits shall be tightly plugged to exclude dust and moisture during construction.
- D. Conduit supports, other than for underground raceways, shall be spaced at intervals of 8-ft or less, as required to obtain rigid construction.

- E. Single conduits shall be supported by means of aluminum one-hole pipe clamps in combination with aluminum one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on trapeze type hangers with steel horizontal members and threaded hanger rods. The rods shall be not less than 3/8-in diameter. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a minimum of 1/2-in clearance between wall and equipment.
- F. Conduit hangers shall be attached to structural steel by means of beam or channel clamps. Where attached to concrete surfaces, concrete expansion anchors shall be provided.
- G. All conduits on exposed work, within partitions and above suspended ceilings, shall be run at right angles to and parallel with the surrounding wall and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. All conduit shall be run perfectly straight and true.
- H. Conduit terminating in pressed steel boxes shall have double locknuts (aluminum) and insulated grounding bushings.
- I. Conduit terminating in gasketed enclosures shall be terminated with grounding type conduit hubs.
- J. Conduits containing equipment grounding conductors and terminating in sheet steel boxes shall have insulated throat grounding bushings with lay-in type lugs.
- K. Conduits shall be installed using threaded fittings unless otherwise specified herein.
- L. Liquidtight flexible metal conduit shall be used for all motor terminations, the primary and secondary of transformers, generator terminations and other equipment where vibration is present.
- M. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.
- N. Aluminum fittings and boxes shall be used with aluminum conduit. Aluminum conduit shall not be imbedded in concrete containing chlorides, unwashed beach sand, sea water, or coral bearing aggregates. Aluminum conduit shall be isolated from other metals with heat shrink tubing (Raychem or equal) or plastic-coated hangers. Strap wrenches shall be used for tightening aluminum conduit. Pipe wrenches, channel locks, chain wrenches, pliers, etc. shall not be used.
- O. All threads on aluminum conduit and fittings shall be cleaned and coated with "No-Oxide" compound before installing.
- P. Aluminum conduit installed in concrete or below grade shall be completely covered with two (2) coats of bitumastic paint or with heat shrink tubing (Raychem or equal).
- Q. Where conduits pass through openings in walls or floor slabs, the remaining openings shall be sealed against the passage of flame and smoke.
- R. PVC conduit to non-metallic and metallic box connections shall be made with sealing rings, with a stainless steel retainer as manufactured by Thomas & Betts Co.
- S. Conduit ends exposed to the weather shall be sealed with conduit sealing bushings.

- T. Expansion fittings shall be used on exposed runs of PVC conduit where required for thermal expansion. Installation and number of fittings shall be as provided per the NEC and approved by the PVC conduit manufacturer.
- U. All conduit entering or leaving a motor control center, switchboard or other multiple compartment enclosure shall be stubbed up into the bottom horizontal wireway or other manufacturer designated area, directly below the vertical section in which the conductors are to be terminated.
- V. Conduit sealing and drain fittings shall be installed in areas designated as NEMA 7.
- W. Spare conduits and conduit stubouts for future construction shall be provided with threaded PVC end caps at each end.
- X. No unbroken run shall exceed 300 feet in length. This length shall be reduced by 75 feet for each 90-degree elbow.
- Y. Aluminum conduit entering manholes and below grade pull boxes shall be terminated with grounding type bushings and connected to a 3/4" x 10' rod with a #6 bare copper wire.
- Z. Underground circuits shall be installed directly to the respective motor control centers, lighting panels, etc., except stainless steel pull boxes shall be wall mounted on structures to eliminate excessive bends. With prior written approval, below grade pull boxes may be used. Splices shall not be made in above or below grade pull boxes unless otherwise indicated on the plans and approved in writing by the ENGINEER.
- AA. All conduits shall have a 4-inch concrete housekeeping pad at all slab and grade penetrations. The housekeeping pad shall have 45-degree, 3/4-inch chamfer at all exposed edges.
- BB. All risers from underground, concrete pads, floors, etc. shall be provided with heat shrink tubing (Raychem Co. or equal) from a point 1 foot-0-inch below bottom of slab or grade to a point not less than 6 inches above grade or surface of slab.
- CC. Existing conduits are to be reused only where specifically noted on the drawings. Mandrels shall be pulled through all existing conduits which will be reused and through all new conduits 2-in in diameter and larger prior to installing conductors.
- DD. 3/16-in polypropylene pull lines shall be installed in all new conduits noted as spares or designated for future equipment.
- EE. Where no size is indicated for junction boxes, pull boxes or terminal cabinets, they shall be sized in accordance with the requirements of NEC Article 314.
- FF. Conduits shall not cross pipe shafts, access hatches or vent duct openings. They shall be routed to avoid such present or future openings in floor or ceiling construction.
- GG. The use of running threads is prohibited. Where such threads are necessary, a 3-piece cast aluminum union shall be used.
- HH. Conduits passing from heated to unheated spaces, at all exterior spaces, refrigerated spaces, and cold air plenums, etc., shall be sealed with "Duxseal" as manufactured by Manville or seal fitting to prevent the accumulation of condensation.

- II. All field cut ends of hot dipped galvanized mounting channel shall be cleaned and painted with cold galvanizing compound before installation.
- JJ. All underground control and instrumentation conduits shall be separated from power conduits by a minimum of 12 inches unless specifically noted otherwise. Crossing of control and instrumentation conduits with power conduits shall be kept to a minimum and where they must cross they shall cross at 90 degree angles.

END OF SECTION

SECTION 16120  
WIRES AND CABLES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish, install and test all wire, cable and appurtenances as shown on the Drawings and as specified herein.
- B. Install data highway, fiber optic, coaxial and I/O cables furnished under Division 13.

1.02 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Section 01300, samples of proposed wire. Each sample shall have the size, type of insulation and voltage stenciled on the jacket.
- B. Approved samples will be sent to the project location for comparison by the Resident Engineer with the wire actually installed.
- C. Installed unapproved wire shall be removed and replaced at no additional cost to the OWNER.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Carefully handle all conductors to avoid kinks and damage to insulation.

PART 2 PRODUCTS

2.01 GENERAL

- A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper.
- B. All conductors shall be stranded, except that lighting and receptacle wiring may be solid.
- C. Except for control, signal and instrumentation circuits, wire smaller than No. 12 AWG shall not be used.
- D. All wire of a given type shall be the product of a single manufacturer.

2.02 MATERIALS

- A. 600 Volt or Less Wire and Cable
  - 1. Wire for lighting, receptacles, and other circuits not exceeding 150 volts to ground shall be NEC type THHN. Below grade and underground the wire shall be type XHHW.
  - 2. Wire for circuits over 150 volts to ground shall be NEC type XHHW for sizes 4/0 AWG and smaller, and shall be NEC type RHW for sizes 250 MCM (kcmil) and larger.
  - 3. Wire for control circuits shall be #14 AWG minimum NEC type XHHW stranded.

4. Equipment grounding conductors shall be installed in all raceways. Equipment grounding conductors shall be the same NEC type as the phase conductor, green and sized per NEC Table 250.122. Ground grid conductors shall be uninsulated unless shown otherwise on the Drawings.
5. Types THHN, XHHW and RHW wire shall be as manufactured by the Southwire Co., Pirelli Cable Corp., Okonite Co., or equal.
6. Multi-conductor control cable shall be stranded, #14 AWG, 600 V, cross-linked polyethylene insulated w/PVC jacket. Type "XLP" as manufactured by the Southwire Co., American Insulated Wire Corp., or equal.
7. Telephone cable shall be #22 AWG, 4-pairs, solid copper PVC insulation and PVC jacket. UL rated Type CMR as manufactured by American Insulated Wire Corp., or equal.

## 2.03 INSTRUMENTATION WIRE

- A. Process instrumentation wire shall be twisted pair, 600 V, cross linked polyethylene insulated, aluminum tape shielded, polyvinyl chloride jacketed type "XLP" as manufactured by the Rockbestos Co., or equal.
- B. Cable for 4-20 mA instrumentation, potentiometer, RTD and similar analog circuits shall be multi-conductor twisted and shielded.
  1. Single pair cable:
    - a. Conductors: 2 No. 16 AWG stranded and twisted.
    - b. Insulation: XLP.
    - c. Shield: 100 percent tape with drain wire.
    - d. Jacket: PVC with UL and manufacturers identification.
  2. Three conductor (triad) cable:
    - a. Conductors: 3 No. 16 AWG stranded and twisted.
    - b. Insulation: XLP.
    - c. Shield: 100 percent tape with drain wire.
    - d. Jacket: PVC with UL and manufacturers identification.
  3. Multiple pair cables (where shown on the Drawings):
    - a. Conductor: Multiple 2 No. 16 AWG stranded and twisted.
    - b. Insulation: XLP.
    - c. Shield: Individual pairs and overall shielded with 100 percent tape and drain wire.
    - d. Jacket: PVC with UL manufacturers identification.

## 2.04 COMMUNICATION CABLE

- A. Ethernet cable shall be designed for use with a high-speed (100 Mbps/Gbps) Ethernet communications network. The twisted pair cable shall have nominal impedance of 100 ohms at 1 Mhz and a maximum attenuation of 10 dB per 1000 feet at 1 Mhz. The twisted pair cable shall be plenum rated and shall have a minimum of four 24 AWG solid copper conductor pairs. All RJ-45 terminations on the twisted pair cable shall be done as specified by the manufacturer. Terminations shall provide strain relief on the cable jacket. Strain relief on the wire and/or wire insulation shall not be acceptable. Cable and connections shall meet or exceed Category 6

ratings and upon completion of the network installation, the system shall be tested to Category 6 standards. Category 6 cable shall be as manufactured by Belden, or equal.

- B. Profibus PA cable shall be 300 V, 1 pair 18 AWG, stranded tinned copper, 100% foil shield, color blue and orange, 100 ohms at 31.25 kHz, PVC jacket, Belden Type 3076F or equal.
- C. Profibus DP cable shall be 300V, 1 pair 22 AWG, stranded tinned copper, 100% foil shield, color red and green, 150 ohms, PVC jacket, Belden Type 3079E or equal.
- D. DeviceNet cable shall be Class 1 (600V), with 2 pairs, 16 and 18 AWG, stranded tinned copper conductors, 100% individually foil shielded, plus a 65% overall tinned copper braid, sunlight/oil-resistant PVC jacket. Power pair (16 AWG) color blue and white. Data pair (18 AWG) color red and black. ODVA (Open DeviceNet Vendor Association) Cable V, Belden Type 7896A or equal.

## 2.05 TERMINATIONS AND SPLICES (POWER CONDUCTORS)

- A. Unless otherwise indicated on the plans, no splices may be made in the cables without prior written approval of the ENGINEER. Where splicing is approved, then splicing material shall be approved by the ENGINEER and cable manufacturer. Splicing materials for all 600 volt splices shall be made with long barrel tin plated copper compression (hydraulically pressed) connectors and insulated with heavy wall heat shrinkable tubing. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor.
- B. 600 volt wire lugs shall be tin plated copper, long barrel compression type (hydraulically pressed) for wire sizes No. 8 AWG and larger. Lugs for No. 10 AWG and smaller wire shall be locking spade type with insulated sleeve. Lugs shall be as manufactured by the Thomas and Betts Co., or equal.

## 2.06 TERMINATION AND SPLICES (CONTROL CONDUCTORS)

- A. Unless otherwise indicated on the plans, no splices may be made in the cables without prior written approval of the ENGINEER. Where splicing is approved, then splicing material shall be approved by the ENGINEER and cable manufacturer. Splicing materials and installation shall be as required by the ENGINEER. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor.
- B. Termination connectors shall be of the expanded vinyl insulated locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

## 2.07 TERMINATIONS (INSTRUMENTATION CABLES)

- A. Termination connectors shall be of the expanded vinyl insulated locking fork-end (upturned leg ends) type as manufactured by 3M Co.; Panduit Corp. or equal.

## 2.08 MOTOR CONNECTIONS

- A. For wire sizes #8 AWG and larger, long barrel tin plated copper compression (hydraulically pressed) type connections (Burndy Co., or equal) shall be installed on the branch circuit wires and the motor leads. Bolted connections shall utilize products which are rated for vibration applications (bolt, nut and spring washer). All connections shall be insulated with heavy duty heat shrinkable material (Raychem Corp. or equal).

## 2.09 WIRE AND CABLE MARKERS

- A. Wire and cable markers shall be type written, heat shrinkable type as manufactured by the W.H. Brady Co., Thomas & Betts Co., 3M Co., or equal.
- B. Wire and cables with diameters exceeding the capacity of the heat shrinkable markers shall be marked with pre-printed, self-adhesive vinyl tapes as manufactured by the W.H. Brady Co., Panduit Corp., or equal.

## 2.10 WALL AND FLOOR SLAB OPENING SEALS

- A. Wall and floor slab openings shall be sealed with "FLAME-SAFE" as manufactured by the Thomas & Betts Corp. or equal.

# PART 3 EXECUTION

## 3.01 INSTALLATION

- A. Uniquely identify all wires, cables and each conductor of multi-conductor cables (except lighting and receptacle wiring) at each end with wire and cable markers.
- B. Use lubrications to facilitate wire pulling. Pulling compound shall be nontoxic, nonflammable, noncombustible and noncorrosive. The material shall be UL listed and compatible with the cable insulation and jacket.
- C. All wire and cable shall be continuous and without splices between points of connection to equipment terminals, except a splice will be permitted by the ENGINEER if the length required between the points of connection exceeds the greatest standard shipping length available from the manufacturer specified or approved by the ENGINEER as the manufacturer of the particular item or wire and cable.
- D. Seal openings in slabs and walls through which wires and cables pass.
- E. Steel fish tapes and/or steel pulling cables shall not be used in PVC conduit runs.
- F. Pull cable from direction that requires the least tension.
- G. Feed cable into raceway with zero tension and without cable crossover at raceway entrance.
- H. Use a feed-in tube and sheave designed for cable installation. Use sheaves with radii that exceed the cable manufacturer's recommended minimum bending radius.

- I. Use a dynamometer and constant velocity power pulling. Velocity should not be less than 15-ft./min or more than 50-ft/min. Do not exceed the cable manufacturer's maximum recommended tension.
- J. If cable cannot be terminated immediately after installation install heat shrinkable end caps.
- K. Fireproof exposed cables in manholes, vaults, pullboxes, switchgear and other areas not protected by conduit where medium voltage cables are present. Use fire-proofing tape and glass tape in accordance with the manufacturer's instructions. Fire-proofing tape shall be with one half-lapped layer of Scotch Brand 77 Electric Arc and Fireproofing Tape by 3M Corp. or equal. Tape shall be secured with a two-layer band of Scotch Brand 69 Glass Electrical Tape by 3M Corp. or equal over the last wrap.
- L. Uniquely identify all cable at supply and receiving ends and in all manholes, handholes or pullboxes. Use embossed brass tags and tywrap fasteners.
- M. Hydraulically or manually operated cable benders shall not be used unless approved in writing by the ENGINEER.
- N. Instrumentation cables shall be installed in conduits as specified. All circuits shall be installed as twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.
- O. Install shielded instrumentation wire from terminal to terminal with no splicing at any intermediate point. Shielded instrumentation wire, coaxial, data highway, I/O and fiberoptic cables shall be run without splices between instruments, terminal boxes, or panels.
- P. Terminal blocks shall be provided at all instrument cable junctions, and all circuits shall be identified at such junctions.
- Q. Ground shielding on instrumentation wire at one end only as recommended by the instrument manufacturer and isolated at all other locations. Terminal blocks shall be provided for inter-connecting shield drain wires at all junction boxes. Where individual circuit shielding is required, each shield circuit shall be provided with its own terminal block.
- R. Install shielded instrumentation wire in conduit and pull boxes that contain only shielded instrumentation wire. Instrumentation cables shall be separated from all other (i.e. power, control, etc.) cables in manholes.
- S. All shielded cable terminations at each end shall be provided with heat shrinkable tubing placed over the exposed shield and conductors. The tubing shall extend 1" minimum over the jacket end and extend ½" minimum from the jacket end over the exposed conductors.

### 3.02 WIRE COLOR CODE

- A. All wire shall be color coded or coded using electrical tape in sizes where colored insulation is not available. Where tape is used as the identification system, it shall be applied in all junction boxes, manholes and other accessible intermediate locations as well as at each termination.

B. The following coding shall be used:

| <u>System</u>  | <u>Wire</u>    | <u>Color</u>       |
|--|----------------|--------------------|
| 240/120 Volts<br>Single-Phase, 3 Wire  | Neutral        | White              |
|  | Line 1         | Black              |
|  | Line 2         | Red                |
| 208Y/120, Volts<br>3 Phase, 4 Wire   | Neutral        | White              |
|  | Phase A        | Black              |
|  | Phase B        | Red                |
|  | Phase C        | Blue               |
| 240/120 Volts<br>3 Phase, 4 Wire<br>delta, center tap<br>ground on phase<br>coil A-C | Neutral        | White              |
|  | Phase A        | Black              |
|  | Phase B (High) | Orange             |
|  | Phase C        | Blue               |
| 480Y/277 Volts<br>3 Phase, 4 Wire  | Neutral        | Gray               |
|  | Phase A        | Brown              |
|  | Phase B        | Orange             |
|  | Phase C        | Yellow             |
| Control (Individual Conductors)  | AC             | Red                |
|  | 24VDC          | Blue               |
|  | 0VDC           | White/Blue Stripes |

### 3.03 FIELD TESTING

- A. Test all 600 volt wire insulation with a megohm meter after installation and prior to termination. Make tests at not less than 1000 volts DC. Submit a written test report of the results to the ENGINEER. Notify ENGINEER in writing 48 hours prior to testing.
- B. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the InterNational Electrical Testing Association unless otherwise modified by this Section. Minimum wire insulation resistance shall not be less than 250 Megohms.
- C. All service conductors shall be tested as in paragraph A above with the ENGINEER present.

END OF SECTION

SECTION 16123  
LOW VOLTAGE CABLE SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install all low voltage cable systems and connecting hardware for the horizontal pathways for the safety and security systems, data networks, and communication systems.
- B. Install data communications, coaxial and specialty I/O cables furnished under other Divisions.
- C. Furnish and install wiring for fire alarm systems.

1.02 RELATED WORK

- A. Power supply wiring up to 600V is included in Section 16120.
- B. Fiber optic cable is included in Section 13321.
- C. Underground ducts, manholes, and handholes are included in Section 16600.

1.03 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 01300.
- B. Shop drawings shall include the following information:
  - 1. Detailed catalog information or drawings describing electrical and physical characteristics of the equipment specified in sufficient detail to show compliance with the Drawings and Specifications.
  - 2. Cable schedules and conduit assignments.
  - 3. Submit cable pulling calculations where required.
  - 4. Test reports.
- C. Project Record Documents:
  - 1. Submit record document information in accordance with Section 16000.
  - 2. Submit the following information for record purposes:
    - a. Field wiring interconnection drawings illustrating all field components and electric connections to the systems supplied under this Section.

1.04 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI)
  - 1. EIA TIA/EIA-569-A; Commercial Building Standards for Telecommunications Pathways and Spaces and related bulletins.

2. EIA TIA/EIA-568-B; Commercial Building Telecommunications Cabling Standard and related bulletins.
  3. ANSI/TIA/EIA-568-C.0 – Generic Communications Cabling for Customer Premises.
  4. ANSI/TIA/EIA-568-C.1 – Commercial Building Communications Cabling Standard Part 1: General Requirements.
  5. ANSI/TIA/EIA-568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
  6. ANSI/TIA/EIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces.
  7. ANSI/TIA/EIA-606-A – Administration Standard for the Commercial Telecommunications Infrastructure.
  8. ANSI/TIA-607-B – Commercial Building Bonding and Grounding (Earthing) Requirements for Telecommunications.
- B. National Electrical Manufacturers Association (NEMA) for relevant equipment standards.
- C. BICSI – TDMM, Building Industries Consulting Services International, Telecommunications Distribution Methods Manual (TDMM).
- D. Underwriters' Laboratories (UL).
- E. National Fire Protection Association (NFPA)
1. NFPA 70 - National Electrical Code.
- F. National Electrical Contractors Association (NECA/BICSI)
1. NECA/BICSI 607, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings and related bulletins.
- G. Where reference is made to one of the above standards, the revision in effect at the time of the bid shall apply.
- 1.05 QUALITY ASSURANCE
- A. Qualifications:
1. All category cabling manufacturers must be able to provide documentation from an independent third-party testing agency that verifies through random sampling that cable components perform at or above the levels contained on their product specifications, not simply at or above the standard.
- B. Regulatory Requirements:
1. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 (NEC) unless more stringent requirements are specified or indicated.

C. Certifications:

1. The manufacturer shall maintain a documented ISO 9001 or 9002 quality assurance program implementing suitable procedures and controls to monitor all aspects of production and testing.
2. All cables and devices shall be UL listed and labeled where standards exist.

1.06 SYSTEM DESCRIPTION

A. Low voltage cable subsystems consist of copper twisted-pair cabling assemblies connecting various outlets and devices located at individual work areas using the following types of cables:

1. Ethernet cables.
2. DeviceNet cables.
3. Profibus cables.
4. RS-485 cables.
5. Shielded twisted pair cables.
6. Unshielded twisted pair cables.

B. Low voltage cabling systems: Includes cables, jacks, splice panels, connecting blocks, patch cords, connectors, jumpers, and necessary support systems, such as cable managers and faceplates.

1. Furnish and install all materials necessary for complete and working cabling systems.

C. System Responsibilities:

1. The CONSTRUCTION CONTRACTOR shall coordinate the work within the Communication Rooms with the OWNER or its designated Telecommunications Contractor concerning access and terminations at rack mounted equipment.

D. Performance Requirements:

1. Surge Withstand Capability: per ANSI/IEEE C62.41 without damage.
2. The equipment and components shall operate continuously at its rated current under the following environmental conditions without damage or degradation of operating characteristics or life:
  - a. Operating Ambient Temperature: 40 degrees C maximum ambient temperature.
  - b. Storage Temperature: -40 degrees C to 65 degrees C.
  - c. Relative Humidity: 0 to 95%, non-condensing.
  - d. Altitude: Operating to 3300 ft, de-rate for higher elevations.

## 1.07 DELIVERY, STORAGE AND HANDLING

### A. Storage and Protection:

1. Store and handle materials in accordance with manufacturer's instructions.
  - a. Keep materials in manufacturer's original, unopened containers and packaging until installation.
  - b. Store materials in clean, dry area indoors.
  - c. Protect materials during storage, handling, and installation to prevent damage.
2. Refer to Section 16000.

## 1.08 WARRANTY

- A. Refer to Section 16000.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Products of the following manufacturers are acceptable.
1. Alpha Wire Company.
  2. Berk-Tek.
  3. Belden CDT.
  4. General Cable.
  5. Or equal.
- C. Like items of materials/equipment shall be the end products of the same manufacturer in order to provide standardization for appearance, performance, and manufacturer's parts and service.

### 2.02 NETWORK CABLING

- A. Provide Ethernet network cables of the cable types indicated on the Drawings and as specified. If no type is indicated, provide Category 6 UTP.
1. Augmented Category 6a Unshielded Twisted Pair.
  2. Enhanced Category 6e Unshielded Twisted Pair.
  3. Category 6 Unshielded Twisted Pair (UTP).
  4. Category 6 Shielded Twisted Pair.

B. Cables shall meet TIA/EIA-568-C.2 standards and shall consist of four non-bonded twisted pair cables formed into a single PVC jacketed cable core.

1. Conductors:
  - a. Solid copper conductors.
  - b. Minimum No. 24 AWG.
2. Insulation:
  - a. Polyolefin polyethylene (non-plenum) or FEP (plenum).
  - b. 300-volt rated insulation.
3. Color code:
  - a. Pair 1: White/blue stripe and blue.
  - b. Pair 2: White/orange stripe and orange.
  - c. Pair 3: White/green stripe and green.
  - d. Pair 4: White/brown stripe and brown.
4. Outer jacket:
  - a. Sunlight resistant, flame retardant polyvinyl chloride outer jacket.
  - b. White sheath for Voice.
  - c. Blue sheath for Data.
  - d. Low Smoke, CMP-50, FEP, clear jacket where required by fire code.
5. Electrical characteristics:
  - a. Frequency range: 0.772-100 MHz.
  - b. Attenuation: 32.1 dB/100 m.
  - c. Near-end crosstalk (NEXT): 39.3 dB.
  - d. Power sum NEXT: 37.3 dB.
  - e. Attenuation to crosstalk ratio (ACR): 7.2 dB.
  - f. Power sum attenuation to crosstalk ratio (PSACR): 5.3 dB/100 m.
  - g. Equal level far-end crosstalk (ELFEXT): 22.8 dB.
  - h. Power sum ELFEXT: 19.8 dB/100 m.
  - i. Return loss: 17.3 dB.
  - j. Propagation delay: 537 ns/100 m.
  - k. Delay skew: 45 ns/100 m.
  - l. Propagation delay (skew), max: 2.5 ns/100 m.

## 2.03 DEVICENET CABLE

A. Provide DeviceNet cables of the cable types as indicated on the Drawings and as specified.

1. Cables shall meet NEC/UL specification for wet locations.
2. Compliant with the device manufacturer's and ODVA specifications and shall pass the ODVA established conformance test.
3. Approved to bear the ODVA Conformance Tested Service Mark.

B. Thick cable types shall consist of two shielded pairs for data and power within an overall jacket:

1. Shielded data pair:
  - a. Tinned, copper conductors, minimum No. 18 AWG.

- b. Flame retardant polypropylene insulated.
    - c. Aluminum foil-polyester tape shield, 100 percent coverage.
    - d. Color: Blue and white.
  - 2. Shielded DC power pair:
    - a. Tinned, copper conductors, minimum No. 16 AWG.
    - b. Polyvinyl chloride insulated.
    - c. Aluminum foil-polyester tape shield, 100 percent coverage.
    - d. Color: Black and red.
  - 3. Outer jacket:
    - a. Sunlight/oil resistant polyvinyl chloride outer jacket.
    - b. 600-volt rated insulation.
    - c. Overall 65 percent tinned copper braid shield.
    - d. Outer shield tinned copper drain wire.
- C. Thin cable types shall consist of two shielded pairs for data and power within an overall jacket:
  - 1. Shielded data pair:
    - a. Tinned, copper conductors, minimum No. 20 AWG.
    - b. Foam polyethylene (FPE) insulated.
    - c. Aluminum foil-polyester tape shield, 100 percent coverage.
    - d. Color: Blue and white.
  - 2. Shielded DC power pair:
    - a. Tinned, copper conductors, minimum No. 18 AWG.
    - b. Polyvinyl chloride insulated.
    - c. Aluminum-foil polyester tape shield, 100 percent coverage.
    - d. Color: Black and red.
  - 3. Outer jacket:
    - a. Sunlight/oil resistant polyvinyl chloride outer jacket.
    - b. 300-volt rated insulation.
    - c. Overall 65 percent tinned copper braid shield.
    - d. Outer shield tinned copper drain wire.

## 2.04 PROFIBUS CABLE

- A. Provide Profibus cables of the cable types as indicated on the Drawings and as specified. Cables shall meet Profibus specifications and be certified when applicable.
  - 1. Profibus PA, single pair:
    - a. Conductors: Tinned copper, minimum No. 18 AWG.
    - b. Insulation: Polyolefin, 300-volt rated.
    - c. Aluminum foil-polyester shield with 100 percent coverage.
    - d. Tinned copper drain wire.
    - e. Outer jacket: Orange colored chlorinated polyethylene (CPE) meeting NEC/UL specifications for direct burial or wet locations.
  - 2. Profibus DP, single pair:
    - a. Conductors: Tinned copper, minimum No. 22 AWG.
    - b. Insulation: Polyolefin, 300-volt rated.

- c. Aluminum foil-polyester shield with 100 percent coverage.
- d. Tinned copper drain wire.
- e. Outer jacket: Purple colored chlorinated polyethylene (CPE) meeting NEC/UL specifications for direct burial or wet locations.

## 2.05 RS-485 CABLE

### A. Two pair shielded twisted cable:

- 1. Conductors:
  - a. Tinned copper, minimum No. 22 AWG.
- 2. Insulation:
  - a. FHDPE: Foam high-density polyethylene.
  - b. 300-volt rated.
- 3. Outer shield:
  - a. 100 percent coverage.
  - b. Aluminum foil-polyester tape.
  - c. Tinned copper braid.
- 4. Outer shield drain wire:
  - a. Tinned, copper conductor.
  - b. Minimum No. 22 AWG.
- 5. Outer jacket:
  - a. Sunlight resistant PVC.
  - b. UL/CSA flame tested.
- 6. Minimum bending radius 2.5 inches.
- 7. Increase conductor sizes for voltage drop. Observe the manufacturers recommendations and distance limitations.

## 2.06 SECURITY AND SURVEILLANCE SYSTEMS

- ### A. Cable applications for card access control, video surveillance, and intrusion detection systems shall be coordinated with the specific requirements of the equipment vendor by the CONSTRUCTION CONTRACTOR. Cables shall meet or exceed the following:
- 1. Peer-to-peer network communication cable (ACU Panel to ACU Panel):
    - a. Two pair, twisted, No. 22 AWG.
    - b. Solid tinned copper conductors.
    - c. Drain wire: solid tinned copper.
    - d. Overall 100 percent shield.
  - 2. Strike power (DC power):
    - a. One pair, twisted, No. 18 AWG.
    - b. Stranded copper conductors.
    - c. Shielded.

3. Detection device inputs such as glass break sensors, motion sensors, etc. (Signal and power):
  - a. Two pair, twisted, No. 22 AWG.
  - b. Stranded copper conductors.
  - c. Shielded.
4. Contact device inputs such as door switches, tamper switches, etc. (Signal):
  - a. One pair, twisted, No. 18 AWG.
  - b. Stranded copper conductors.
  - c. Shielded.
5. Card reader communication cable: (ACU Panel to reader):
  - a. Eight conductors, twisted, No. 22 AWG.
  - b. Stranded copper conductors.
  - c. Overall 100 percent shield.
6. Miscellaneous I/O (per point)
  - a. One pair, twisted, No. 18 AWG.
  - b. Stranded copper conductors.
  - c. Shielded.
7. Ethernet cable for IP based systems: Cat 6.
8. Security cable outer jacket shall be yellow.
9. Increase conductor sizes for voltage drop. Observe the manufacturers recommendations and distance limitations.
10. Cable and wire installed between access control components and intelligent field panels and power supplies at indoor locations shall be installed in conduit. Cable and wire installed in underground raceways shall be rated for wet locations.

## 2.07 TERMINATIONS

- A. Provide modular jacks, patch panels, connecting blocks, patch cords, connectors, enclosures, jumpers, and necessary support systems, such as cable managers and faceplates for terminating low voltage cable systems.
  1. Modular Jacks.
    - a. 8-position modular RJ-45 jack, IDC terminals, T568A/B wiring scheme.
    - b. Identification: Stamped or have icons for identification.
    - c. Voice color: fog white.
    - d. Data color: orange.
  2. Work Area Outlets
    - a. Flush-Mounted Faceplates: Coordinate with Architect to match finish. Part numbers shown are for standard color fog white.
    - b. 1-port faceplate with mounting lugs for wall phone, stainless steel, mounts within single-gang wall box, Legrand/Ortronics OR-403STJ1WP, or equal.
    - c. 2-port faceplate, high-impact thermo-plastic, with recessed label fields, mounts within single-gang wall box, Legrand/Ortronics OR-40300548, or equal.

- d. 4-port faceplate, high-impact thermo-plastic, with recessed label fields, mounts within single-gang wall box, Legrand/Ortronics OR-40300546, or equal.
  - e. Modular Furniture Faceplates: 4-port modular furniture bezel to fit furniture knockout, with recessed label field.
  - f. Each WAO shall have individually cabled voice and data jacks.
  - g. A Fiber to the Desktop (FTTD) Work Area Outlet (WAO) shall consist of an 8-port faceplate with an expanded electrical device box inside the wall that allows for proper fiber bend radius, two LC type fiber optic connectors, voice and data jacks, and one 4-strand indoor single mode fiber optic cable.
3. Termination Blocks
- a. Category 6, 96 pair, 110-style, with mounting legs, wall mount.
  - b. Block Labels: Clear plastic holder for 110 blocks with paper inserts.
  - c. Wiring Troughs: Horizontal trough for routing of patch cords and cross-connect wire, with mounting legs.
  - d. Mounting Brackets: 19-inch, rack-mount brackets for 200 pair, 110 termination blocks and wiring troughs.
4. Patch Panels
- a. Voice/Data Patch Panels: 24 or 48-port, 8-position modular jack panel, high-density, 8-port modules, Category 6, IDC terminals, T568A/B wiring scheme.
  - b. FTTD Patch Panels: Refer to Section 26 05 20.
  - c. Modular Patch Cords: Factory-terminated, double-ended, 8-position to 8-position, modular, stranded conductors, Category 6, 4 pair.
  - d. 110/110 Patch Cords: Factory-terminated, double-ended, 110-connector to 110-connector, modular, stranded conductors, Category 6, 4 pair.
  - e. 110/Modular 8-Position Patch Cords: Factory-terminated, double-ended, 110-connector to 8-position, modular, stranded conductors, Category 6, 4 pair.
  - f. Patch cords shall be manufactured by the same manufacturer as the data patch panels and modules to ensure compatibility, performance and warranty, and shall meet or exceed Category 6 performance requirements.
  - g. Cable management panel: Ortronics OR-808044855, or equal.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. Install low voltage cable systems in accordance with Section 16120 and this Section. Install cables in conduit, cable trays, spaces below raised floors, open ceiling areas, non-ventilated spaces above ceiling tile, and through plenum air-handling spaces above ceiling tile.
- B. Install communications horizontal cabling in accordance with manufacturer's instructions, ANSI/TIA/EIA-568-C.0, ANSI/TIA/EIA-568-C.1, ANSI/TIA/EIA-569-B, BICSI TDDMM, and NFPA 70.
- C. Inspect installed conduit, wireway, cable trays, and inner duct to ensure cable pathways are completely and thoroughly clean before installing cabling. Clean raceway and inner duct systems as necessary.
- D. Protect exposed cables where subject to damage.

1. Provide abrasion protection for cable or wire bundles which pass through holes or across edges of sheet metal.
  2. Use protective bushings to protect cables.
  3. Protect installed cabling from damage during construction.
- E. Install a 1/8-inch minimum nylon pull cord with cables in each conduit and in each empty conduit.
- F. Do not fill greater than TIA/EIA-569-B and the NEC maximum fill for particular raceway type.
- G. Replace any damaged cables or cables that fail the specified tests.
- H. Install cables in continuous lengths from origin to destination, without splices, except for designated transition or consolidation points. Where transition or consolidation points are allowed, they shall be located in accessible locations and housed in enclosure suitable for the intended purpose.
- I. Each voice jack and each data jack shall be connected to a dedicated 4-pair Unshielded Twisted Pair (UTP) Category 6 cable.
- J. Provide pulling calculations for cables installed using mechanical pulling equipment to verify that the maximum cable tension and sidewall pressure will not exceed manufacturer's recommended values. Submit the calculations to the Engineer a minimum of two weeks before cable installation.

### 3.02 INSTALLATION

- A. All of the systems cabling shall be installed in conduit except where shown otherwise on the Drawings. For retrofitting existing spaces, surface raceway systems such as Wiremold may be used subject to approval of the Engineer.
- B. Install a minimum of a 1-inch conduit from each WAO box to the telephone equipment room. Looping of multiple work area outlets or floor boxes with a single conduit is not allowed. Dedicated cable baskets or trays specifically designed for communications service may be used above false ceilings or other locations indicated on the Drawings. Maintain adequate separation between telephone and electrical power facilities to prevent induced voltages and EMI.
- C. Bundle cables in groups of no more than amount of cables designed for by cable support manufacturer based on cable OD and weight. Support bundles at a maximum of 48-inch intervals if J-hook or trapeze system is used.
- D. Install appropriate carriers to support cabling, where support for cables are required. Do not allow cables to rest on acoustic ceiling grids, plumbing pipes, or electrical conduits. Do not attach cables to ceiling grid or lighting fixture wires.
- E. Install cable supports above fire-sprinkler system. Do not attach cables to fire-sprinkler system or ancillary equipment or hardware. Install cable system and support hardware so that it does not obscure valves, fire alarm conduit, boxes, or other control devices.

- F. Provide following minimum separation distances between low voltage copper cables and power wiring of 480 volts or less:
1. Open or Nonmetal Communications Pathways:
    - a. Electric motors, fluorescent light fixtures, and unshielded power lines carrying up to 3 kVA: 12 inches.
    - b. Electrical equipment and unshielded power lines carrying more than 5 kVA: 36 inches.
    - c. Large electrical motors or transformers: 48 inches.
  2. Grounded Metal Conduit Communications Pathways:
    - a. Electrical equipment and unshielded power lines carrying up to 2 kVA: 2-1/2 inches.
    - b. Electrical equipment and unshielded power lines carrying from 2 kVA to 5 kVA: 6 inches.
    - c. Electrical equipment and unshielded power lines carrying more than 5 kVA: 12 inches.
    - d. Power lines enclosed in grounded metal conduit (or equivalent shielding) carrying from 2 kVA to 5 kVA: 3 inches.
    - e. Power lines enclosed in grounded metal conduit (or equivalent shielding) carrying more than 5 kVA: 6 inches.

### 3.03 TERMINATIONS

- A. Horizontal cables shall not be connected directly to telecommunications or network equipment. Suitable termination hardware including patch panels, 110-type punch-down blocks, and factory-manufactured patch cords shall be used to make this connection.
1. Cross-connect jumpers shall be used for analog voice circuits only.
  2. VoIP and data cabling shall be terminated on separate patch panels in the telephone room. Patch panels shall be mounted on a wall-mounted bracket, in a free standing welded steel equipment rack, or in an enclosed data cabinet as shown on the Drawings.
  3. One cable management panel shall be installed for each data patch panel in all wall, rack and cabinet installations.
- B. Coil cables to house cable coil without exceeding manufacturers bend radius.
1. In hollow wall installations where box eliminators are used, store excess wire in wall.
  2. Store no more than 12 inches of UTP and 36 inches of fiber slack.
  3. Loosely coil excess slack and store in ceiling above each drop location, when there is not enough space present in outlet box to store slack cables.
  4. Do not exceed a 1-in minimum bending radius for 4-pair twisted cables.
- C. Dress and terminate cables in accordance with ANSI/TIA/EIA-568-C.0, ANSI/TIA/EIA-C.1, BICSI TDM, and manufacturer's instructions.
1. Terminate 4-pair cables on jack and patch panels using T568-B or T568-A wiring scheme.
  2. Pair Untwist at Termination: Do not exceed 12 mm (1/2 inch).

3. Bend Radius of Horizontal Cables: Not less than 4 times cable OD.
4. Maintain cable jacket to within 25 mm (1 inch) of termination point.
5. Neatly bundle cables and dress to their respective panels or blocks.
  - a. Feed each panel or block by individual bundle separated and dressed back to point of cable entrance into rack or frame.
- D. Terminate shielded cable foil shields and drain wires to maintain shield continuity and shielding effectiveness from the cable to the connector. The connector manufacturer's installation instructions should be followed for shielded cable termination.
- E. Provide network data outlets (RJ-45) at locations shown on the Drawings and at the following locations:
  1. Install a minimum of two data outlets at the Fire Alarm Control Panel (FACP) location in the electrical or mechanical room.
  2. Install a minimum of one data outlet at each HVAC control panel.
  3. Install a minimum of two data outlets in each electrical room.
  4. Install a minimum of one data outlet at the security system control panel.
  5. Provide a 120VAC duplex power receptacle within three feet of each data outlet location.
  6. Data outlets located in hose or wash-down areas shall be installed above the anticipated damp area, and shall include a UL listed, NEMA rated water resistant cover.

### 3.04 FIELD QUALITY CONTROL

- A. Test all cables in accordance with this specification section, ANSI/TIA/EIA-568-C.0, ANSI/TIA/EIA-568-C.1, and ANSI/TIA/EIA-568-C.2 standards, and manufacturer's instructions.
- B. Test cables and termination hardware 100 percent for defects in installation and verify cabling system performance under installed conditions in accordance with ANSI/TIA/EIA-568-C.0.
  1. Verify all pairs of each installed cable before system acceptance.
  2. Defects in cabling system installation, including but not limited to cables, connectors, patch panels, and connector blocks shall be repaired or replaced to ensure 100 percent useable conductors in all cables installed.
- C. Testing
  1. Test twisted-pair copper cable links for continuity, pair reversals, shorts, opens, and performance as specified.
    - a. Additional testing is required to verify Category performance.
    - b. Test horizontal cabling using manufacturers approved certification tester (Fluke or Agilent) for Category 6a, Category 6, and Category 5e performance compliance in accordance with ANSI/TIA/EIA-568-C.2.

- c. Category 6a shall conform to ANSI/TIA/EIA-568-C-2 for augmented Category 6 to 500 MHz.
  2. Follow ANSI/TIA/EIA-568-C.2.
  3. Basic Tests Required:
    - a. Wire map.
    - b. Length (feet).
    - c. Insertion loss (dB), formerly attenuation.
    - d. NEXT (Near end crosstalk) (dB).
    - e. Return loss (dB).
    - f. ELFEXT (dB).
    - g. Propagation delay (ns).
    - h. Delay skew (ns).
    - i. PSNEXT (Power sum near-end crosstalk loss) (dB).
    - j. PSELFEXT (Power sum equal level far-end crosstalk loss) (dB).
  4. Category 6a: auto test to 500 MHz.
  5. Category 6: auto test to 250 MHz.
  6. Category 5e: auto test to 100 MHz.
  7. Provide test results in approved certification testers original software format on CD, with the following minimum information per cable:
    - a. Circuit ID.
    - b. Information from specified basic tests required.
    - c. Test Result: "Pass" or "Fail".
    - d. Date and time of test.
    - e. Project name.
    - f. NVP.
    - g. Software version.
  8. No failed test will be accepted. Retest these results and submit after a "Pass" is received.
  9. Submit software copy of test results, in original tester software format, to the Owner and the Engineer.
  10. Submit fully functional version of tester software for use by the Engineer in reviewing test results.
  11. Report in writing to the Engineer immediately, along with copy of test results, failed test results that cannot be remedied through re-termination (as in the case of reversed or split pairs).
- D. Verify networking performance with all interfacing systems by other manufacturers.
- 3.05 LABELING
- A. Label horizontal cables using machine-printed label at each end of cable at approximately 12 inches from termination point and again at approximately 48 inches from termination point. Labeling shall be in accordance with ANSI/TIA/EIA-606-A and manufacturer's instructions.

1. Handwritten labels are not acceptable.
2. Label patch panel ports and work area outlet ports with cable identifier.
3. Coordinate with the Owner's specific labeling requirements.
4. Note labeling information on as-built drawings.

3.06 CLEANING

- A. Remove all rubbish and debris from the work area. Remove dirt, dust, and concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags.

END OF SECTION

## SECTION 16150 MOTORS

### PART 1 GENERAL

#### 1.01 SCOPE OF WORK

- A. All motors shall be furnished as called for in other Sections of these Specifications and shall be in conformance with the requirements of this section.

#### 1.02 QUALIFICATIONS

- A. Routine tests shall be performed on representative motors, and shall include the information described on NEMA MG1-12.54 "Report of Test Form for Routine Tests on Induction Motors". Efficiency shall be determined in accordance with IEEE Publication No. 112, Method B. Power factor shall be measured on representative motors.

#### 1.03 SUBMITTALS

- A. Submittal of motor data for acceptance shall include complete nameplate data and test characteristics in accordance with NEMA Standard MG1-12.54 "Report of Test Form for Routine Tests on Induction Motors" and, in addition, the following for motors typical of the units furnished:
  - 1. Efficiency at  $\frac{1}{2}$ ,  $\frac{3}{4}$  and full load.
  - 2. Power factor at  $\frac{1}{2}$ ,  $\frac{3}{4}$  and full load.
  - 3. Motor outline, dimensions and weight.
  - 4. Descriptive bulletins, including full description of insulation system.
  - 5. Bearing design data.
  - 6. Special features (i.e., space heaters, temperature detectors, etc.).
- B. The motor manufacturer shall submit to the ENGINEER as provided in Section 01300, certified dimension prints showing nameplate data and outline dimensions within three weeks of the date they receive the order.
- C. Guarantee: All equipment furnished and installed under this Section shall be guaranteed against defects of workmanship, materials and proper installation for a period of one (1) year from date of acceptance. All such equipment or parts proven defective, due to the above noted causes, shall be replaced in the machines by the CONSTRUCTION CONTRACTOR at no expense to the OWNER.
- D. Provide equipment warranty in accordance with Section 01740.

#### 1.04 REFERENCE STANDARDS

- A. Institute of Electrical and Electronics Engineers (IEEE)

- B. National Electrical Manufacturers Association (NEMA)
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Unless otherwise noted, all motors  $\frac{1}{2}$  through 100 horsepower shall be rated 230/460 volt, 3 phase, 60 Hertz A.C.; motors 125 horsepower and above shall be rated 460 volt, 3-phase, 60 Hertz, and motors below  $\frac{1}{2}$  horsepower shall be rated 115/230 volt, 1 phase, 60 Hertz A.C.
- B. All motors used with variable frequency drives shall be rated for inverter duty and shall be in accordance with the latest NEMA MG1, Section IV, Part 31.
- C. All motors shall be built in accordance with current NEMA, IEEE, ANSI and AFBMA standards. Motors shall be of the type and quality described by this Section and other Divisions of the Specifications, and/or as shown on the Drawings, fully capable of performing in accordance with Manufacturer's nameplate rating, and free from defective material and workmanship.

### 2.02 RATINGS

- A. All motors shall be sufficient size for the duty to be performed and shall not exceed their full-rated load when the driven equipment is operating at specified capacity and over the operational range. Unless otherwise noted, motors driving pumps, blowers, etc. shall not be overloaded at any head or discharge condition. The motor shall not be required to deliver more than its rated nameplate horsepower, at the 1.0 service factor, under any condition of mechanical or hydraulic loading (i.e. although a 1.15 service factor is required, it may not be used under any condition).
- B. Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating. Where shown on the Electrical Drawings to be operated on a reduced voltage starter, the motor shall develop ample torque under the conditions imposed by the reduced voltage starting method.
- C. All motors shall be continuous time rated suitable for operation in a 40 degrees C ambient unless noted otherwise.
- D. Specific motor data such as Hp, rpm, etc., is specified under the detailed specification for the equipment with which the motor is supplied.

### 2.03 NAMEPLATES

- A. The motor manufacturer's nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MG1-10.38 or MG1-20.60, as applicable.

## 2.04 CONDENSATION HEATERS

- A. Condensation heaters, where specified herein or under the detailed mechanical specifications shall be of the cartridge or flexible wrap around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120 Volt, single phase with wattage as required. The heater wattage and voltage shall be embossed on the motor nameplate.

## 2.05 WINDING TEMPERATURE DETECTORS

- A. Winding temperature detectors, unless specified otherwise herein shall be a factory installed, embedded, bi-metallic switch type with leads terminating in the main conduit box. This device shall protect the motor against damage from overheating caused by single phasing, overload, high ambient temperature, abnormal voltage, locked rotor, frequent starts or ventilation failure. The switch shall have normally open contacts. Not less than three detectors shall be furnished with each motor.
- B. All motors operating with variable frequency drives shall be equipped with winding temperature detectors.

## 2.06 THREE PHASE INDUCTION MOTORS

- A. Motors 30 horsepower and larger shall have a 120-volt space heater for moisture control.
- B. Unless specifically noted in other Sections of these Specifications, all motors shall have minimum efficiencies as listed below:

| <u>Horsepower</u> | <u>NEMA Nominal<br/>Efficiency, %</u> |
|-------------------|---------------------------------------|
| 1-2               | 84.0                                  |
| 3-5               | 88.5                                  |
| 7-1/2             | 89.5                                  |
| 10                | 90.2                                  |
| 15                | 91.0                                  |
| 20                | 92.0                                  |
| 25                | 92.2                                  |
| 30                | 92.4                                  |
| 40-50             | 94.0                                  |
| 60-100            | 94.5                                  |
| Over 100          | 95.0                                  |

## 2.07 CONSTRUCTION

- A. General:
1. All drip-proof and weather protected Type I and Type II motors shall have epoxy encapsulated windings. Totally enclosed motors shall be provided with an upgraded insulation by additional dips and bakes to increase moisture resistance and shall not be encapsulated. Motors for outdoor service shall have vacuum pressure impregnated (VPI) epoxy insulation for moisture resistance. Two speed motors shall be of the two winding type.

2. Squirrel-cage rotors shall be made from high-grade steel laminations adequately fastened together and to the shaft, or shall be cast aluminum or bar-type construction with brazed end rings.
3. All motors shall be of the premium efficiency and high power factor type. All motors shall be the corrosion resistant type conforming to motors designated as "Corro-Duty" by U.S. Motors or equal.
4. Vertical motors shall be hollow or solid shaft as required by the equipment furnished under other Sections of these Specifications.
5. Totally enclosed non-ventilated (TENV) motors shall include the same ratings and accessories as specified for TEFC motors. Explosion-proof motors shall be UL listed and FM approved for Class 1, Division 1 hazardous areas.

B. Low Voltage, Three Phase Motors:

1. Motors shall be of the squirrel-cage induction type. Horizontal, vertical solid shaft, vertical hollow shaft, normal thrust and high thrust types shall be furnished as called for on the Drawings and as specified in other Sections of these specifications. Motors shall be of the type and quality described by these Specifications, and/or as shown on the schedule on the Drawings, fully capable of performing in accordance with Manufacturer's nameplate rating, and free from defective material and workmanship.
2. Motors shall have normal or high starting torque (as required), low starting current (not to exceed 650 percent full load current), and low slip.
3. Unless otherwise specified, motors shall be totally enclosed fan-cooled construction with a 1.15 service factor at the Class B Temperature-Rise.
4. The output shaft shall be suitable for direct connection or belt drive as required.
5. Motors shall have a Class F non-hygroscopic insulation system but shall be limited to Class B Temperature-Rise, at 1.15 service factor.
6. All motors shall have a final coating of chemical resistant corrosion and fungus protective epoxy fortified enamel finish sprayed over red primer over all interior and exterior surfaces. Stator bore and rotor of all motors shall be epoxy coated.
7. All fittings, bolts, nuts, and screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads.
8. All machine surfaces shall be coated with rust inhibitor for easy disassembly.
9. Conduit box shall be split from top to bottom and shall be capable of being rotated to four 90 degree positions. Synthetic rubber-like gaskets shall be provided between the frame and the conduit box and sealed with a non-wicking, non-hygroscopic insulating material. A frame mounted pad with drilled and tapped hole, not less than 1/4-inch diameter, shall be provided inside the conduit box for motor frame grounding. All motor conduit boxes shall be provided with the correct number of conduit openings sized as indicated on the drawings. Boxes shall be suitably sized for conductor bending and terminations.

10. Totally enclosed motors shall be provided with condensate drain hole and epoxy coated motor windings to protect against moisture.
11. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all frames 254T and larger. Enclosures shall have stainless steel screens. Motors shall be protected for corrosion, fungus and insects.
12. Low voltage, three phase motors shall be manufactured by U.S. Motors, TECO, Marathon, Siemens, General Electric, Toshiba or Reliance Electric.
13. Fractional Horsepower:
  - a. Fractional horsepower motors shall be rigid, welded-steel, designed to maintain accurate alignment of motor components and provide adequate protection. End shields shall be cast iron or heavy fabricated steel. Windings shall be of varnish-insulated wire with slot insulation of polyester film, baked-on bonding treatment to make the stator winding strongly resistant to heat, aging, moisture, electrical stresses and other hazards.
  - b. Motor shaft shall be made from high-grade, cold-rolled shaft steel with drive-shaft extensions carefully machined to standard NEMA dimensions for the particular drive connection.
  - c. For light to moderate loading, bearings shall be quiet all-angle sleeve type with large oil reservoir that prevents leakage and permits motor operation in any position.
  - d. For heavy loading, bearings shall be carefully selected precision ball bearings with extra quality, long-life grease, and large reservoir providing 10 years' normal operation without re-lubrication.
14. Integral Horsepower:
  - a. Motor frames and end shields shall be cast iron or heavy fabricated steel of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed.
  - b. Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibrations.
  - c. The shaft shall be made of high-grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in motors of the particular rating. Bearing journals shall be ground and polished.
  - d. Rotors shall be made from high-grade steel laminations adequately fastened together, and to the shaft. Rotor squirrel-cage windings may be cast-aluminum or bar-type construction with brazed end rings.
  - e. Motors shall be equipped with vacuum-degassed anti-friction bearings made to AFBMA Standards, and be of ample capacity for the motor rating. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent lubrication, but facilities shall be provided for adding new lubricant and draining out old lubricant without motor disassembly. The bearing housing shall have long, tight, running fits or rotating seals to protect against the entrance of foreign matter into the bearings, or leakage of lubricant out of the bearing cavity.
  - f. Bearings of high thrust motors will be locked for momentary up-thrust of 30 percent down-thrust. All bearings shall have a minimum B10 life rating of 5 years in accordance with AFBMA life and thrust values.
  - g. Vertical hollow-shaft motors will have non-reverse ratchets to prevent backspin. Non-reverse ratchets shall be suitable for duty with variable frequency drives.

C. Low Voltage, Single Phase Motors:

1. Single phase motors shall be split-phase and capacitor-start induction types rated for continuous horsepower at the rpm indicated on the drawings or as required by the specifications. Motors shall be rated 115/230 volts, 60 Hertz, single phase, open drip-proof, or totally enclosed fan cooled as indicated on the drawings or as required by the specifications, with temperature rise in accordance with NEMA Standards for Class B insulation.
2. Totally enclosed fan cooled motors shall be designed for severe-duty.
3. Motors shall have corrosion and fungus protective finish on internal and external surfaces. All fittings shall have a corrosion protective plating.
4. Mechanical characteristics shall be the same as specified for polyphase fractional horsepower motors.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Motor Connections: All motors shall be connected to the conduit system by means of a short section 18-inch minimum of liquid tight conduit unless otherwise indicated. For all motor connections of No. 4 AWG or larger wire size, the CONSTRUCTION CONTRACTOR shall install a grounding conductor in the conduit and terminate at main conduit box and at the motor control center or variable frequency drive with approved ground lugs and clamps.
- B. Low Voltage: For wire sizes #8 AWG and larger, long barrel tin-plated copper compression (hydraulically pressed) type connections (Burndy Co., or equal) shall be installed on the branch circuit wires and the motor leads. Bolted connections shall utilize products which are rated for vibration applications (bolt, nut and spring washer). All connections shall be insulated with heavy duty heat shrinkable material (Raychem Corp. or equal).

3.02 TESTS AND CHECKS

- A. The following tests shall be performed on all motors after installation but before putting motors into service.
  1. The CONSTRUCTION CONTRACTOR shall megger (1000 volts DC) each motor winding before energizing the motor, and, if insulation resistance is found to be low, shall notify the ENGINEER and shall not energize the motor. The following table gives minimum acceptable insulation resistance in megohms at various temperatures and for various voltages with readings being taken after one (1) minute of megger test run.

| <u>Degrees</u><br><u>Winding Temperature</u> |          | <u>Voltage</u> |               |              |
|--|----------|----------------|---------------|--------------|
| <u>F</u>                                     | <u>C</u> | <u>115 V.</u>  | <u>230 V.</u> | <u>460V.</u> |
| 37   | 3.9      | 60             | 108           | 210          |
| 50   | 10       | 32             | 60            | 120          |
| 68   | 20       | 13             | 26            | 50           |
| 86   | 30       | 5.6            | 11            | 21           |
| 104  | 45       | 2.4            | 4.5           | 8.8          |
| 122  | 50       | 1              | 2             | 3.7          |
| 140  | 60       | 0.50           | 0.85          | 1.6          |

2. The CONSTRUCTION CONTRACTOR shall check all motors for correct clearances and alignment and for correct lubrication, and shall lubricate if required in accordance with Manufacturer's instructions. The CONSTRUCTION CONTRACTOR shall check direction of rotation of all motors and reverse connections if necessary. The correction for wrong rotational direction shall be made at the motor.
  3. All tests shall meet the requirements of, but not be limited to, IEEE 43, 85 and 112. Efficiency tests for IEEE 112 shall include Method B.
  4. The CONSTRUCTION CONTRACTOR shall provide to the ENGINEER a typed list of all motors 1 HP and larger listing the no load motor current and voltage and the full load current and voltage. Any phase current imbalance greater than 10% shall be reported to the ENGINEER.
- B. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the InterNational Electrical Testing Association (NETA Standard ATS).

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SECTION 16191  
MISCELLANEOUS EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install all miscellaneous equipment as shown on the Drawings and as specified herein.
- B. This Section provides the requirements for miscellaneous equipment typically employed in a facility, however, not all components specified in this Section are necessarily utilized on this project.

1.02 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Section 01300, detailed catalog information or drawings with sufficient detail to determine compliance with the specifications including describing electrical and physical characteristics of all equipment specified.

1.03 REFERENCE STANDARDS

- A. Equipment enclosures shall have NEMA ratings suitable for the location in which they are installed, as specified in Section 16000.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Disconnect Switches
  - 1. Disconnect switches shall be NEMA 4X heavy-duty, quick-make, quick-break, visible blades, 600 Volt, 3 Pole with full cover interlock, interlock defeat and flange mounted operating handle unless otherwise noted. All current carrying parts shall be copper.
  - 2. NEMA 4X enclosures shall be stainless steel.
  - 3. NEMA 7 enclosures shall be cast aluminum.
  - 4. Lugs shall be copper.
  - 5. All exterior hardware shall be stainless steel.
  - 6. Switches shall be as manufactured by Eaton or Schneider Electric/Square D Company.
- B. Fused Disconnect Switches
  - 1. Fused disconnect switches shall be NEMA 4X heavy-duty, quick-make, quick-break, visible blades, 600 Volt, 3 Pole with full cover interlock, interlock defeat and flange mounted operating handle unless otherwise noted. All current carrying parts shall be copper.

2. Fuses shall be rejection type, 600 Volts, 200,000 A.I.C., dual element, time delay, Bussman Fusetron, Class RK-5 or equal.
3. NEMA 4X enclosures shall be stainless steel.
4. NEMA 7 enclosures shall be cast aluminum.
5. Lugs shall be copper.
6. All exterior hardware shall be stainless steel.
7. Switches shall be as manufactured by Eaton or Schneider Electric/ Square D Company.

C. Manual Motor Starters

1. Manual starters shall be furnished and installed for all typed of single-phase motors. Manual starters shall be non-reversing, reversing or two speed type as required. NEMA sizes shall be as required for the actual horsepower of the motor furnished. Manual starters shall have motor overload protection in each phase. Built-in control stations shall be furnished as required or as shown on the Drawings.
2. NEMA 4X enclosures shall be stainless steel.
3. NEMA 7 enclosures shall be cast aluminum.
4. Manual motor starters shall be as manufactured by Eaton or Schneider Electric/Square D Company.

D. Magnetic Motor Starters

1. Motor starters shall be 2 or 3 Pole, single or 3 Phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing unless otherwise shown on the Drawings. NEMA sizes shall be as required for the horsepowers shown on the Drawings.
2. Two speed starters shall be for single or two winding motors as required by the actual motor furnished or as shown on the Drawings.
3. Each motor starter shall have a 120 Volt operating coil, and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as required or as shown on the Drawings. A minimum of one N.O. and one N.C. auxiliary contacts shall be provided in addition to the contacts shown on the Drawings.
4. Overload relays shall be non-adjustable, ambient compensated and manually reset.
5. Control power transformers shall be sized for additional load where required. Transformer secondaries shall be equipped with time-delay fuses.
6. Built-in control stations and indicating lights shall be furnished as specified herein where shown on the Drawings.
7. NEMA 4X enclosures shall be stainless steel.

8. NEMA Type 7 enclosures shall be cast aluminum.
9. Magnetic motor starters shall be as manufactured by Eaton or Schneider Electric/ Square D Company.

E. Combination Magnetic Motor Starters

1. Motor starters shall be a combination motor circuit protector and contactor, 2 or 3 Pole, single or 3 Phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing unless otherwise shown on the Drawings. NEMA sizes shall be as required for the horsepower shown on the Drawings. Motor circuit protectors shall be molded case with adjustable magnetic trip only. They shall be specifically designed for use with magnetic motor starters. Motor circuit protectors shall be current limiting type, with additional current limiters if required. Combination motor starters shall be fully rated for 65,000 Amps RMS symmetrical.
2. Reduced voltage starters: Solid state, six SCR, full wave type with adjustable current limit and voltage ramp to control starting torque, automatic load sensing circuit to minimize energy consumption, line and load side surge protection and noise suppression and controlled deceleration adjustment to reduce the effects of surges caused by centrifugal pump loads. Provide heat sinks and ventilation to remove heat from the structure. Each starter shall include a motor horsepower rated isolation contactor to positively disconnect the line voltage when the SCR control is off.
3. Each motor starter shall have a 120 Volt operating coil, and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as required or as shown on the Drawings. A minimum of one N.O. and one N.C. auxiliary contacts shall be provided in addition to the contacts shown on the Drawings.
4. Overload relays shall be non-adjustable, ambient compensated and manually reset.
5. Control power transformers shall be sized for additional load where required. Transformer secondaries shall be equipped with time-delay fuses.
6. Built-in control stations and indicating lights shall be furnished as specified herein where shown on the Drawings.
7. NEMA 4X enclosures shall be stainless steel.
8. NEMA Type 7 enclosures shall be cast aluminum.
9. Combination magnetic motor starters shall be as manufactured by Eaton or Schneider Electric/ Square D Company.

F. Control Stations and Indicators

1. Control stations shall be heavy-duty type, with full size (30.5mm) NEMA 4X or 7 operators, indicators, etc.
2. Indicators shall be full voltage and push-to-test type. Indicators located indoors shall be LED type and indicators located outdoors shall be incandescent lamp type.

3. NEMA 4X enclosures shall be stainless steel.
4. NEMA 7 enclosures shall be cast aluminum.
5. Control stations shall be Square D Company Class 9001, similar by Eaton or General Electric Company.

G. General Purpose Dry Type Transformers

1. Transformers shall be dry type, two-winding with kVA and voltage ratings as shown on the Drawings.
2. Four full capacity taps shall be furnished, two 2-1/2 percent above and four 2-1/2 percent below rated primary voltage.
3. Maximum temperature rise shall be 80 degrees C. Windings shall be copper.
4. Transformers shall be built in accordance with ANSI C89.2 and NEMA ST-20.
5. Transformers shall be provided in NEMA 1 enclosures unless otherwise noted on the Drawings or as required by Section 16000. Where a NEMA 4X and/or stainless steel enclosure is required, the transformer shall be of the TENV type.
6. Transformers shall be furnished with hot dipped galvanized mounting hardware. Where a NEMA 4X and/or stainless steel enclosure is required, the hardware shall be 316 stainless steel.
7. Transformers shall be manufactured by Eaton or Schneider Electric/ Square D Company.

H. Transformer-Panel Assembly

1. Each Transformer-Panel Assembly (TPA) shall include a main primary breaker, a dry type transformer and a secondary panelboard with main breaker.
2. Enclosures shall be type NEMA 1 enclosures unless otherwise noted on the Drawings or as required by Section 16000. Main primary, secondary, and feeder breakers shall be enclosed with a padlockable hinged door. Where NEMA 3R stainless steel enclosure is required, the hardware shall be 316 stainless steel.
3. Transformers shall be dry type, two-winding with kVA and voltage ratings as shown on the Drawings.
4. Transformer windings shall be copper, 115-degree C rise, epoxy-resin encapsulated with two full capacity taps rated 5 percent below rated primary voltage.
5. Interconnecting wiring between the primary breaker and transformer, transformer and secondary main breaker, and secondary main breaker and distribution section shall be factory installed.
6. Panelboard bus shall be copper.

7. TPA main primary breaker shall have a minimum interrupting rating of 18 kA at 480 volts and shall be sized per manufacturer's standard for the kVA size.
8. TPA secondary main breaker shall have a minimum interrupting rating of 10 kA at 240 volts and shall be sized per manufacturer's standard for the kVA size.
9. TPA feeder breakers shall be bolt-on type with a minimum interrupting rating of 10 kA.
10. Panelboard section shall include copper equipment ground bar.
11. TPA shall be Mini Power-Zone as manufactured by Schneider Electric/Square D or Mini-Power Center as manufactured by Eaton.

I. Lightning and Surge Protection

1. Transient voltage surge suppressors (TVSS) also known as surge protective devices (SPD) shall be provided as indicated on the Drawings.
2. TVSS devices shall be tested and labeled in accordance with the latest edition of the following standards: ANSI/IEEE C62.41, ANSI/IEEE C62.45, NEMA LS-1, UL 1449, UL 1283 and NEC Article 285.
3. The TVSS shall be UL listed at or above the available fault current level at the point of TVSS application by UL, per UL 1449 latest edition.
4. The TVSS shall be of a parallel design using fast-acting energy protection that will divert and dissipate the surge energy.
5. Each TVSS shall incorporate 200kAIC fusing and shall monitor all modes of protection and provide LED indicator lights to provide positive operational status of each protected phase.
6. Minimum surge current ratings shall be as follows:
  - a. Switchgear, switchboards, or distribution panels – 300 kA per phase (150 kA per mode).
  - b. Motor control centers – 160 kA per phase (80 kA per mode).
  - c. Branch panels or control panels, 480 volts – 160 kA per phase (80 kA per mode).
  - d. Branch panels, single phase 120/240 volts or three phase 120/208 volts – 80 kA per phase (40 kA per mode).
7. Manufacturers: Innovative Technologies or approved equal.

J. Wireway

1. NEMA 1 wireway shall be gasketed painted steel with stainless steel screw covers.
2. NEMA 4X wireway shall be 316 stainless steel with gasketed clamped covers.
3. NEMA 1 wireway shall be Square-Duct as manufactured by the Square D Co.; NEMA 4X shall be Bulletin F-22 as manufactured by the Hoffman Engineering Co. or equal.

K. Control Relays

1. Control relays shall be heavy duty machine tool type, with 10 Amp, 300 Volt convertible contacts. Number of contacts and coil voltage shall be as shown on the Drawings. General use relays shall be Square D Company, Class 8501 Type X, similar by; Cutler-Hammer, Allen-Bradley Company or General Electric Company. Latching relays shall be Square D Company, Class 8501 Type X, similar by; Cutler-Hammer, Allen-Bradley Company or General Electric Company.
2. Time delay relays shall be pneumatic, 600 Volt, 20 Amp contacts, with calibrated knob operated adjustment and numerical time dial. On delay and off delay types and timing ranges shall be as shown on the Drawings or as required for proper operation of the actual equipment furnished. Relays shall be Agastat Model 7012 or 7022 or equal.

L. Polyethylene Warning Tape

1. Warning tape shall be 5 mil red polyethylene film, 6-in minimum width. Tape shall be capable of being detected or located by either conductive or inductive location techniques.
2. Warning tape shall be Mutual Industries Part No. 17774 or equal.

M. Terminal Blocks

1. Terminal blocks shall be 600 Volt, channel mounted, with tubular screw and pressure plate.
2. Terminal blocks shall be Bulletin 1492-CA1 as manufactured by the Allen-Bradley Co. or equal.

N. JIC Boxes for GF Receptacles

1. JIC boxes shall be 6-inches x 6-inches x 4-inches aluminum continuous hinge clamp cover boxes, Hoffman Catalog Number A-606 CHAL with Type L23 stainless steel fast operating JIC clamp, or equal.
2. Install 1-1/2-inch bushings in bottom of box for cord and plug to pass through.

O. Corrosion Inhibitors

1. All equipment enclosures, terminal boxes, etc, located in a NEMA 4X rated area (where shown on the Drawings) that contains electrical or electronic equipment or terminal strips shall be furnished with an internally mounted, chemically treated corrosion inhibitor pad.
2. The corrosion inhibitor pads shall be as manufactured by Hoffman Engineering Co.; 3M or equal.

P. Equipment Mounting Stands

1. Equipment mounting stands shall be custom fabricated from 1/4-in 316 stainless steel plate and 3-in 316 stainless steel channel, unless otherwise shown on the Drawings.
2. All hardware shall be 316 stainless steel.

Q. Terminal Cabinets:

1. Interiors shall be so designed that control relays and terminal blocks can be replaced or added without disturbing adjacent units. Each cabinet shall be furnished with a minimum of 50 spare terminals.
2. All interiors shall be completely factory assembled with control relays, terminal blocks, insulating barriers, etc. All 120 volt AC and DC terminal blocks shall be isolated from each other by insulating barriers or separate enclosures.
3. All wiring within the cabinets shall be grouped together in harnesses and secured to the structure.
4. All shielded cables shall terminate in separate cabinets. A third terminal shall be provided for each twisted shielded pair and the shield for each connected thereto, unless otherwise noted on manufacturer's shop drawings.
5. Terminal blocks shall be tubular screw type with pressure plates and shall be rated 600 volts. Terminal blocks shall be Allen Bradley Catalog Number 1492-CA1 or equal.
6. Boxes shall be made from 14-gauge galvanized steel and shall be of sufficient size to provide a minimum of 4 inches of wiring space on all sides and between adjacent terminal blocks. A minimum 2-inch spare shall be provided between control relays. A minimum of four mounting studs shall be provided on each cabinet. Cabinets shall be furnished without knockouts. Holes for raceways shall be drilled on the job.
7. A single or double hinged door shall cover the front of each terminal cabinet. Doors shall have a neoprene gasket, vault type handle, three-point catch and lock. Two keys shall be supplied for each lock. All locks shall be keyed alike. A terminal block schedule shall be provided with each terminal point numbered and identified (typewritten) as to function.
8. All exterior and interior steel surfaces of the cabinets shall be properly cleaned and finished with ANSI 61 grey over a rust-inhibiting phosphatized coating conforming to ANSI A55.1. The finish paint shall be of a type to which field applied paint will adhere.
9. Cabinets in wet, damp, corrosive and all outdoor locations shall be NEMA 4X 316 stainless steel.
10. Cabinets shall be Hoffman Engineering Company with latch kit hardware or be an equal product.

R. Break-Glass Emergency Station

1. Break-Glass Emergency Station shall be of the break glass design with a weatherproof cast metal outer case finished in fire red and have an attached chain hung "Hammer". A glass panel shall be mounted in front of the push button operator. Switch contacts shall be 1-open, 1-closed, rated 10 Amp, 600 Volts.
2. A black phenolic nameplate with engraved white lettering to read: GENERATOR EMERGENCY STOP (28 characters maximum) shall be fastened to the outer case front. Station shall be equal to Key Systems, Inc., Catalog No. 561-S (Surface mounting), 561 (Semi-flush mounting), similar by Crouse-Hinds; Killark or equal.

S. Power Monitors

1. Microprocessor based metering: At each circuit location shown on the Drawings, furnish a digital microprocessor based metering device capable of monitoring and displaying the functions listed below. The device shall provide the status input functions indicated and the capability to communicate data to a centralized monitoring system via a data highway network. The device shall be UL listed. The device shall be Siemens PAC4200, or approved equal, and include a communications card for interface with PROFIBUS DP control system. Coordinate with the Division 13 specifications and the Instrumentation Drawings for the data acquisition parameters requirements.
2. Metering Functions
  - a. The Digital AC Instrumentation Package shall be capable of measuring, calculating and directly displaying on the front panel display the following information:
    - 1) Volts on each phase plus average of all three phases.
    - 2) Current on each phase plus average of all three phases.
    - 3) Neutral or ground current.
    - 4) Frequency.
    - 5) Power Factor.
    - 6) KVA.
    - 7) KVAR.
    - 8) KW.
    - 9) Total KWH as an accumulating total, providing bi-directional (import/export) indication.
    - 10) Total KVARH as an accumulating total, providing bi-directional (import/ export) indication.
    - 11) Amps Demand.
3. Monitoring and Control Functions
  - a. Provide eight self-powered digital status inputs to monitor the following points:
    - 1) Circuit breaker OPEN status.
    - 2) Circuit breaker CLOSED status.
    - 3) Circuit breaker TRIPPED status.
    - 4) Circuit breaker OUT OF SERVICE (withdrawn) status.
  - b. Provide one auxiliary analog input rated 1.0 VAC/VDC nominal full scale input which can be used to measure an external variable such as transformer temperature, air temperature, or battery voltage.
  - c. Provide one auxiliary analog output (selectable 0-20ma or 4-20ma) proportional to any measure parameter.
  - d. Provide three Form C dry contact control relay outputs rated 277 VAC or 30 VDC at 10 Amp maximum load current, that can each function as:
    - 1) Setpoint relays that operate as a function of any measured parameter for demand, power factor, or load control. Seventeen programmable setpoints shall each have programmable operate and release limits and time delays on operate and release. Relays shall provide selectable pulse mode or tach mode operation.
    - 2) Remote control relays operated by commands via the communications port.
    - 3) Breaker trip relay (over/under volt, volt unbalance, phase reversal, current unbalance, over/under frequency).
    - 4) KWH or KVARH pulse output relay.
    - 5) Alarm relays.
4. Operational Features

- a. Provide the following operating features:
    - 1) True RMS measurements.
    - 2) Connect directly to PT's and CT's for systems over 600 volts.
    - 3) Provision for a fourth current input for measurement of ground or neutral current.
    - 4) 300 amp, one second surge protection on all four current inputs.
    - 5) 3-field, 20 character, high visibility 0.4-in character height vacuum-fluorescent display with a programmable time out feature.
  - b. Store in non-volatile memory the following:
    - 1) A time-stamped alarm and event log of up to 50 events which records event date, time (to 1 second), event type and value for all over/under limit conditions, all status input activity and all relay operations. Log shall be read via the communications port.
    - 2) A time-stamped minimum/maximum log, which records the value of any parameter exceeding the previous highest or lowest value recorded. Log shall be read from the front panel display or via communication port.
    - 3) A time-stamped snapshot (historical) log, with a 100 snapshot capacity and user-definable snapshot interval from 1 second to 400 days which records snapshot values for Average Volts, Average Amps, KW, KVAR, KW Demand, Power Factor, Frequency, KWH, KWH Reverse, KVARH and Auxiliary Volts Input. Log shall be read via the communications port.
    - 4) All setup data.
5. The device shall be field programmable as follows:
- a. Volts scale, volts mode (wye, delta, single phase), amps scale, Vaux scale, baud rate and the relay operation shall be programmable from the front panel.
  - b. All parameters above, plus additional alarm/event parameters shall be programmable via the communications port using a portable terminal or a computer.
    - 1) The programming shall be password protected.
6. Waveform Capture
- a. Provide waveform capture capability allowing any of the eight voltage and current input channels to be digitally sampled at 256 samples/60 Hz cycle. Waveform capture shall be initiated using commands made via the communications port. Waveform capture data shall be made accessible via the communications port.
7. Data Communications
- a. Provide a serial communication port which has:
    - 1) Switchable RS-232C and RS-485 capability.
    - 2) Addressable polling of multiple units.
    - 3) Packet transmission.
    - 4) Selectable transmission at 300 to 19,200 baud.
  - b. Provide all communication cables to interconnect monitors within the electrical equipment.
  - c. All necessary cables, connectors, software, hardware, etc. shall be provided as required to interface with a computer system and/or related PLCs as specified herein or in other Sections and Divisions of the specifications.

## 2.02 CONTROL SYSTEM

- A. The Manufacturer shall provide a complete and fully functional control system to manually or automatically operate the control system as specified herein and in other applicable sections of these specifications. All Manufacturers recommended safety devices shall be furnished to

protect operators. All control devices, unless specified otherwise, shall be mounted in the Control Panel.

B. Control Panel Construction

1. The control panel shall consist of a main circuit breaker, a motor circuit protector (MCP) and magnetic starter for each motor, and a 120-volt control power transformer (fused on primary and secondary). All control components shall be mounted in one common enclosure. Control switches shall provide means to operate each motor manually or automatically. Where variable frequency drives (VFD) are required, thermal magnetic circuit breakers shall be provided and all controls for VFD speed adjustment and speed monitoring shall be accessible from the front door.
2. Where variable frequency drives are required, they shall be mounted within the specified enclosures and meet the requirements of this section. Refer to Section 16370 for additional variable frequency drive requirements.
3. Unless specifically noted otherwise, the electrical control equipment shall be mounted within a NEMA 4X enclosure, constructed of not less than 14 gauge 316 stainless steel. Latches shall be quarter turn quick release type and all hardware shall be 316 stainless steel. Where NEMA 3R or 12 enclosures are specifically required, the door shall be provided with a pad-lockable vault type 3-point latch. The enclosure shall be equipped with a door and shall incorporate a removable back panel on which control components shall be mounted. Back panel shall be secured to enclosure with collar studs. Door(s) shall be interlocked with main circuit breaker and provided with pad-locking provision.
4. All motor branch circuit breakers, motor starters and control relays shall be of highest industrial quality, securely fastened to the removable back panels with screws and lock washers. Back panels shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any component.
5. A thermal-magnetic air circuit breaker, Type FH (65KAIC) as manufactured by the Square D Company, or equal, shall be furnished for the main breaker. All circuit breakers shall be sealed by the manufacturer after calibration to prevent tampering. Each circuit breaker shall be adequately sized to meet the equipment operating conditions. Motor Circuit Protectors (MCP) shall be molded case with adjustable magnetic trip only, "Mag-Gard" as manufactured by the Square D or equal.
6. An open frame, across-the-line, NEMA-rated magnetic motor/starter, Class 8536 as manufactured by the Square D Company, or equal, shall be furnished for each motor. All motor starters shall be provided with motor circuit protectors and equipped to provide under-voltage release and overload protection on all three phases. Motor starter contacts shall be easily replaceable without removing the motor starter from its mounted position. Overloads shall be of the melting alloy or bi-metallic type, adjustable overloads are not acceptable, Class 10 quick trip overloads shall be provided for all submersible motors. Overload reset push-buttons shall be located on the exterior of the door. Normally open and normally closed auxiliary motor overload contacts wired to terminal blocks shall be provided for each motor starter within the control panel.
7. Reduced voltage starters: Solid state, six SCR, full wave type with adjustable current limit and voltage ramp to control starting torque, automatic load sensing circuit to minimize energy consumption, line and load side surge protection and noise suppression and

controlled deceleration adjustment to reduce the effects of surges caused by centrifugal pump loads. Provide heat sinks and ventilation to remove heat from the structure. Each starter shall include a motor horsepower rated isolation contactor to positively disconnect the line voltage when the SCR control is off.

8. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by Divisions 13, 16 and as shown on the drawings.
9. All operating control and instruments shall be securely mounted on the exterior door. All controls and instruments shall be clearly labeled to indicate function. All exterior mounted equipment shall be NEMA 4X.
10. Mode selector switches shall be Hand-Off-Auto type to permit override of automatic control and manual actuation of shutdown. Switches shall be NEMA 4X (800H) as manufactured by Allen-Bradley, or equal, providing three (3) switch positions, each of which shall be clearly labeled according to function.
11. Indicator lamps shall be LED (indoors) or Incandescent (outdoors) full voltage type and mounted in NEMA 4X (800H) modules, as manufactured by Allen-Bradley. Lamp modules shall be equipped to operate at 120-volt input. Lamps shall be easily replaceable from the front of the control compartment door without removing lamp module from its mounted position. Indicators shall be provided for individual motor run and an indicator for each failure condition.
12. A six (6) digit, non-reset elapsed time meter shall be connected to each motor starter to indicate the total running time of each motor in "hours" and "tenth of hours". The elapsed time meters shall be Series T50 as manufactured by the ENM Company or equal.
13. A failure alarm with horn and beacon light shall be provided. Silence and reset pushbuttons shall also be furnished. A common failure reset pushbutton shall be provided to reset the alarm conditions (reset shall occur only if fault condition has been cleared). The alarm horn shall be weatherproof rated with gasket (Federal Signal Corporation, Cat. #350 or equal). The alarm beacon shall be NEMA 4X rated, red lens and solid state flasher (Ingam Products Inc. LRX-40).
14. The control panel shall operate on a power supply of 480 volts, 3-phase, 60 Hertz unless otherwise noted.
15. The control diagrams and overload tables shall be laminated to the inside of the door except where door space is limited the laminated documents shall be in the print storage pocket.
16. Print storage pockets shall be provided on the inside of each panel. Pocket shall be of sufficient size as required to hold all prints necessary to service the equipment. A set of reduced drawings shall be provided for each panel, fixed to fit in the storage pocket.
17. A duplex GFCI utility receptacle (circuit breaker protected) providing 120 volts, 60 Hertz, single phase current shall be mounted on the side of the enclosure.
18. The control panel shall include an adjustable time delay relay to prevent any two motors from starting simultaneously. All timing relays shall be solid state, with pin (octal) and bases, relays shall be T-series as manufactured by Diversified Electronics Inc. or equal.

19. Alternators shall be provided to sequence motors, alternators shall be 008-120-13SP or 009-120-23AP as manufactured by Sta-con, or equal.
20. A phase monitor shall be provided for the control panel, monitors shall be model SUA-440-ASA as manufactured by Diversified Electronics Inc., or equal.
21. All exterior mounted equipment shall be rated NEMA 4X. Hinged NEMA 4X 316 stainless steel viewing windows will be permitted where such equipment is not available with a NEMA 4X rating.
22. The control panel shall be provided with lightning and surge protection. Protection devices shall be mounted within the control panel enclosure. Lead lengths shall not be longer than 12 inches from the main circuit breaker and as straight as possible. Protection shall be rated for peak current 80kA per phase, non-modular design. Advanced Protection Technologies series TE/XF or equal. Exact model number per voltage and phase power system used.
23. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers.
24. Wiring shall be stranded copper, minimum size #14 AWG (except for shielded instrumentation cable), with 600 volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation.
25. The control panel shall be provided with nameplates identifying each component, selector switches, pilot lights, etc. Nameplates shall be permanently affixed using an epoxy process (inner door nameplates shall be fastened with stainless steel screws). Nameplates shall be laminated plastic, engraved white letters with a black background.
26. All control panels shall be provided with a master nameplate located on the exterior door.
27. Where applicable provide a nameplate which reads as follows "CAUTION - THIS PANEL CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE." Letters shall be black on a high visibility yellow background.
28. Corrosion Inhibitor Emitter: Inclusion of an industrial corrosion inhibitor emitter that shall protect internal components of control panel from corrosion for up to one year. One spare emitter shall be provided for each control panel.
29. All control relays shall have 10 amp rated contacts (minimum), 11 pin with mounting base, 3PDT (minimum), with LED indicators to show relay status, relays shall be manufactured by Potter Brumfield or equal.
30. Terminal blocks shall be 600 volt heavy duty rated, tubular clamp type. Terminal strips shall be Allen Bradley catalog #1492-CA-1 or equal. Each terminal shall be individually labeled.
31. The completed control panel assembly shall be U.L. certified. The minimum overall short-circuit withstand rating of the control panel and devices shall be 65,000 Amperes RMS symmetrical at 480 volts.
32. Intrinsically safe relays shall be solid state type with 5 amp output contacts, suitable for use on 120 volt, 60 hertz power supply and shall be Factory Mutual approved for devices in

Class 1, Division 1 hazardous atmospheres. Intrinsically safe relays shall be Gems Solid State Safe-Pak as manufactured by Gems Sensors, Division of Transamerica Delaval, Inc. or equal.

33. All electronic control equipment (i.e. controllers, isolators, signal boosters, transmitters, PLC's, etc.) shall be as specified in Division 13.
34. A copper ground bar with sufficient terminals for all field and panel ground connections shall be provided.
35. All signal wiring entering and exiting the control panel shall be provided with surge protection. Surge protection shall be as specified in Division 13.
36. An 8-inch (minimum) clear space within the enclosure shall be provided horizontally along the entire top and bottom of the control panel. A 4-inch (minimum) clear space within the enclosure shall be provided vertically along the entire sides of the control panel. No devices, terminals, etc. shall be installed within this space, the space shall be provided for field conduit and wiring access only.
37. Incoming phase conductor terminals shall be clearly identified. All wiring within the control panel shall be color coded or coded using electrical tape in sizes where colored insulation is not available. The following coding shall be used.

| <u>System</u>                                     | <u>Wire</u>           | <u>Color</u>       |
|---|-----------------------|--------------------|
| Incoming line voltage                             | Phase conductors      | Black              |
|   | Ground                | Green              |
|   | Neutral (As Required) | White              |
| Less than line voltage<br>(individual conductors) | AC                    | Red                |
|   | 24VDC                 | Blue               |
|   | 0VDC                  | White/Blue Stripes |
|   | Foreign               | Yellow             |

#### C. Spare Parts

1. The following number of spare parts shall be furnished for each control panel.
  - a. 1 Indicator light assembly.
  - b. 2 control relays for each type furnished.
  - c. 5 fuses for each type/size furnished.
  - d. 1 set thermal overloads for each size furnished.
  - e. 1 selector switch for each type furnished.
  - f. 1 starter coil for each size furnished.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

##### A. Mounting Stands

1. Field mounted disconnects, pushbutton control stations, etc., shall be mounted on 316 stainless steel stands as specified herein or as shown on the Drawings. Where clearance

requirements for stands may not be maintained, the ENGINEER may direct equipment to be wall-mounted adjacent to the motor or device, but in no case shall the distance from the motor or device to the control station exceed 3 ft.

B. Miscellaneous Equipment

1. Perform tests and adjust as required per Section 16000.
2. Provide and install identification as required per Section 16000.
3. All wiring shall be done in a neat and workmanlike manner.
4. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner or clean lint-free rags. Do not use compressed air.

END OF SECTION

SECTION 16216  
DIESEL ENGINE DRIVEN GENERATOR  
(SELF-CONTAINED WITH WEATHERPROOF SOUND ATTENUATED ENCLOSURE)

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The CONSTRUCTION CONTRACTOR shall furnish all labor, materials, equipment, tools and services, and shall install, place in operation, and field test one new skid mounted diesel engine driven generator unit with weatherproof sound attenuated enclosure, and required supporting systems as shown on the Drawings and specified herein.
- B. The unit shall have a continuous standby power rating (site rated) of not less than 937 KVA/ 750 KW at 80 percent lagging power factor with 3 phase, 60 Hertz, 480 volt, 4 wire, alternating current generator, complete with excitation system, controls, steel sub-base and all essential and desirable appurtenances. The unit shall be certified to meet the appropriate EPA Tier emission standards based upon the size and function of the engine-generator set.
- C. The unit shall be arranged for automatic starting and stopping and load electrical transfer upon failure of the normal source of utility power. Parallel operation with Power Company is not required.
- D. Units shall also be capable of remote monitoring from the plant control system. See Instrumentation Drawings and Specifications for monitoring interface requirements to the plant control system.
- E. All equipment and controls specified in this Section shall be new and be considered part of the engine generator package. The engine generator Manufacturer or his licensee shall be responsible for furnishing the package in its entirety as specified herein. Various components of the package, including interface wiring and interconnection piping shall be furnished and installed by others. However, the engine generator package shall be complete in all respects and shall include all equipment and controls necessary for a fully operational alternative electrical power supply.
- F. The equipment to be furnished under this Section includes; but shall not be limited to the following for each unit:
  - 1. Generator set with unit mounted radiator.
  - 2. Main line circuit breaker, 100% rated.
  - 3. All required ductwork for an engine driven radiator cooled unit.
  - 4. Entire engine exhaust system.
  - 5. Fuel system piping and appurtenances.
  - 6. Fuel cooler factory mounted on engine radiator.
  - 7. Flexible connectors and/or expansion joints for field piping.
  - 8. Engine generator control and instrumentation cabinet, gauges and alarms.

9. Engine mounted DC electric starting system with battery and battery charger.
10. Spring type vibration isolators.
11. Weather-proof sound attenuated enclosure.
12. JEA Standard SCADA Interface Panel
13. Spare parts and special tools.
14. Services of a Manufacturer's representative.

#### 1.02 RELATED WORK

- A. The concrete foundation is included in Division 3.
- B. All electrical equipment and work furnished under this section shall meet the requirements of Division 16.
- C. Conduit and wire within generator enclosure shall comply with Sections 16110 and 16120.
- D. Power monitoring is included in Section 16191.
- E. Regulatory provisions regarding fuel tanks are included in Section 01170.
- F. Fuel system piping, above ground bulk diesel fuel oil storage tank, and associated appurtenances are included in Section 15600.

#### 1.03 SUBMITTALS

- A. Submit shop drawings and product data, in accordance with Section 01300, which shall include the following:
  1. Copy of this specification confirming compliance with each paragraph.
  2. Shop drawings, catalog cuts, internal wiring schematics and other materials required to completely describe the systems and equipment being furnished.
  3. Identification, description and dimensions for each separately installed sub-assembly or piece of equipment and associated piping and electrical connection details and schematics.
  4. Foundation drawings, indicating size and location of anchor bolts.
  5. Performance specifications of all items of equipment.
  6. Detailed description of jacket water treatment materials and procedures.
  7. Control panel layout drawings showing interior and exterior views, dimensions, paint finish specifications and component bill of materials, and schematics.

8. Complete electrical, instrumentation, control and wiring diagrams in sufficient detail to allow installation of instrumentation and controls and electrical components. Specifically, the following is required:
  - a. Complete instrumentation and control schematics, presented in conformance with Instrument Society of America Bulletin S5.1, latest edition and NFPA 79, latest edition.
  - b. Complete electrical circuit schematics, including all generator control, alarms, and power to motors, accessories, instruments, etc. Schematics shall include all termination points in each control panel. All wiring shall be identified by numbers and every termination point shall be assigned a number. Termination point number (including wire number) shall appear on the schematics for each wiring termination shown.
  - c. Complete external electrical interconnection diagrams for wiring between control panels, switchgear and engine terminal boxes.
9. Complete Operations and Maintenance Manuals, as specified in Section 01730, covering all equipment furnished, annotated to reference only the specific model numbers supplied. Include parts lists and parts prices current to the date of submittal; include information relevant to parts supply and ordering. It is essential that this information be received prior to the startup and testing of the engine/generator unit.

B. Design Data

1. Submit design data for engine, generator, and accessories in format indicated in Paragraphs B2 through B12 (For rated KW capacity).
2. Engine Data
  - a. Manufacturer
  - b. Model
  - c. Number and arrangement of cylinders
  - d. RPM
  - e. Bore x stroke
  - f. Maximum power at rated RPM
  - g. BMEP at rated KW (including any parasitic loads and generator efficiency)
  - h. Piston speed, feet per minute
  - i. Make and model of governor
3. Generator Data
  - a. Manufacturer
  - b. Model
  - c. Rated KVA
  - d. Rated KW
  - e. Voltage
  - f. Temperature rise above 40 degrees C ambient
    - 1) Stator by thermometer \_\_\_ degrees C
    - 2) Field by resistance \_\_\_ degrees C
    - 3) Class of insulation \_\_\_ degrees C
4. Generator efficiency including excitation losses and at 80 percent PF
  - a. Full load \_\_\_ percent

- b. Three-quarters load \_\_\_\_ percent
  - c. Half load \_\_\_\_ percent
5. Guaranteed fuel consumption rate (at generator terminals/138,000 BTU/gallon)
  - a. Full load, gal/hr \_\_\_\_\_
  - b. Three-quarters load, gal/hr \_\_\_\_\_
  - c. Half load, gal/hr \_\_\_\_\_
6. Generator unit and accessories
  - a. Weight of skid mounted unit \_\_\_\_\_ lbs.
  - b. Overall length \_\_\_\_\_ inches
  - c. Overall width \_\_\_\_\_ inches
  - d. Overall height \_\_\_\_\_ inches
  - e. Exhaust pipe size \_\_\_\_\_ inches
7. Exhaust gas emissions data, maximum values at loads varying from full to 1/4 load:
  - a. Temperature \_\_\_\_\_ degrees F
  - b. Flow \_\_\_\_\_ ACFM (mass and volume)
  - c. Carbon Monoxide (CO) \_\_\_\_\_ grams/BHP-hr
  - d. Nitrogen Oxides (NOx) \_\_\_\_\_ grams/BHP-hr
  - e. Hydrocarbons (HC) \_\_\_\_\_ grams/BHP-hr
  - f. \*Sulfur Dioxide (SO<sub>2</sub>) \_\_\_\_\_ grams/BHP-hr
  - g. \*Based on \_\_\_\_ percent sulfur content by weight in the fuel
8. CFM of air required for combustion and ventilation based upon inlet air temperature of 40 degrees C: \_\_\_\_ CFM
9. Heat radiated to room by engine and generator: \_\_\_\_ BTU/min
10. Heat rejected to jacket water including lubricating oil and intercooler (if required) \_\_\_\_ BTU/min
11. Height from bottom of skid required for removing piston with connecting rod; (also for removing cylinder liner): \_\_\_\_-ft
12. The unit guaranteed to be adequate for motor starting as required by Paragraph 1.06C of this Specification.
13. Radiator (engine driven) fan cooling air volume and required BHP: \_\_\_\_\_ BHP

C. Test Reports

1. Furnish four copies of the Manufacturer's certified shop test record of the complete engine driven generator unit. The final test record shall confirm the generator set performance required in Paragraph 1.06.

1.04 REFERENCE STANDARDS

- A. Design, manufacturing and assembly, testing and installation of elements of the equipment herein specified shall be in accordance with but not limited to published standards of the following, as applicable:

1. American Gear Manufacturers Association (AGMA)
2. American Institute of Steel Construction (AISC)
3. American Iron and Steel Institute (AISI)
4. American Society of Mechanical Engineers (ASME)
5. American National Standards Institute (ANSI)
6. American Society for Testing Materials (ASTM)
7. American Welding Society (AWS)
8. Anti-Friction Bearing Manufacturers Association (AFBMA)
9. Diesel Engine Manufacturers Association (DEMA)
10. Institute of Electrical and Electronics Engineers (IEEE)
11. Instrument Society of America (ISA)
12. International Standards Organization (ISO)
13. National Electrical Code (NEC)
14. National Electrical Manufacturers Association (NEMA)
15. National Fire Protection Association (NFPA)
16. Occupational Safety and Health Administration (OSHA)
17. Steel Structures Painting Council (SSPC)
18. Underwriters Laboratories, Inc. (UL)
19. US Environmental Protection Agency (EPA) – New Source Performance Standard for Stationary Reciprocating Compression Ignition Engines (NSPS)
20. Florida Building Code (FBC)
21. Florida Administrative Code 62-762

- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

#### 1.05 QUALITY ASSURANCE

- A. The engine-generator set shall be the standard product, as modified by these specifications, of a Manufacturer regularly engaged in the production of this type of equipment and which maintains a permanent service organization and supply of spare parts in place at the time of the bid within 150 miles of the project site. The unit to be furnished shall be built from components which have proven compatibility, reliability and are coordinated to operate as a unit. To qualify as a Manufacturer, the engine must be the principal item manufactured and the completed engine generator set shall be supplied by that Manufacturer's authorized dealer only. The dealer

shall have a minimum of ten (10) years' experience in the field of power generation. The manufacturing facility shall be ISO 9001 certified. The three pre-approved vendors are Ring Power (Caterpillar), Cummins, and Zabatt Power Systems (AKSA).

- B. The unit shall be of such physical dimensions to fit into the space provided as indicated on the Drawings. Maximum overall footprint (including intake hood and discharge hood) shall be 306" long by 88" wide.
- C. The CONSTRUCTION CONTRACTOR shall require that the standby generator Manufacturer coordinate his design with the supplier of the Ozone System equipment to assure that sufficient generator reactance is provided to limit the line harmonics to acceptable levels as specified in IEEE Standard 519-2014 and to assure that the generator voltage control system will provide stable operation in the presence of such harmonics.
- D. All mechanical equipment shall be designed and built for 24-hour continuous service at any and all points within the specified range of operation without overheating or excessive vibration or strain, and require only that degree of maintenance generally accepted as peculiar to the specific type of equipment required. All parts and components of all units shall be designed and built for interchangeability so that replacement parts may be installed without any additional fitting or machining.
- E. Components of mechanical and electrical equipment shall be the products of Manufacturers who can produce evidence of their ability to promptly furnish any and all interchangeable replacement parts as may be needed at any time within the expected life of the equipment.
- F. The CONSTRUCTION CONTRACTOR shall submit information on torsional forces analysis on the engine generator package and upon request, any other additional information that the ENGINEER may deem necessary to verify that the specified generator set shall be free of harmful torsional stresses during any range of normal operation. Provide torsional test results and report to the ENGINEER.
- G. The Manufacturer shall have suitable testing facilities adequate for performing the shop tests and inspections specified herein. The CONSTRUCTION CONTRACTOR shall submit a description of the Manufacturer's testing facilities. The descriptive matter shall contain illustrative photographs, drawings and such other matter as may be requested.
- H. Services of Manufacturer's Representative
  - 1. Provide services of factory-trained service technician, specifically trained on type of equipment specified. Submit qualifications of service technician for approval. Man-day requirements listed are exclusive of travel time and do not relieve CONSTRUCTION CONTRACTOR of obligation to provide sufficient service to place equipment in satisfactory operation.
  - 2. Installation: to assist in location of anchor bolts; setting, leveling and field erection; coordination of piping, electrical, miscellaneous utility connections: 4 man-days.
  - 3. Start-up, testing and calibration: 4 man-days.
  - 4. Operation and maintenance instruction: 1 man-day.

5. Service inspections during first year of actual operation, for use at OWNER's request, and exclusive of repair, malfunction, or other troubleshooting service calls: 3 man-days (not anticipated as consecutive).

#### 1.06 UNIT PERFORMANCE

- A. The automatic voltage regulation at steady state operations shall be within plus or minus 0.25 percent from zero load to full-rated load for any load variation. Upon application or removal of full-rated load in one step, the transient voltage, and recovery to steady state operation shall be within nine seconds.
- B. Stable or steady state operation is defined as operation with the frequency variation not exceeding plus or minus 0.25 percent (0.15 Hertz) and voltage variation plus or minus 0.25 percent of their mean value for constant load from zero load to full rated load. A rheostat shall provide a minimum of plus or minus five percent voltage adjustment from rated voltage.
- C. The unit shall be sized to operate Plant at 110%, started in sequence unless otherwise specified, per JEA Facilities Standards Manual.
- D. The maximum voltage dip (including any instantaneous voltage dip) during starting shall be 20%.
- E. The generator shall be designed and manufactured with sufficient reactance so as to be capable of supplying electrical power to both new and existing solid state switching devices such as variable frequency drives, reduced voltage solid-state starters and other nonlinear electrical loads to limit the associated harmonics to acceptable and non-damaging levels, and to assure that the generator voltage control system will provide stable and proper electrical operation in the presence of such harmonics.
- F. The unit shall be in compliant to UL2200 labeled.
- G. The unit shall be in compliant to NFPA 110.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.
- B. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
- C. All mechanical and electrical equipment shall be coated, wrapped and otherwise protected from rain, drippings of any sort, dust, dirt, mud, flood and condensed water vapor during shipment and while installed in place during construction. The protective coverings shall remain in place until the work areas are substantially free of all construction dust and debris. Full details of proposed protective measures shall be submitted for approval to the ENGINEER prior to shipment. Generator space heater shall be energized at all times during storage.
- D. All units shall be properly packaged for truck shipment and especially treated for long periods of storage before use in a hot humid climate.

## 1.08 PROJECT/SITE REQUIREMENTS

- A. The engine generator shall be installed as an outdoor unit, within an acoustically-treated weatherproof enclosure. Automatic temperature controls will operate to limit the maximum summertime temperature in the area of the generator, considering full-load engine generator heat radiation to 43 degrees C (110 degrees F). All equipment furnished to install under this Section shall be designed for an ambient temperature of 43 degrees C.

## 1.09 MAINTENANCE

### A. Maintenance Service

- 1. Provide to the OWNER, at time of acceptance of the unit, a written one-year Manufacturer's standard service contract for the diesel engine generator and essential support systems, commencing on the date of acceptance of the unit. Contract shall include one preventive maintenance inspection of the installation prior to expiration of the warranty period to assure the safe and dependable operation of the system. The preventive maintenance inspection shall be in addition to the site visits specified in Paragraph 1.05 H.5 above. This service contract does not supersede or replace the Manufacturer's standard **two**-year equipment warranty.
- B. Provide one set of all special tools that are required for the normal operation and maintenance of the engine driven generator unit.
- C. Provide the following spare parts:
  - 1. Three (3) of each type of power and control fuse.
  - 2. Two (2) of each type of lamp.
  - 3. Two (2) spare lamp lenses of each color and type.
- D. The spare parts and maintenance tools shall be packed in containers, permanently labeled by word and part number for easy identification of the items and with the words "For Use Only for the Diesel Engine Generator Unit" and properly packed for an extended period of storage before use.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. The engine-generator sets shall be a factory assembled unit, specifically designed and equipped for operation on ultra-low No. 2 diesel fuel oil, and shall be Caterpillar C27, or equal as manufactured by Cummins, or equal as manufactured by AKSA. The engine and generator shall be directly connected with a semi-flexible steel coupling, shall be free from injurious torsional or other vibration and shall be vibro-mounted with a heavy steel sub-base. The diesel engine shall be vertical in-line, or V-type not over twelve cylinders, four stroke cycle, turbo-charged with intercooler using engine jacket water, full diesel, electronic fuel injection, arranged for direct connection to an alternating current generator. The unit shall operate at a rotative speed of not more than 1800 rpm and shall develop its full KW rating including radiator fan power, if so equipped at a BMEP not to exceed the following:

1. Four stroke cycle naturally aspirated 190 PSI.
  2. Four stroke cycle turbocharged 307 PSI.
  3. Four stroke cycle turbocharged with aftercooler 385 PSI using engine jacket water for aftercooler.
  4. The piston speed shall not exceed 2250 FPM.
  5. Units offered at ratings in excess of their published ratings are not acceptable and will not be approved.
- B. The engines shall be rigid, neat in appearance and shall allow easy access to the various parts for maintenance purposes. The bed plate and frame shall be of heavy construction. All parts shall be properly enclosed to prevent the throwing or dripping of oil.
- C. The engine-generator sets shall be pre-piped and pre-wired as a package unit insofar as possible. Separate pre-wired terminal boxes shall be provided on the engine-generator skid for low voltage A.C. and D.C. interface wiring.

## 2.02 ENGINES

### A. General

1. The engines shall be capable of withstanding a 5 percent overload for two hours out of every 24 hours without harmful detonation, overheating or other evidence of distress.
2. The complete engine-generator unit shall be free from harmful torsional or other vibration throughout the entire operation range of speed and load.

## 2.03 EQUIPMENT

### A. Governor

1. The engine governor shall be an electronic isochronous speed controller. Speed droop shall be externally adjustable from 0 to 10% from no load to full rated load and shall automatically adjust generator frequency from within a maximum of 0.25% of rated frequency under steady state operating no load and loaded conditions. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. The governor shall incorporate provisions for limiting fuel during start-up, and included capability for compensation adjustment. The use of generator set manufacturer's factory installed electronic engine control system to perform the governor functions of controlling fuel and speed is acceptable.
2. Furnish also a separate overspeed shutdown device which shall, in case of predetermined overspeed or the operation of various protective devices as later specified, instantly stop the engine without the fuel injection system losing its prime.

### B. Supporting Structure

1. The diesel engine-generator shall be directly bolted, doweled, and aligned on a rigid, fabricated steel base, suitably sized to maintain the correct alignment, supported by Korfund or equal heavy duty spring type vibro isolators, anchored to the outdoor enclosure.

## 2.04 SYSTEMS

### A. Fuel Oil Systems

1. Bulk diesel fuel oil storage tank shall be installed on the site.
2. The fuel system shall be integral with the engine. It shall consist of a fuel filtration system, consisting of a 10-micron particle removal cartridge, followed by a water separation cartridge, engine mounted mechanically driven transfer pump, injection pumps, supply and return fuel lines, and fuel injectors. The transfer pump shall be engine driven and shall deliver fuel under low pressure to individual injection pumps. The designed and installed fuel system shall be capable of delivering fuel flow from the bulk diesel fuel oil storage tanks to the engine fuel inlets or nozzles, at any level of fuel within the tank, sufficient for full rated operation of the engine under all ambient temperature conditions and shall return any unused fuel to the bulk diesel fuel oil storage tank.
3. Provide a fuel filter/water separator system installed on the engine and flexibly connected to the engine fuel supply. The filter shall be of the replaceable filter type, with clear water/sediment trap bowls for each. A 2-inch diameter differential pressure gauge with 0-15 psig scale and adjustable alarm switch shall be installed across the filters. Fuel shall be piped with flexible connections from the filter/water separator system to the intake of the engine fuel pump and then from the engine's fuel return to the bulk fuel storage tank fuel return. The twin element cartridge housing shall be as manufactured by Racor, or equal, with a Racor cartridge nominal 10-micron particle and a Racor cartridge for water separation.
4. Provide fuel lines as required to complete the connections of the fuel supply and fuel return between the engine and the bulk diesel fuel oil storage tank. Use diesel fuel oil impervious flexible connections at the engine fuel supply and return connections.
5. The fuel piping between the bulk fuel storage tank and the engine shall be as specified in Section 15600 and of a size recommended by the engine manufacturer and shall include flexible hose connections in both the supply and return piping. A Preferred or equal 1-inch size Fire Safe ball valve, by Contromatic or Jamesbury, shall be installed in the engine suction supply line between the bulk fuel storage tank and the diesel engine. The engine and bulk fuel tank will be located within 50 feet of each other and at similar elevations. Engine fuel pump shall be capable of pumping the necessary fuel without the need for additional pumps.
6. All parts of the fuel system shall meet the approval of, and be installed in complete compliance with, all applicable local, state and federal codes, laws and regulations.

### B. Electric (Battery) Starting Systems

1. Starting shall be accomplished by an engine mounted, solenoid shift electric starter, capable of withstanding five consecutive continuous cranking periods of 10 seconds duration each separated by 15 seconds rest periods before shutting down completely and sounding the alarm.

For engine-generator sets rated 750kW and above, a redundant electric starting motor shall be provided.

2. The starting battery(ies) shall be low maintenance, long life, lead acid type, especially designed for diesel engine cranking service, and of a capacity as recommended by the battery Manufacturer for cranking the engine being furnished, for the necessary break-away current as required and the spinning current for four consecutive starts of 15 seconds of cranking on each start, without being recharged, with a battery temperature of 45 degrees F and with the SAE 30 oil in the engine maintained at 60 degrees F. The battery(ies) shall be manufactured by CTD Power Systems, Chloride, or equal. An insulated protective covering, battery rack and suitable cables shall be provided.
3. Cell containers shall be sealed, translucent, shock absorbing, heat resistant plastic with electrolyte level marks and spray proof, flame arresting type vents. Battery shall be furnished with all connectors and hardware, lifting device, electrolyte terminal plates, cables, grease, hydrometer and brushes for cleaning posts and connectors.
4. Floor mounted structural steel battery racks shall be furnished specifically designed for battery service. The racks shall be finished with an acid and fire resistant epoxy coating and non-metallic rain covers.
5. Battery chargers shall be a UL listed, fully automatic, filtered, float-type, charger suitable for wall or rack mounting. Input voltage shall be 120 volts A.C., single phase, 60 Hz. The D.C. output shall be regulated to within one percent with plus or minus ten percent fluctuations of the input voltage and shall be current limited at 120 percent of rated output. Accessories shall include D.C. ammeter and voltmeter (panel type; 2 percent accuracy), adjustable float and equalize controls and toggle switch, A.C. and D.C. circuit breakers, A.C. power failure alarm relay, low D.C. voltage alarm relay and D.C. ground fault relay. The charger shall be Chloride Model SCR-F; LaMarche Model A12B or equal.

#### C. Air Intake Systems

1. The engines shall be equipped with suitably sized dry type air intake filter(s) to protect working parts of the engine from dirt and grit with replaceable type filter element. In-line air inlet silencers shall be provided between the turbocharger and the air inlet filter. A crankcase breather shall be included and hose extended to the radiator discharge air location on the unit.

#### D. Lubrication System

1. The engines shall be provided with a full pressure lubricating oil system arranged to cool the pistons and to distribute oil to all moving parts of the engine including the turbocharger bearings and including full flow filter of the replaceable element type and a suitably sized shell and tube type oil cooler and an AMOT or equal automatic temperature regulator. An engine driven lubricating oil circulating pump shall be provided for the engine. This pump shall be of the positive displacement type, and shall have ample capacity to circulate the amount of lubricating oil and cooling oil required by the engine and turbocharger. The engines shall be provided with a sump type crankcase arrangement of sufficient capacity to suit the requirements of the engine.

2. The engines shall be furnished with a Kenco or equal float operated oil level controller with engine mounted integral oil storage tank. It shall be installed in such a position that it will maintain a constant crankcase oil level as recommended by the engine manufacturer and visually indicate the oil level.

E. Engine Cooling Systems

1. The units shall be radiator cooled with a blower or pusher type fan mechanically driven by the engine. The radiator shall be Bronze Glow 100% dipped. Fan and belts shall be completely guarded in accordance with OSHA regulations. The cooling system shall be adequate for cooling the units at full rated load and, for installation in a climate (Northeast Florida Region) where freezing temperatures are encountered, shall be adequate for proper cooling in summer with a 50 percent ethylene glycol anti-freeze solution with rust inhibitor in the radiator, and with an ambient air temperature of 110 degrees F. A pressurized radiator cap, if used, shall be rated for not more than 6 PSI on the cooling systems. Furnish and install a suitable air discharge duct from the face of the radiator to the wall and incorporate in the wall automatic discharge dampers which shall automatically open when the unit starts and automatically close when the unit stops. The automatic dampers shall be furnished and installed as specified herein. The cooling system shall be adequate for properly cooling the unit at full rated KW capacity and with an ambient temperature of 110 degrees F. Louvers or openings shall be properly screened to prevent the entry of rodents, insects or birds.
  - a. Attached engine driven, centrifugal jacket water pump equipped with a mechanical seal and capable of circulating the required amount of jacket water through the radiator and required additional piping, to be suitably sized and furnished by engine manufacturer. Hose shall be silicone and have shut-off valves in accordance with JEA specifications.
  - b. Suitably sized full flow lubricating oil cooler.
  - c. Provide AMOT or equal automatic temperature regulators for the engine jacket water and lubricating oil which shall maintain pre-set temperature without restricting the rates of flow through the engine.
  - d. The engine thermostat shall be "AMOT" or equal which shall automatically maintain jacket water temperature at predetermined values without restricting the rate of flow through the engine.
  - e. The temperature regulators, and other cooling system components shall, as far as practical, be mounted on the engine or unit sub-base and factory piped. All external connections to the engine shall be made with flexible metal hose suitable for the pressure and temperatures involved. All pipe sizes shall be as recommended by the engine manufacturer.
  - f. As required by the manufacturer, the expansion tank shall be roof mounted adjacent to the silencer. Manufacturer shall provide all piping, supports, building modifications, etc. as required for a complete installation.
2. Provide suitable jacket water treatment for the prevention of both scale formation and corrosion in the engine water jackets and cooling system components which are in contact with the engine jacket water. This treatment shall be added to the cooling system prior to running the field acceptance test. The treatment shall be NALCOOL 2000 as supplied by and applied in strict accordance with the recommendations of the NALCO Chemical Company, 6233 West 65th Street, Chicago, IL 60638, or equal.
3. Before adding the recommended treatment, the engine jacket water system shall be thoroughly cleaned and conditioned, using NALCO 2015 Twin Pac, two step engine

cooling system cleaning treatment, or equal, strictly in accordance with the manufacturer's instructions and using particular care to thoroughly flush and remove the soda ash immediately after 15 minutes of idling engine operation.

F. Exhaust System

1. High degree exhaust silencer, Maxim Model M51, or equal, for critical grade silencing, shall be installed. The exhaust silencer noise attenuation shall be 28 to 32 dBA and be stainless steel construction. The exhaust silencer and exhaust piping shall be Type 304L stainless steel, stainless steel with flanged fittings and of the size recommended by the engine Manufacturer. Suitable stainless steel bellows expansion joints shall be provided and installed where required to provide for expansion of the pipe caused by a 1200 degree F temperature change. The exhaust system shall be connected to the engine by a suitable section of flexible stainless steel bellows construction, exhaust flex as recommended by the engine Manufacturer as suitable for the maximum temperature condition which may be encountered. All exhaust line elbows shall be long radius.
2. The silencer shall be supported by a welded stainless angle iron cradle; silencer shall be bolted or strapped to cradle and then bolted to the roof support members mounted inside the roof of the enclosure for a horizontal mounting on top of the enclosure.
3. All exhaust piping shall be Type 304L, Schedule 10S stainless steel, and the exhaust shall discharge horizontally at the silencer outlet, with 45-degree bevel cut with a stainless expanded metal bird screen.
4. The intake of the silencer shall connect to the flexible exhaust connection by stainless steel pipe. Size as required by the engine manufacturer. A flexible stainless steel exhaust adapter, 18-inch minimum length, shall be furnished for mounting between the engine and silencer. The flexible exhaust connection as specified shall mount directly on exhaust manifold and shall be mounted so that no weight is exerted on the manifold at any time.
5. It is the intent of this specification to provide complete compliance with all applicable local, State and Federal codes, laws and regulations.

G. Miscellaneous Equipment and Requirements

1. Heaters
  - a. Two automatic thermostatically controlled heaters shall be provided to maintain not less than 90 degrees F temperature with an ambient temperature of 30 degrees F (-1.11 degrees C) for the engine jacket water (sized for Northeast Florida climate) and engine lubricating oil system(s).
  - b. Each heater shall be powered by MPZ-GEN, specified under Paragraph 2.07.
  - c. All heaters shall be automatically deactivated when the engine generator unit is in operation.
  - d. All jacket water heater hoses shall be silicone type.
2. Hearing Protection
  - a. Two (2) circumaural hearing protection devices MSA Noisefoe Mark IV ear muffs or equal shall be furnished for the hearing protection of operating personnel. Provide with high impact plastic window type cabinet, suitable for wall mounting.

3. Remote Emergency Stop Break Glass Station
  - a. Two NEMA 4X emergency stop break glass stations to be located at each exterior entrance of the enclosure per NFPA 110.

## 2.05 GENERATOR CONTROL PANEL

- A. An engine mounted steel control panel shall be furnished and mounted on the generator skid unit. The panel shall be EMCP 4.2, or equal and shall contain, but not be limited to, the following equipment / function:
  1. Frequency Meter, dial type.
  2. Voltmeter, 2 percent accuracy.
  3. Ammeter, 2 percent accuracy.
  4. Ammeter phase selector switch.
  5. Voltmeter selector switch (4 position) line-to-line.
  6. Automatic starting controls as specified.
  7. Voltage level adjustment rheostat.
  8. Dry contacts for remote alarms wired to terminal strips.
  9. Main line circuit breaker, 100% rated.
  10. Individual fault indicator lights for low oil pressure, high water temperature, overspeed, and overcrank with pre-alarm and remote alarm contacts.
  11. Four position function switch marked “auto”, “manual”, “off/reset”, and “stop”.
  12. Running time meter, oil pressure and water temperature gauges.
  13. Panel lights, transformers, fuses, etc., as required.
  14. Panel mounted kilowatt meter.
  15. Unit mounted annunciator with audio/visual alarms and individual fault indicator lights. Provide additional dry contact alarm for each condition.
  16. Emergency stop pushbutton.
  17. Remote Annunciator NFPA 110.
  18. All engine-generator units shall be capable of interfacing with JEA SCADA equipment.
  19. Two normally-open dry contacts that will close when engine is running and open when engine is stopped.
  20. Programmable cycle timer (PCT) for automatic exercising.
- B. The 100% rated main line, molded case circuit breaker shall be installed on the generator unit and sized to the output of the generator. The location of the breaker (left or right hand will be

confirmed during the shop drawing review process). The trip unit for each pole shall have elements providing inverse time delay during overload conditions, instantaneous magnetic tripping for short circuit protection and ground fault tripping. The main line circuit breaker shall be installed in an oversized box.

C. Engine-Generator Interface to OWNER SCADA System

1. All engine-generator units shall be capable of interfacing with JEA SCADA equipment.
2. The following Inputs for each engine-generator set shall be set up for the interface to a Siemens ET200SP Distributed I/O Module (Model 6ES7 155-6BU00-0CU1). The ET200SP module will feed the generator status information to the SCADA equipment over Profibus DP. Contacts from the generator shall be prewired and labeled to the ET200SP. Connect Greenleaf EFC-420.1 data converter and Automatic Transfer Switch contacts.
3. Digital Inputs to ET200SP (Are to be connected in this order)
  - a. Generator Run (From Generator)
  - b. Generator Fault (From Generator)
  - c. Generator Not in Auto (From Generator)
  - d. Generator Remote Stop (From Generator)
  - e. Generator Overcrank (From Generator)
  - f. Generator Max Run Time (From Generator)
  - g. Generator Underspeed (From Generator)
  - h. Generator Low Coolant Temperature (From Generator)
  - i. Generator High Coolant Temperature (From Generator)
  - j. Generator Low Coolant Level (From Generator)
  - k. Generator Low Oil Pressure Warning (From Generator)
  - l. Generator Circuit Breaker Closed (From Generator)
  - m. Battery Voltage Warning (From Generator)
  - n. Battery Fault (From Generator)
  - o. Battery Charger AC Fail (From Battery Charger)
  - p. Fuel Leak (From Greenleaf data converter)
  - q. Normal Power Available (from Automatic Transfer Switch)
  - r. Transfer Switch Normal (from Automatic Transfer Switch)
  - s. Automatic Transfer Switch Emergency (from Automatic Transfer Switch)

D. Engine-Generator Interface to JEA SCADA System with PLC S7-1200 or S7-300

1. The following inputs for each engine-generator set shall be set up for the interface to a Siemens S7-1200 or S7-300 Distributed I/O Module in SCADA via Ethernet cable. The modules will feed the generator status information from the ET200SP distributed I/O in the Generator to the SCADA equipment over Profibus. Contacts from the generator landed in the ET200SP Distributed I/O will communicate with SCADA via a shielded Ethernet cable. Connect Greenleaf EFC-420.1 data converter and Automatic Transfer Switch contacts.
2. Digital Inputs to ET200SP per JEA Standards drawings (Appendix A).
3. Analog Input to ET200SP
  - a. Fuel Level (from Greenleaf data converter)

4. The Bill of Materials below is the list of the devices to be provided and installed with each engine-generator.

| Manufacturer    | P/N                 | Description   | Qty |
|-----------------|---------------------|---|-----|
| Attabox         | AH12106C            | Enclosure, NEMA 4X, Polycarbonate, Clear cover        | 1   |
| Attabox         | BP1210A             | Back Panel, 12ga., Aluminum, Unpainted                | 1   |
| Phoenix Contact | 2907562             | Circuit Breaker, UL489 branch rated, C-Curve, 1-Pole, | 1   |
| Siemens         | 6AG1 155-6AA01-7BN0 | Interface Module, SIPLUS ET200SP IM155-6PN            | 1   |
| Siemens         | 6AG1 131-6BF01-7BA0 | Digital Input Module, SIPLUS ET200SP DI 8x24VDC ST    | 3   |
| Siemens         | 6AG1 134-6GD00-7BA1 | Analog Input Module, SIPLUS ET200SP AI 4xI 2-/4-Wire  | 1   |
| Siemens         | 6AG1 193-6BP00-7DA0 | Base Module, White                                    | 4   |
| Citel           | DS220S-24DC         | Surge Protector, 24VDC                                | 1   |
| Phoenix Contact | 2313931             | Profinet Network Isolator                             | 1   |
| WAGO            | 2002-1406           | Terminal, Push-In, 1-Circuit, Yellow                  | 2   |
| WAGO            | 2002-1404           | Terminal, Push-In, 1-Circuit, Blue                    | 2   |
| WAGO            | 2002-1407           | Terminal, Push-In, 1-Circuit, Green/Yellow, Grounding | 1   |
| WAGO            | 2002-1492           | Terminal End Plate, Orange                            | 3   |
| WAGO            | 2002-400            | Adjacent Jumper, 2-Way Continuous                     | 2   |
| WAGO            | 249-116             | End Anchor, 6mm, Gray                                 | 2   |
| WAGO            | 210-112             | Din Rail, Galvanized, Slotted, 2m                     | 1   |
| Square D        | PK5GTA              | Equipment Ground Bar Kit                              | 1   |
| Siemens         | 6XV1 840-2AH10      | Profinet Cable, Fast Connect                          | 1   |
| Siemens         | 6AG1 901-1BB10-7AA0 | Profinet Connector, SIPLUS                            | 2   |

5. The PLC will be powered from the 24VDC supply from SCADA to the ET200SP in a separate ½” conduit from the generator to the RTU cabinet.
6. Fourteen (14) #18 tinned MTW Blue SCADA digital input wires shall be provided for each unit and ran back to SCADA RTU cabinet.
7. Two (2) Profinet Cables from the I/O Panel to RTU shall be in ¾” conduit from the generator to the RTU. Cable shall be Siemens 6XV 840-2AH10 with connector Siemens 6AG1 901-1BB10-7AA0 on each end of cable.
8. All field wiring shall connect directly to I/O base terminals using ferrules with end sleeves.
9. All mounting screws shall be drilled and tapped (no self-tapping screws are allowed).
10. All mounting screws shall be stainless steel.
11. Din rail shall be model 1492-DR9 or equivalent.
12. Two (2) TSP #18 shielded pair of analog inputs shall be provided for each and ran back to SCADA RTU cabinet. TSP wire shall be Belden 3072 Twinax.
13. Communication wire from Generator to ATS and the RTU shall 18ga Tin Coated MTW copper wire.
14. Grounding shall be done as per JEA Standards drawings (Appendix A).
15. Electrical conduits shall be installed as per JEA Standards drawings (Appendix A).

16. The (14) #18 tinned MTW Blue SCADA wire shall be labeled as per JEA Standard drawings (Appendix A).
17. Generator installation and wiring reference JEA Water and Sewer Standards.
18. In the event of a standalone fuel tank, add one ½-inch conduit from fuel tank to Generator Control Panel for Greenleaf.
19. All electrical runs shall be in either rigid or non-metallic liquid tight conduit for on exterior of enclosure. All electrical runs shall be Aluminum EMT or non-metallic liquid tight conduit for interior of enclosure.
20. All cables, conduits and panels will be installed regardless of SCADA system on site to accommodate future installs.

## 2.06 GENERATORS AND EXCITATION SYSTEMS

- A. The generator shall be of the drip-proof, guarded, bracket type, especially designed for connection to the specified engine and shall be for 3-phase, 60-Hertz, 4-wire, 480-volt operation and shall be "Y" connected. The generator shall be mechanically and torsionally matched to the engine driver and shall be designed to withstand inherent pulsating torques of the engine.
- B. Generator windings shall be braced for full line-to-ground and phase-to-phase fault with both generators operating.
- C. The generators shall have a forged or cast alloy steel flanged shaft for direct connection through a suitable flywheel type coupling to the engine, or with suitable adapter and disc coupling; and shall be of the single bearing type with anti-friction bearing. Full load efficiency of the combined generator, exciter and regulator shall be not less than 93 percent.
- D. The generator windings, insulation and excitation system shall be braced to withstand any possible short-circuit stresses and shall be designed to withstand any overheating or stresses caused by harmonics generated by the variable frequency drives. The excitation and voltage control system shall sustain at least 300 percent rated generated current for ten seconds when a 3 phase symmetrical short-circuit is applied at the generator terminals. The unit shall be "Radio Interference Proof" (RIP) and the "Telephone Influence Factor" (TIF) shall be within the limits of Section 9, ANSI C50.12.
- E. The generator shall utilize a brushless, rotating field, Permanent Magnetic Generator (PMG) type excitation system with an electronic closed loop voltage regulator. The exciter rotor and field windings shall have Class H insulation, rated for Class B (80 degrees C) temperature rise at generator full load prime power rating.
- F. The generator stator core shall be built up of low carbon steel laminating precision punched, deburred and individually insulated. Stator coils shall be all copper, random or form wound and inserted in insulated core slots. Wound core shall be repeatedly treated a minimum of three times with thermosetting synthetic varnish and backed for maximum moisture resistance, high dielectric strength and high bonding qualities. Armature lamination followers and frame ribs shall be welded integral with frame. The average dielectric strength for the form wound coils of the ground and end turn insulation shall not be less than 400 volts per mil. A vacuum pressure impregnation (VPI) process shall be utilized on form wound stator windings.

- G. The generator shall be furnished with 120 volt anti-condensation space heaters, designed to hold a minimum temperature of 90 degrees F.
- H. Generator rotor poles shall be built up of individually insulated steel punchings. Poles shall be wound and bonded with high strength varnish, then baked. Cage connections shall be brazed for strong construction and permanent electrical characteristics. Each pole shall be dovetailed and keyed to rotor shaft. The rotor shall be dynamically balanced for all speeds up to 125 percent of rated speed per NEMA specifications. The entire rotor assembly shall be 100 percent epoxy resin vacuum pressure impregnated, then baked.
- I. A cooling fan shall be mounted on the rotor to draw air from exciter end, over rotor poles and through louvered openings in drive end.
- J. The generator shall have an oil lubricated anti-friction bearing. The designed bearing life, based on B-10 curve of the Anti-Friction Bearing Manufacturers' Association, shall not be less than 40,000 hours.
- K. Voltage regulator shall be hermetically sealed, silicon controlled rectifier type and shall employ a zener reference and three phase sensing. The voltage regulator shall provide automatic protection of the entire unit on 3-phase short-circuits. The voltage regulator shall include automatic over-excitation and under-frequency protection. Input isolation transformers and filters shall be provided to minimize disturbances caused by line harmonics. Exciter shall be fast response type with a rotating rectifier and surge suppresser, 3 phase, full-wave bridge. They shall feature low time constant design to minimize voltage transients under severe load changes.
- L. Voltage regulation shall be within plus or minus 1 percent of rated voltage from no load to full load. Steady-state modulation shall not exceed plus or minus 1/2 percent. Instantaneous voltage dip shall not exceed 20 percent of rated voltage when full load at rated power factor is applied. Upon single step application of full load, recovery of stable operation shall occur within nine seconds.
- M. The voltage regulator and associated equipment shall be mounted in the generator terminal boxes.
- N. Generator stator leads shall be connected to copper bus bars in an oversize terminal box with differential and ground fault protection current transformers.
- O. Accessories and Attachments:
  - 1. Terminal Box: The unit shall contain a terminal box and any extension necessary and shall be sized and provided with space for four (4) - CT's for differential and ground fault protection. Suitable lugs shall be provided for terminating 480 volt cables with stress cones.
  - 2. Low Voltage Terminal Boxes: The generator shall have a separate low voltage AC and DC terminal boxes with suitably marked terminal strip for high bearing temperature (each bearing), high stator temperature, and space heater connections.
  - 3. Space Heaters: Space heaters shall be installed on the generator frame to maintain temperature of the entire generator above the dew phase. Heaters shall be automatically disconnected when the engine starts, all required controls shall be provided at the generator control panels.

## 2.07 WEATHERPROOF SOUND ATTENUATED ALUMINUM ENCLOSURE

- A. The complete engine-generator set, main line circuit breaker, battery charger, exhaust silencer, etc. shall be enclosed within a weatherproof, sound attenuated aluminum enclosure. The enclosure shall be of the walk-in type and shall be of the drop over configuration, suitable for pad mounting. The minimum distance from engine-generator and generator to end wall shall not be less than 3'-0" for walk-in type enclosures. The complete engine-generator set shall be enclosed in a modular, walk-in type weatherproof enclosure. The enclosure shall provide 6 feet minimum head clearance and 24-inch minimum walk around clearance on the sides not including radiator. The enclosure shall consist of two sidewalls, two end walls, louvers, and roof. The enclosure shall be designed to provide a sound level of mechanical noise of 86 dB(A) at 15 feet from any point of the enclosure. The enclosure shall be manufactured by Phoenix Products, Advanced Manufacturing & Power Systems Inc., or Fidelity Manufacturing.
- B. The engine generator supplier shall be responsible for coordinating the location of all equipment to be housed in the enclosures and on the enclosure roofs. The intent of these specifications is to call attention to certain features of the enclosures construction. The engine supplier shall furnish complete shop drawings for the enclosures in accordance with the requirements of Division 1. Shop drawings shall include but not be limited to the following specific items:
  - 1. Complete dimensional drawings for the enclosure showing the location of all equipment installed within the enclosure or on the enclosure roof.
  - 2. Installation details showing the location and special installation requirements of all foundation anchor bolts and other non-factory installed enclosure components such as silencer supports, engine exhaust piping, miscellaneous electrical components and other miscellaneous appurtenances such as wall and roof penetrations.
  - 3. Detailed power distribution drawings, conduit and wire schedules, and details of all miscellaneous electrical components including mini-power zone, receptacles, junction boxes, lighting fixtures, transformers and switches. Electrical drawings shall indicate all required field connectors and connections resulting from the assembly of the enclosure sections.
- C. Exact enclosure height shall be determined by the generator and enclosure manufacturer and shall be suitable to accommodate the engine cooling radiators, shroud, etc.
- D. Each enclosure section shall consist of a roof, two end walls and side walls, of anodized marine grade aluminum white panels.
  - 1. Design wind resistance in accordance with the Florida Building Code Sixth Edition (2017):
    - a. Ultimate design wind speed,  $V_{ult}$ : 194 mph
    - b. Nominal design wind speed,  $V_{asd}$ : 150 mph
    - c. Exposure category: C
  - 2. Roof Live Load: 20 psf uniform.
  - 3. Enclosure shall be certified to meet the following latest codes:
    - a. Florida Building Code Sixth Edition (2017) and ASCE 7-10.
    - b. Florida Mechanical Code
    - c. National Electrical Code

d. National Fire Prevention Association

- E. Drop over type enclosures shall have a rubber gasket under it with a rubber cement type adhesive to keep gasket in place to prevent water intrusion into enclosure as well as keep engine fluids from leaking out.
- F. The enclosure shall be constructed of removable side panels and end panels. All fasteners and hardware used in construction of the enclosure shall be stainless steel. The enclosure shall be braced as necessary to support the silencer and designed to withstand the ultimate design wind speed,  $V_{ult}$ , without damage. All bracing and reinforcing members shall be integral to the enclosure.
- G. The enclosure shall be complete with fully gasketed access doors, providing a weathertight perimeter seal, locking door handles, and duplicate keys. Number and location of doors shall be adequate to provide easy access for operation and maintenance. Doors and frames shall be factory installed. All exposed screws, bolts and nuts, if used shall be Type 316 stainless steel. A bolt-in-place removable end wall panel located at the generator end shall also be included.
- H. Lighting within the enclosure shall incorporate switchable LED light fixtures. Provide a minimum of four (4) light fixtures controlled by spring wound 120-minute timer light switch.
- I. A minimum of two (2) 120VAC, 20 Amp GFCI convenience duplex receptacles shall be provided within the enclosure.
- J. The CONSTRUCTION CONTRACTOR shall supply one 60A/3P, 480V, three phase power supply from existing Switchboard SWBD-A to MPZ-GEN to provide electrical service to the enclosure. Manufacturer shall provide a 15KVA, 480-208/120V, 3-phase, 4-wire transformer-panel assembly (MPZ-GEN) within the enclosure, meeting all NEC clearances. The transformer-panel assembly shall be in accordance with Section 16191. All equipment and devices for the generator set and enclosure shall be pre-wired to panel MPZ-GEN which shall include primary and secondary breakers. Equipment and devices include, but are not limited to: tow convenience receptacles, enclosure lights, fuel transfer pumps, water jacket heaters, fuel level and leak detection system, and battery charger.
- K. Provide appropriate conduit entrances for power, control and signal wiring into the enclosure.
- L. The enclosure manufacturer shall provide electrical layout drawings for all equipment supplied.
- M. All electrical materials, installations, etc. shall be in strict accordance with Division 16 requirements. Conduit shall be rigid aluminum, minimum size  $\frac{3}{4}$ -inch. Wire shall be type THHN/THWN.
- N. Radiator discharge will be through a gravity operated damper and into a hood. The system shall not exceed 0.5" w.g. total external static pressure to ensure adequate airflow for cooling and combustion.
- O. Inlet louvers and hoods shall be removable and constructed of aluminum and riveted into an aluminized steel frame to form a rigid water resistant assembly. The system shall not exceed 0.25 w.g. total external static pressure to ensure adequate airflow for cooling and combustion. All intakes shall be screened with stainless steel mesh to prevent the entrance of rodents or insects.

- P. The sound insulation shall comply with the UL Standard 94HF-1 Flammability Test, covering all the inside walls of the enclosure and shall consist of the type, thickness and number of baffles required to limit the resulting noise level of the unit operating at full load to not more than 86 dBA at a distance of 15 feet from the enclosure in any direction. There shall be no puretones. Insulation in walls and roof shall be semi-rigid, thermo-acoustic.
- Q. The enclosures shall be provided with a four-point lifting system at or near the enclosure base, with capacity suitable for rigging the entire assembly.

## 2.08 SURFACE PREPARATION AND SHOP PAINTING

- A. The engine generator set and associated equipment shall be shop primed and finished coated in accordance with the Manufacturer's standard practice prior to shipment. The paint shall be suitable to an outdoor environment and approved by the OWNER. An adequate supply of touch-up paint shall be supplied by the Manufacturer.

## 2.09 SHOP TEST

- A. A complete engine generator unit and the generator main breaker and control panel shall be shop tested prior to shipment. Shop tests shall be performed in northeast Florida. Four copies of the complete certified test record shall be submitted to the ENGINEER within 30 days after the completed test.
- B. The Manufacturer shall notify the OWNER at least one week prior to the shop test. The OWNER reserves the right to witness the shop test.
- C. If such tests indicate specified performance has not been met, the Manufacturer shall pay the cost of all corrective measures and additional tests until such time as test demonstrate that specified performance has been met.
- D. These tests for the unit shall be sufficient to assure that the unit will operate successfully and meet all specified operational requirements. The Manufacturer shall furnish all necessary instruments, filters, starting air, fuel gas, cooling water, electric power and load banks for the test.
- E. The shop test shall consist of, but not be limited to, four continuous hours of operation. Voltage and frequency regulation and transient response shall be tested and recorded to show full compliance with this specification. During the shop test, readings shall be taken and recorded every thirty minutes for each of the following:
  - 1. Time.
  - 2. Ambient temperature.
  - 3. Volts for each phase.
  - 4. Load:
    - a. Amps for each phase.
    - b. KW.
    - c. Power factor.
    - d. Frequency.
    - e. Engine jacket water temperature.

- f. Cooling water temperature (in and out).
  - g. Intake manifold pressure.
  - h. Lubricating oil pressure.
  - i. Crankcase pressure.
  - j. Lube oil temperature.
  - k. Intake manifold temperature.
  - l. Exhaust gas temperature.
  - m. Raw water cooling flow for heat exchanger.
  - n. Gallons of fuel consumed per hour.
  - o. Emission compliance.
- F. The generator shall be shop tested in accordance with IEEE Standard 115. Testing shall include the following:
  - 1. Cold resistance of all windings.
  - 2. Insulation resistance of all windings.
  - 3. Polarity of field coils.
  - 4. High potential on all windings.
  - 5. Open circuit saturation.
  - 6. Air gap measurement.
  - 7. Regulation (with regulator).
  - 8. Transient voltage dip and response.
  - 9. Voltage and current balance.
- G. The procedure for the shop test of the diesel engine shall cover the engine Manufacturer's standard practice and shall also include at least, but not be limited, to the following:
  - 1. Prior to all starts during initial tests and all starts after new running parts have been installed, the engine shall be connected to a separately driven lubricating oil pump and filtered oil circulated through all of the engine channels. The engine shall be thoroughly inspected for oil leaks prior to shipment, paying particular attention to leaks around the shims of bearing shells in engines where shims are used.
  - 2. The engine shall be pre-lubricated for a sufficient period of time to insure adequate lubrication. Caution shall be taken to avoid the accumulation of oil in the combustion chambers.
  - 3. Engine and generator alignment shall be checked and generator air gap measured prior to the test.
- H. Provision shall be made for bypass filtering and full-flow straining of the lubricating oil during the test. The strainer shall be so constructed that it will not pass particles over 0.003-in.
  - 1. The engine shall be tested with the governor intended for permanent use on the engine. New, clean lubricating oil shall be used in the governor.

2. An air filter or cleaner shall be used for the supply of combustion air during all testing.
  3. All starting air lines shall be fitted with water traps and lubricators.
  4. The engine shall be given a suitable wearing-in run before the witnessed shop test as recommended by the Manufacturer. Before recording any readings, all operating temperatures and pressures shall have become stabilized.
  5. All alarm, shutdown, and control functions shall be demonstrated. Transient response shall be measured to indicate compliance with the performance specifications.
- I. After completion of all testing, the following is required:
1. The load limit shall be sealed. The seal shall be applied, using a seal press which embosses the Manufacturer's initials on the lead seal.
  2. All entrapped water shall be drained, and proper protection applied to prevent the entry of water during shipment or a long period in storage while waiting for installation.
  3. The engine shall be given proper treatment for its protection for extended storage at the job site while waiting for completion of installation.

## PART 3 EXECUTION

### 3.01 COORDINATION

- A. Coordinate with other trades, equipment, and systems to the fullest extent possible.

### 3.02 INSTALLATION

- A. Provide services of a qualified field representative with a minimum of 5 years' experience in diesel engine generator set installations, training and instruction to check the installation of the generator unit to ensure a proper installation.
- B. The complete generator unit shall be mounted on a welded steel sub-base of sufficient rigidity and strength to maintain alignment of the unit. The base shall be suitable for, and there shall be included, spring type vibration isolators for mounting the unit on a level surface of a concrete pad. The spring type vibration isolators shall be supplied by the generator unit Manufacturer.

### 3.03 EQUIPMENT START-UP

- A. Operate unit to demonstrate ability to operate continuously without vibration, jamming, leakage or overheating and to perform specified functions, after installation and after Manufacturer's representative check of installed equipment.
- B. Comply with Manufacturer's operating and maintenance instructions during start-up and operation.
- C. Promptly correct improper installation of equipment.
- D. Cooperate with supplier of equipment at time of start-up and in making of all final adjustments necessary to place equipment in satisfactory working order. Start-up shall not commence without the presence of the Manufacturer's representative.

- E. The CONSTRUCTION CONTRACTOR shall be responsible to fill the above ground bulk diesel fuel oil storage tank to 50% full with new diesel fuel oil as recommended by the generator Manufacturer prior to generator system startup and testing. Upon satisfactory completion of all generator system testing, including the switchgear startup and plant SCADA system monitoring, the CONSTRUCTION CONTRACTOR shall be responsible to provide and fill the fuel oil storage tank to 90% full with new diesel fuel oil as recommended by the generator Manufacturer.

### 3.04 FIELD TESTS

- A. Upon completion of the installation and as soon as conditions permit, the emergency power supply system including the engine driven generator, electrical circuits, controls, switchgear and other devices shall be tested in the presence of the ENGINEER by the CONSTRUCTION CONTRACTOR and the service representative for the Manufacturer of the engine driven generator unit to assure that the system functions as specified.
  - 1. Prior to scheduling the test, the CONSTRUCTION CONTRACTOR shall notify the ENGINEER in writing that all requirements and provisions of the Contract Documents have been fulfilled, that all apparatus shall be clean, properly adjusted and ready for operation and that the Instruction Manuals, parts lists and record drawings described in Paragraph 1.03, have been submitted.
  - 2. The Manufacturers' representatives shall make such changes in wiring or connections and such adjustments, repairs or replacements necessary to make the circuit, device or control system function as specified and otherwise comply with the Contract Documents.
- B. The test shall consist of four hours of continuous operation of the unit at full rated load using a portable resistive load bank. During the test, the same readings as outlined under Shop Test Paragraph 2.10E, shall be taken and recorded at 30 minute intervals.
- C. As part of the field test, each of the automatic shutdown devices shall be tested and the respective values recorded at which the devices will stop the engine. Any adjustments required shall be made in the devices to make the operating values correspond to those recommended by the engine Manufacturer and as recorded during the stop test.
- D. After the four-hour test has been completed, additional testing shall be performed to demonstrate the emergency power supply system's ability to meet the automatic starting, load transfer and motor starting requirements as specified under Paragraph 1.06C.
- E. The CONSTRUCTION CONTRACTOR shall provide a person qualified to conduct sound level testing to take and record octave band sound pressure level readings with the portable resistive load shut off and operating the engine driven generator using the station load available at the time the field tests are conducted. These readings shall be within the limits permitted by this specification.
- F. Piping shall be tested in strict accordance with the Manufacturers testing requirements. For each double wall fuel oil line entering the building, provide a pressure test port with threaded plug in the double wall piping termination fitting. Piping shall be subjected to an air test of 10 psig maximum.

- G. If the emergency power supply system fails to fulfill the performance requirements of this specification, corrective action shall be taken and the system retested to assure full compliance. All expenses associated with the field tests, including any corrective action, shall be borne to the CONSTRUCTION CONTRACTOR.

END OF SECTION

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SECTION 16370  
VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to manufacture, assemble, shop-test, and install variable frequency drives with integral isolation/phase shift transformers, output filters as shown on the Drawings and as specified herein. All variable frequency drives shall be coordinated with the equipment manufacturer as specified in Division 11.
- B. These specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment furnished. They are, however, intended to cover the furnishing, the shop testing, the delivery and complete installation and field testing, of all materials, equipment and appurtenances for the variable frequency drives herein specified.
- C. The Contractor shall furnish only one manufacturer of variable frequency drives as specified herein.
- D. The work shall include the services of factory representatives of the variable frequency drive manufacturers to inspect the final installation, to perform field acceptance tests on the installed equipment and to instruct the regular operating personnel in the care, operation and maintenance of equipment.

1.02 DESCRIPTION OF SYSTEMS

- A. The variable frequency drives specified hereinafter will become part of a complete system as specified in Division 11. The Contractor shall coordinate with the manufacturer of the Division 11 equipment to ensure the compatibility of the equipment.
- B. The variable frequency drives will operate motors as specified in Division 11 and Section 16150. The drives furnished herein under shall be totally compatible with the Motors to be supplied.
- C. Additional controls shall be provided as required by Division 11 and 13 and as shown on the drawings.

1.03 QUALIFICATIONS

- A. Variable speed drives shall be of sufficient size for the duty to be performed and shall not exceed their full-rated capacity when the driven equipment is operating as specified.
- B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement. The equipment furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.
- C. All equipment furnished under these Specifications shall be new and unused and shall be the standard cataloged product of a manufacturer having a successful record of manufacturing and servicing the equipment and systems specified herein for a minimum of five (5) years.

- D. The variable frequency drive manufacturer shall maintain, as part of a national network (United States), engineering service facilities within 250 miles of the project site to provide start-up service, emergency service, calls, repair work, service contracts, and maintenance and training of customer personnel. When requested by the Engineer, documentation shall be provided showing compliance, capabilities and references for this requirement.
- E. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- F. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.
- G. Approved Manufacturer: Eaton CFX 9000 Series.

#### 1.04 SUBMITTALS

- A. Copies of all materials required to establish compliance with the specifications shall be submitted. Submittals shall include at least the following:
  - 1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations. Details to also include front elevations with designation of devices and equipment on door(s) and internal to the enclosure. Internal layout of components including dimensions and space requirements. Standard preprinted sheets or drawings simply marked to indicate applicability to this contract will not be acceptable.
  - 2. Descriptive literature, bulletins and/or catalogs of the equipment.
  - 3. Data on the characteristics and performance of the variable frequency drives. Data shall include certification that the variable frequency drives are warranted for use with the motors specified in Division 11 and Section 16150.
  - 4. Complete drawings shall be furnished for approval before proceeding with manufacture and shall consist of job specific master wiring diagrams, elementary or control schematics including coordination with other electrical control devices operating in conjunction with the variable frequency drive, and suitable outline drawings with sufficient details for locating conduit stub-ups and field wiring. Due to the complexity of the system, it is imperative the above drawings be clear and carefully prepared to facilitate interconnections with other equipment. Standard preprinted sheets or drawings simply marked to indicate applicability to this contract will not be acceptable.
  - 5. The total weight of the equipment including the weight of the single largest item.
  - 6. A complete total bill of materials of all equipment.
  - 7. A list of the manufacturer's recommended spare parts with the manufacturer's current price for each item.

#### 1.05 OPERATING INSTRUCTIONS

- A. The operating and maintenance manuals shall be furnished in accordance with Section 01730. The manuals shall be prepared specifically for this installation and shall include all required

cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

- B. A factory personnel of the manufacturer who has complete knowledge of proper operation and maintenance of the specified equipment shall provide all the instruction and training as specified herein. This shall be done in conjunction with and coordinated with the O&M instructions to be provided for the equipment, motors and control panels.
- C. The cost of training programs to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the System being supplied. The manufacturer shall include the travel and expenses for two Owner personnel attending factory training.
- D. The manufacturer shall provide classroom training detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project as per Section 01730.
- E. The manufacturer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to Owner.
- F. The training program shall represent a comprehensive program covering all aspects of the VFD and maintenance of the system.
- G. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule.
- H. Factory Training: Factory training shall be conducted before System is commissioned, and subsequent to final manual submittals. Factory training shall consist of schooling and hands-on experience. The class shall be for two people and consist of four days of extensive training covering the following:
  - 1. Theory of Operation
  - 2. Use of Software
  - 3. Troubleshooting and Maintenance
- I. On-site Training: On-site (field) training shall be conducted at the Owner's site and shall provide detailed hands-on instruction to Owner's personnel covering: system debugging, program modification, trouble-shooting, maintenance procedures, calibration procedures, and system operation. The training shall run at times chosen by the Owner. The training shall be conducted over a period of five days.

#### 1.06 TOOLS AND SPARE PARTS

- A. One (1) set of all special tools required for normal operation and maintenance shall be provided.
- B. Provide the following spare parts for each size drive in the quantities specified:
  - 1. One (1) of each type printed circuit board.
  - 2. Two (2) power diodes.

3. One (1) pair power transistors.
  4. 50 percent replacement fuses, all types and sizes.
  5. One (1) quart of enclosure touch-up paint.
- C. Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturers name, description and part number on the exterior of the package.

#### 1.07 PRODUCT HANDLING

- A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.
- B. All equipment and spare parts must be properly protected against any damage during a prolonged period at the site.
- C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.
- D. Each box or package shall be properly marked to show its net weight in addition to its contents.

#### 1.08 WARRANTY

- A. All equipment supplied under this Section shall be warranted by the Contractor and the equipment manufacturers for a period of one (1) year from startup or 24 months from shipment, whichever occurs first in accordance with Section 01740.
- B. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the machine(s) and the unit(s) restored to service at no additional cost to the Owner.
- C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

### PART 2 PRODUCTS

#### 2.01 GENERAL

- A. The Contractor shall furnish and supervise installation of variable frequency drives as described in this specification and as detailed on the applicable Drawings.
- B. The Contractor shall be responsible for the erection, installation, and startup of the equipment covered by this specification.
- C. The variable frequency drive shall comply with the latest applicable standards of ANSI, NEMA, IEEE, and the National Electrical Code.
- D. Variable frequency drives shall operate as specified on standby generators or normal power sources.

- E. Variable frequency drives shall be 6 pulse.
- F. Each variable frequency drive shall be provided with a minimum 5% input line reactor and a dv/dt output filter.

## 2.02 CONSTRUCTION

- A. The variable frequency drives (VFD) shall be rated at 480 VAC input with features and options as specified.
- B. The variable frequency drives shall be rated for the HP, full load current and rpm of the motor. The variable frequency drives shall be designed to provide microprocessor-based continuous speed adjustment of three-phase motors. The variable frequency output voltage shall provide constant volts-per-Hertz excitation for the motor up to 60 Hertz. The variable frequency drives shall be optimized for an adjustable or selectable carrier frequency to reduce motor noise. The carrier frequency shall be field adjustable and adjusted by the manufacturer's field Engineer during start up.
- C. The variable frequency drives shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency output via a two-step operation. Variable frequency drives utilizing a third power section are not acceptable. Adjustable Voltage and Current Source variable frequency drives are not acceptable. Transistors shall be used in the inverter section. GTOs and SCRs are not acceptable.
- D. The variable frequency drives shall be current regulated. Variable frequency drives permitting instantaneous overcurrent trips other than an output short circuit are not acceptable.
- E. The variable frequency drives shall have an efficiency that exceeds 97% at 100% speed and load. The efficiency shall exceed 90% at 50% speed and load. The variable frequency drives shall maintain the line side displacement power factor no less than .95 regardless of speed and load. Variable frequency drive efficiency shall be defined as drive output power at the motor output terminals divided by the input power at the line side of the main circuit breaker.
- F. Standard operation conditions shall be:
  - 1. Incoming power: Three phase, 480V (+10% to -10%) and 60 hertz (+/- 2 hertz) power to a fixed potential DC bus level.
  - 2. Humidity: 0 to 95% (noncondensing).
  - 3. Altitude: 0 to 3,300 feet above sea level.
  - 4. Ambient temperature: 0 to 40 degrees C.
- G. The variable frequency drives shall be able to start into a spinning motor. The variable frequency drives shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the variable frequency drives shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor in the preset method of starting.
- H. Variable frequency drive enclosures shall be NEMA Type 1 gasketed free-standing floor-mounted, force ventilated (with replaceable air filters) construction requiring front access

only. Variable frequency drives requiring rear access for any maintenance are not acceptable. The cooling air required to dissipate heat generated by the power electronics shall be isolated from all drive electronics. Variable frequency drives using liquid-cooled assemblies in conjunction with associated pumps, piping, and separate remote mounted exchangers are not acceptable. The inverters and converters shall have complete unobstructed front accessibility with easily removable assemblies. The complete enclosure shall maintain a constant height, width and depth. The height for all floor-mounted enclosures shall be 90" high. The enclosures shall include the integral isolation/phase shift transformer (as required), input line reactor, dv/dt output filter, and shall not be more than:

HSP Pump No. 5                      48" in width and 25" in depth (bottom entry/exit for cables)

- I. All variable frequency drive programmable parameters shall be adjustable from a digital operator keypad located on the front door of the variable frequency drive. Parameters shall include:
  1. Programmable maximum and minimum frequency.
  2. Programmable acceleration and deceleration times.
  3. Selectable carrier frequencies, V/Hz, and critical frequency avoidance lockout.
  4. Adjustable electronic overload and torque limits.
  5. Multiple attempt automatic restart following utility outage or fault condition.
  6. Jog, thread, and preset speeds.
  7. Keypad lockout and factory default overrides.
  8. Adjustable slip compensation (+/- 5%).
- J. The variable frequency drives shall be additionally equipped with a digital operator station mounted on the enclosure front door. Control operator devices and indication lights shall include:
  1. Local digital speed control.
  2. Hand-Off-Auto control selector switch.
  3. Local-Remote speed control selector switch.
  4. LED status lights for run, fault, alarm, up-to-speed, power on, and drive ready status.
  5. Additional controls as required by Division 11 and 13 and as shown on the Drawings. Pump Failure will require pump fail timer (as required). Provide for terminations of remote mounted operator control devices and field devices.
- K. The variable frequency drives shall have the following system interfaces:
  1. Inputs:

- a. Two (2) isolated process control speed reference interfaces to receive and isolate 0-10 Vdc or 4-20 mAdc signals.
  - b. Dedicated terminal blocks for interface with remote operator and field devices.
  - c. 120 Vac control to allow variable frequency drives to interface with remote contacts and with two or three-wire control.
  - d. Additional inputs as required by Division 11 or 13 and as shown on the Drawings.
2. Outputs:
  - a. Four (4) analog output signals 0-10 Vdc or 4-20 mAdc for external metering.
  - b. Run relay with an isolated set of form C contacts.
  - c. Dry contact output (N.O.) to indicate protective function trip.
  - d. Dry contact output (N.O.) to indicate common alarm.
  - e. Additional outputs as required by Division 11 or 13 and as shown on the Drawings.
3. Monitoring and Displays:
  - a. The variable frequency drives shall have a 40-character vacuum fluorescent display indicating monitored functions as described in the following paragraph.
4. The following parameters shall be monitored:
  - a. Input current (3 phases)
  - b. Input voltage (3 phases)
  - c. Output current (3 phases)
  - d. Output voltage (3 phases)
  - e. Output frequency
  - f. Kilowatts
  - g. Drive temperature
  - h. Time
  - i. Date
  - j. Motor rpm
  - k. Ten (10) most recent trips/faults

L. Protection Functions:

1. The variable frequency drives shall have the following protective features (with indication for a. through i.):
  - a. Speed compensated electronic motor overload current.
  - b. Undervoltage.
  - c. Overfrequency.
  - d. Overtemperature.
  - e. Ground Fault.
  - f. DC bus protection.
  - g. Inrush current limit (adjustable 50 to 150%).
  - h. Input and output phase loss.
  - i. Emergency stop pushbutton (Red mushroom head and maintained).
  - j. Current limiting fuses shall be provided on the input side of the VFDs to protect against fault currents up to 200,000 A sym.
  - k. The output side of the VFDs shall be equipped with a current limiting reactor to reduce the amount of fault current to the VFDs.
  - l. Phase insensitive to input power.
  - m. Surge protection device (160 kA minimum) from input AC line transients at line side of main circuit breaker.
  - n. Electrical isolation between the power, control and logic circuits.

- o. Drive to be capable of withstanding output terminal line short or open circuits without component failure.

M. Additional Features shall be provided as follows:

1. Input and output line reactors.
2. The variable frequency drives shall be equipped with a flange mounted molded case input circuit breaker (65,000 AIC minimum). The breaker shall be interlocked with the enclosure doors to prevent access to the variable frequency drive unless the breaker is in the open position and to prevent moving the breaker to the ON position while the unit door is open. The circuit breaker shall have provisions for padlocking in the open position. Provide mechanical interlocks on doors of auxiliary sections of multi-bay or multi-cubical cabinets.
3. Fused space heaters with thermostat to minimize condensation potential upon drive shutdown.
4. The variable frequency drives shall be variable torque design. Provide constant torque design as required by Division 11.
5. Variable frequency drives shall be capable of unidirectional operation.
6. Variable frequency drives shall have 115 VAC control power for operator devices.
7. Control relays shall be machine tool type, heavy duty type, industrial grade, 600 volt, 10 amp rating, Square D, Class 8501, Type X or equal.
8. All wiring shall be numbered at each end with permanent heat shrink markers. Wiring less than 6 inches may be numbered at only one end.
9. A copper ground bus.
10. Separate door-mounted output ammeter, ammeter switch, non-resettable elapsed time meter (0-99999.9 hour) and speed indicating meter in addition to those specified through the door display.
11. Power unit fan loss protection by automatically switching to a 100% spare cooling fan. Cooling fans shall be on when the variable frequency drive is operating and off when drive is off (fans shall run for a period of time after the variable frequency drive shuts down to dissipate heat and controlled by a thermal switch).
12. All bus and exposed copper shall be tin-plated.
13. All floor mounted enclosures shall have complete 24" (minimum) clear space in bottom of the cubical for line, motor and field cable terminations. All wall mounted enclosures shall have complete 18" (minimum) clear space in bottom of the enclosure for line, motor and field cable terminations.
14. Barriers and warning signs on terminals that are energized with the power disconnect OFF.
15. A 2-inch by 5-inch, nominal, engraved three-layer laminated plastic master nameplates on each VFD fastened with stainless steel screws or rivets. Nameplates shall be black letters

with white background core, 3/8-inch high lettering and shall indicate equipment designation as shown on the Drawings.

16. Provide legend plates or 1-inch by 3-inch engraved nameplates with 1/4-inch lettering for identification of pilot devices and meters.
17. Provide permanent warning signs as follows:
  - a. "DANGER - HIGH VOLTAGE - KEEP OUT" on all enclosure doors.
  - b. "WARNING - HAZARD OF ELECTRIC SHOCK - DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT".
18. A switchable LED light within each floor mounted section of the enclosure.
19. Provide a communication card for interface with PROFIBUS DP control system. Coordinate with the Division 13 specifications and the Instrumentation Drawings for the control and data acquisition parameters requirements.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Field wiring shall be in accordance with manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's recommendations.

#### 3.02 SHOP PAINTING

- A. Prior to shop painting, all surfaces shall be thoroughly cleaned, dry, and free from all mill/scale, rust, grease, dirt, and other foreign matter.
- B. Variable frequency drive enclosures shall be shop painted.

#### 3.03 INSPECTION, TESTING AND STORAGE

- A. The Contractor shall notify the Engineer two weeks prior to all factory and field tests. The Engineer shall have the option to inspect all tests at the factory and in the field.
- B. The manufacturer shall test the variable frequency drive with a motor load (full rated) prior to shipment for 4 hours. All printed circuit boards shall be tested at 50 degrees C for 40 hours. The variable frequency drive manufacturer shall provide the actual test data and certification that the tests have been completed prior to shipment to the Engineer for approval.
- C. Field Tests:
  1. Field tests of the drive shall be made by the manufacturer who will furnish all equipment and record all data. The Contractor shall be present during testing.
  2. Field tests are the basis of demonstrating equipment proficiency and correct operation.
  3. If the drive performance does not meet the Specifications, corrective measures shall be taken or the drive shall be removed and replaced with a drive which satisfies the conditions

specified. A seven (7) day 24 hour (actual operation) operating period as specified herein of the drive will be required before acceptance. The Contractor shall provide for seven (7) day 24 hour (minimum) on-site supervision of the field acceptance tests. If a drive fails to perform and must be replaced, the rejected drive shall not be removed until the replacement drive has been delivered to the site. If corrective measures are to be taken, such measures shall be done on-site at such times as convenient to the Owner. The Owner shall be allowed to use any drive supplied immediately following installation and testing whether or not the equipment meets the conditions specified.

4. Factory representatives of the manufacturer who are competent and experienced and who have complete knowledge in the proper operation and maintenance of the equipment shall be provided to inspect and supervise the installation of the equipment and supervise the initial test run. The first visit will be for checking and inspecting the equipment during installation. The second visit will be to operate and supervise the initial field test. If problems are encountered in operation of the equipment additional service shall be provided at no additional cost to the Owner. These services are in addition to the services required for training.
5. Training will not be permitted until all equipment is fully operational. In the event that the equipment becomes inoperable under warranty provisions, additional training will be provided at no additional cost to the Owner as follows:

| <u>Inoperable Period</u> | <u>Additional Training</u> |
|--------------------------|----------------------------|
| 0-2 weeks                | None                       |
| 2-6 weeks                | 2 days                     |
| More than 6 weeks        | 5 days                     |

6. All training shall be coordinated and conducted concurrently with training to be supplied by the equipment and motor manufacturers.
7. Functional Test: Prior to plant start-up, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test. Submit test procedure for review and approval by the Engineer.
8. Vibration Test: Vibration analyses shall be performed on the equipment when operating the variable frequency drive through its entire speed range. Where loads and drives are separated by intermediate flexible shafting, vibration shall be measured both at the top motor bearing and at two points on the equipment bearing, 90 degrees apart.
9. Performance Testing: Demonstrate system performance by operating the system for a seven (7) day continuous period while varying the application load, as the input conditions allow, to verify system performance. Record all data necessary to document the successful performance of the system. Provide all instruments, equipment, and labor required to accomplish this test. If a unit fails the performance test, the supplier will be allowed to readjust and retest the system. If the unit fails the second test, the unit will be rejected and the Contractor shall furnish a unit that will perform as specified.
10. Check each alarm and detection device for proper operation.
11. The drive manufacturer shall provide all necessary personnel and equipment necessary to properly start-up and pass all tests at no additional cost to Owner.

12. A copy of all tests and checks performed in the field complete with meter readings and recordings, where applicable, shall be submitted to the Engineer.

D. General:

1. All factory and field tests are typical for each variable frequency drive.
2. Electrical equipment shall at all times during manufacture, testing, delivery and construction be adequately protected against mechanical injury or damage by water. Electrical equipment shall not be stored out-of-doors. Electrical equipment shall be stored in dry permanent shelters. Temporary connections shall be provided to operate space heaters and temporary lights required for heat shall be provided to control moisture. If any apparatus has been damaged prior to acceptance the Owner, such damage shall be repaired by the Contractor at his own cost and expense. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such special tests as directed by the Engineer, at the cost and expense of the Contractor, or shall be replaced by the Contractor at his own expense.

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SECTION 16470  
PANELBOARDS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all panelboards as shown on the Drawings and as specified herein.
- B. All panelboard wiring shall include wiring numbers and terminal point numbers cross referenced to shop drawing and subsequent record drawing submittals.

1.02 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Section 01300, shop drawings and product data, for the following as a minimum:
  - 1. Equipment outline drawings showing elevation and plan views, dimensions and weight. Indicate all options, special features, ratings and deviations from this Section.
  - 2. Bus arrangement drawings.
  - 3. Product data sheets and catalog numbers for circuit breakers, etc. List all options, trip adjustments and accessories furnished specifically for this project.
  - 4. Instruction and renewal parts books.
  - 5. Test and inspection reports.
  - 6. Complete bill of materials list.
  - 7. The equipment drawings, summary tables, and bill of materials list shall be computer generated (i.e. no hand-drawn drawings, sketches, lists will be accepted).

1.03 REFERENCE STANDARDS

- A. Panelboards shall be in accordance with the Underwriter Laboratories (UL) "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled where procedures exist. Panelboards shall also comply with NEMA Standard for Panelboards and the National Electrical Code (NEC).
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 MANUFACTURERS

- A. 120/240 Volt, single phase, 3 Wire and 120/208 Volt, 3 Phase, 4 Wire panelboards shall be Type NQ as manufactured by Schneider Electric/Square D or Type Pow-R-Line by Eaton.
- B. 277/480 Volt, 3 Phase, 4 Wire panelboards shall be; Type NF as manufactured by Schneider Electric/Square D or Type Pow-R-Line by Eaton.

- C. 480 Volt, 3 Phase, 3 Wire panelboards shall be; I-Line series as manufactured by Schneider Electric/Square D or Type Pow-R-Line by Eaton.
- D. NEMA 3R and 4X panelboards shall be as specified herein, provided in 316 stainless steel enclosures as manufactured by the Hoffman or equal and completely assembled by the panelboard manufacturer.
- E. Refer to additional requirements for manufacturers in Section 16000. Alternate suppliers must be submitted for approval to the ENGINEER in writing four weeks prior to the original bid date with supporting documentation to confirm all aspects of the specifications.

## PART 2 PRODUCTS

### 2.01 GENERAL

#### A. Rating

- 1. Panelboard ratings shall be as shown on the Drawings. All panelboards shall be rated for the intended voltage.
- 2. Circuit breaker panelboards shall be fully rated for the specified circuit breaker fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.

### 2.02 MATERIALS (NEMA 1)

#### A. Interiors

- 1. All interiors shall be completely factory assembled with circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper wire of the sizes indicated.
- 2. Interiors shall be so designed that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.
- 3. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.
- 4. A nameplate shall be provided listing manufacturer's name, panel type and rating.

#### B. Buses

- 1. Bus bars for the mains shall be of tin plated copper. Full size tin plated copper neutral bars shall be included. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Bussing shall be braced throughout to conform to industry standard practice governing short circuit stresses in panelboards. Phase bussing shall be full height without reduction. Cross connectors shall be tin plated copper. Each panel shall be provided with a ground bus bar, with removable link/jumper between neutral and ground bus. The ground bus shall be sized to the maximum number of circuit breakers that can be installed in the panelboard.

2. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.
3. Spaces for future circuit breakers shall be bussed for the maximum device that can be fitted into them.
4. Tin plated copper equipment ground bars shall be furnished.

C. Boxes

1. Recessed or flush mounted boxes shall be made from galvanized code gauge steel having multiple knockouts, unless otherwise noted. Boxes shall be of sufficient size to provide a minimum gutter space of 4-in on all sides.
2. Surface mounted boxes and trims shall have an internal and external finish as specified in Paragraph 2.02.D.4 below.
3. At least four studs for mounting the panelboard interior shall be furnished.
4. All conduit entrances shall be field punched.

D. Trim

1. Hinged doors covering all circuit breaker handles shall be included in all panel trims.
2. Doors shall have semi flush type cylinder lock and catch, except that doors over 48-in in height shall have a vault handle and 3-point catch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Furnish two keys for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door. All trims shall be door-in-door type construction.
3. The trims shall be fabricated from code gauge sheet steel.
4. All exterior and interior steel surfaces of the panelboard shall be properly cleaned and finished with ANSI Z55.1, No. 49 or 61 light gray paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.
5. Trims for flush panels shall overlap the box by at least 3/4-in all around. Surface mounted panel trims shall have the same width and height as the box. Trims shall be fastened with quarter turn clamps.

2.03 MATERIALS (NEMA 3R AND 4X)

A. Interiors and Buses

1. Interiors and buses shall be as hereinbefore specified for NEMA 1 construction.

B. Boxes and Covers

1. Boxes, covers and hardware shall be made from 316 stainless steel with natural finish.

2. Boxes and covers shall have continuous welded seams and shall be hinged (piano type) together and gasketed.
3. Conduit openings shall be tapped.

## 2.04 CIRCUIT BREAKERS

- A. Panelboards shall be equipped with circuit breakers with frame size and trip settings as shown on the Drawings.
- B. Circuit breakers shall be molded case, bolt-in type with interrupting capacity as noted on the Contract Documents.
- C. GFCI (ground fault circuit interrupter) shall be provided for circuits as required and where indicated the Drawings. GFCI units shall be 1 Pole, 120 Volt, molded case, bolt-on breakers, incorporating a solid state ground fault interrupter circuit insulated and isolated from the breaker mechanism. The unit shall be UL listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time) and an interrupting capacity as noted on the Contract Documents.
- D. Circuit breakers feeding fire alarm control panels shall be colored red.
- E. Circuit breakers shall be manufactured by the panelboard manufacturer.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Mount boxes for surface mounted panelboards so there is at least 1/2-in air space between the box and the wall.
- B. Connect panelboard branch circuit loads so that the load is distributed as equally as possible between the phase busses. Record normal base load phase voltages and currents for each phase and the total neutral current and submit to the ENGINEER for review.
- C. Install markers on the front cover of all panelboards which identify the voltage rating. Markers shall be made of self-sticking B-500 vinyl cloth printed with black characters on an Alert Orange background, 2-1/4-in high by 9-in wide, Style A as manufactured by W.H. Brady Co. or equal.
- D. Install a 1-in by 3-in nominal laminated plastic nameplate with 1/2-in white letters on a black background on each panelboard. Nameplate lettering shall be as shown on the Drawings. Nameplates shall be stainless steel screw mounted.
- E. Unless otherwise noted on the Drawings, top of cabinets shall be mounted 6 feet-0-inch above the floor, properly aligned and adequately supported independently of the connecting raceways.
- F. All wiring in panelboards shall be neatly formed, grouped, and identified to provide a neat and orderly appearance. A typewritten directory card identifying all circuits shall be placed in the card holder inside the front cover.
- G. All panelboards shall be protected from physical damage, water damage, moisture, corrosion, dirt and dust during construction. Any panelboard judged to be unacceptable by the ENGINEER

shall be replaced by the CONSTRUCTION CONTRACTOR at no additional cost to the OWNER.

- H. Standard factory testing shall be performed for the equipment furnished under this section and these tests shall be in accordance with the latest version of NEMA and UL standards. Certified copies of these tests shall be provided to the ENGINEER upon request.
- I. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the InterNational Electrical Testing Association (NETA Standard ATS) unless otherwise modified by this Section.

### 3.02 CLEANING

- A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner or clean lint-free rags. Do not use compressed air.

END OF SECTION

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## SECTION 16500 LIGHTING SYSTEM

### PART 1 GENERAL

#### 1.01 SCOPE OF WORK

- A. Furnish and install complete lighting systems including panelboards, transformers, lighting fixtures, receptacles, switches, contactors, and all necessary accessories and appurtenances required as hereinafter specified and shown on the Drawings.

#### 1.02 RELATED WORK

- A. All concrete and reinforcing steel required for exterior lighting pole bases shall be as specified under Division 3, but the responsibility of furnishing and installing the material shall be that of Division 16.
- B. Conduit is included in Section 16110.
- C. Wire is included in Section 16120.
- D. Transformers are included in Section 16191.
- E. Panelboards are included in Section 16470.

#### 1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300. Submittals shall include those set forth in Section 16000, Paragraph 1.03.

#### 1.04 REFERENCE STANDARDS

- A. All lighting fixtures shall be in accordance with the National Electrical Code (NEC) and shall be constructed in accordance with the latest edition of the Underwriters Laboratories (UL) "Standards for Safety, Electric Lighting Fixtures." All lighting fixtures shall be UL labeled.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Lighting Fixtures
  - 1. Lighting fixture types shall be furnished as required by the "Lighting Fixture Schedule" on the Drawings. The catalog numbers are given as a guide to the design and quality of fixture desired. Equivalent designs and equal quality fixtures of other manufacturers will be acceptable upon approval by the ENGINEER.
- B. Lamps
  - 1. Fluorescent lamps shall be medium bi-pin, recessed, double contact, rapid start, standard cool white as shown on the "Fixture Schedule".

2. Metal halide lamps shall be clear and of the size and type as shown on the "Lighting Fixture Schedule."
3. All lamps shall be of one manufacturer and shall be as manufactured by Osram/Sylvania Electric Products, Inc.; General Electric Co.; North American Philips Lighting Corp. or equal.

C. Ballasts

1. Fluorescent ballasts shall be electronic, high-frequency, full-output rapid-start type for use on 265 mA, T8 lamps.
  - a. All ballasts shall be UL listed, ETL certified, Class "P", high power factor (minimum 0.90).
  - b. Ballasts shall have a "A" sound rating or better.
  - c. All ballasts used in exterior applications shall have a minimum starting temperature of 0 degrees F unless otherwise specified.
  - d. All interior ballasts shall have a minimum starting temperature of 50 degrees F.
  - e. Ballasts shall be series wired type and designed to operate the number and length of lamps specified.
  - f. The total harmonic distortion (THD) of each ballast shall be in accordance with the requirements of the utility company and in no case shall it be less than 10 percent THD.
  - g. Ballasts shall have a minimum ballast factor of 0.88.
  - h. Ballasts shall have nominal power factor 0.90 or higher.
  - i. Ballasts shall have a maximum lamp current crest factor of 1.7.
  - j. Ballast shall provide normal rated life for the lamp specified.
  - k. All electronic ballasts shall be warranted for parts and replacement for 1 full year from the date of installation.
  - l. Electronic ballasts shall be as manufactured by Advance, Model Mark V, similar by Valmont; Osram/Sylvania; MagneTek or equal.
2. Metal halide ballast shall be pulse start type of the correct size and voltage for the fixture it is to serve as shown on the "Lighting Fixture Schedule". All ballasts shall be as manufactured by Holophone Lighting; MagneTek Universal Manufacturing; Advance Transformer Co. or equal.

D. Flexible Fixture Hangers

1. Flexible fixture hangers used in non-hazardous areas shall be type ARB and flexible fixture supports used in hazardous areas shall be Type ECHF as manufactured by the Crouse-Hinds Co., similar by Appleton Electric Co.; Killark Electrical Mfg. Co. or equal.
2. Where required in Section 16000 all pendent mounted and recessed in suspended ceilings, recessed lighting fixtures shall be provided with four anti-sway supports to meet Type II seismic requirements.

E. Emergency Lighting Battery Units

1. Emergency lighting units and remote lighting heads shall be as specified in the "Lighting Fixture Schedule" shown on the Drawings.

2. Battery units shall be of the self-contained, fully automatic type with sealed lead acid batteries.
3. Unit enclosures shall be compatible to their environment and units shall comply with the requirements of NFPA 70 (NEC).
4. All necessary mounting hardware shall be provided.

F. Photo Electric Controls

1. Photo electric control with time delay for outdoor lighting shall be completely self-contained and not affected by moisture, vibration or temperature changes.
2. ON/OFF adjustments are to be made by movement of a light level selector without the use of tools in a range from 2 to 50 foot candles.
3. Photo electric control device shall be SPST, and have 2000-watt tungsten capacity and be Tork Catalog Number 2101 (120V); 2104 (208-277V) or approved equal by Intermatic Inc., Carlon, or approved equal.

G. Device Color

1. In administrative office areas, conference rooms, breakrooms, restrooms, and control rooms, switches, receptacles and other devices shall be white.
2. In all other areas (electrical, mechanical, process, etc.), switches, receptacles and other devices shall be gray.

H. Switches

1. Wall switches shall be of the indicating, toggle action, flush mounting quiet type. All switches shall conform to Federal Specification WS896-E.
2. Wall switches shall be the manufacturer's "industrial specification grade". Wall switches shall be the following types and manufacturer or approved equal.
  - a. Single pole - Arrow-Hart, Series 1991, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.
  - b. Double pole - Arrow-Hart, Series 1992, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.
  - c. Three way - Arrow-Hart, Series 1993, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.
  - d. Four way - Arrow-Hart, Series 1994, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.
  - e. Single pole, key operated - Arrow-Hart Catalog Number 1991-L, or approved equal.
  - f. Single pole, pilot indicating, Bryant Catalog Number 4901-PLR120, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.
  - g. Momentary contact, 2 circuit, center off - Arrow-Hart, Series 1895, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.
  - h. Weatherproof cover for standard toggle switches - Crouse-Hinds Catalog Number DS181, or approved equal by Appleton Electric Co., L.E. Mason Co., or approved equal.

- i. Explosion-proof single pole switches shall be for 20 amperes, 120/277 volts, mounted in cast boxes and be similar and equal to Crouse-Hinds EDS Series, or approved equal by Appleton Electric Co., L.E. Mason Co., or approved equal.

#### I. Receptacles

1. Receptacles shall be the manufacturer's "industrial specification grade". Receptacles shall be of the following types and manufacturer or approved equal. Receptacles shall conform to Federal Specification WC596-F.
  - a. Duplex, 20A, 125V, 2P, 3W; Arrow-Hart, Series 5362, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.
  - b. Weatherproof or corrosion resistant single, 20A, 125V, 2P, 3W; by Harvey Hubbell, Inc., Pass & Seymour, Inc., with TayMac Corp., #30310G cover, or approved equal.
  - c. Weatherproof or corrosion resistant duplex, 20A, 125V, 2P, 3W; by Harvey Hubbell, Inc., Pass & Seymour, Inc., with TayMac Corp., #10310G cover, or approved equal.
  - d. Ground fault interrupter, duplex, 20A, 125V, 2P, 3W; Arrow-Hart Series GF 5342, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.
  - e. Duplex, 20A, 125V, 2P, 3W with transient voltage surge suppressor and indicator light; Pass & Seymour Series 6362-5P, approved equal by Harvey Hubbell Inc., Bryant Electric Co., or approved equal.
  - f. Stainless steel indoor mounting plate for G.F.I. receptacle; Arrow-Hart Catalog Number 97061, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc. or approved equal.
  - g. Weatherproof cover for G.F.I. receptacle shall be TayMac Corp., #20310G, or approved equal.
  - h. Explosion-proof, 20A, 125V, 2P, 3W; Appleton Electric Co. Catalog Number EFS175-2023 or EFSC175-2023 or approved equal by Crouse-Hinds Co., Killark Electric Manufacturing Co., or approved equal. Furnish one Appleton Electric Co. Catalog Number ECP-1523 cap or approved equal by Crouse-Hinds Co., Killark Electric Manufacturing Co., or approved equal for every two receptacles (minimum of one).
  - i. Single, 20A, 250V, 2P, 3W; Arrow-Hart Catalog Number 5861, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.
  - j. Single, 30A, 125V, 2P, 3W; Arrow-Hart Catalog Number 5716; cap: Arrow-Hart Catalog Number 5717.
  - k. Single, 30A, 250V, (3 phase) 3P, 4W; Arrow Hart Catalog Number 8430N; Cap: Arrow-Hart Catalog Number 8432AN.

#### J. Device Plates

1. Plates for flush mounted devices shall be of the required number of gangs for the application involved and shall be:
  - a. Smooth high strength thermoplastic or nylon of the same manufacturer as the device for all administrative office type areas. Color to match device.
  - b. Type 302 (18-8) high nickel stainless steel of the same manufacturer as the device for all other areas.
2. Plates for surface mounted device boxes shall be of the same material as the box.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Each fixture shall be a completely finished unit with all components, mounting and/or hanging devices necessary, for the proper installation of the particular fixture in its designated location and shall be completely wired ready for connection to the branch circuit wires at the outlet.
- B. All flush mounted fixtures shall be supported from the structure and shall not be dependent on the hung ceilings for their support.
- C. Fixtures noted to be installed flush in suspended ceilings shall be of mounting types suited for the type ceiling involved. It shall be the responsibility of the electrical contractor to verify the ceiling types prior to ordering fixtures.
- D. Flexible fixture hangers shall be used for all pendant mounted fixtures. Fixtures 2-ft long and larger shall be supported with a minimum of two fixture hangers.
- E. Conduit run in areas with hung ceilings shall be installed in the space above the hung ceiling as close to the structure as possible. Conduits shall be supported from the structure.
- F. Exterior lighting poles shall be mounted plumb.
- G. Fixture locations are shown on the Drawings in approximate locations; however, exact locations shall be coordinated so as to avoid conflicts with HVAC ducts, equipment and other obstacles.
- H. Switch and receptacle outlets shall be installed flush with the finished floor or wall when raceways are shown as "concealed" on the Drawings.
- I. Device Mounting Height
  - 1. Switches and occupancy sensors shall be mounted 48" AFF (above finished floor) to center of box, located on the strike side of the door.
  - 2. Wall mounted receptacles shall be vertically mounted, AFF to the center of the box as follows, unless otherwise noted on the Drawings.
    - a. Process areas and shops – 36"
    - b. Administration office areas – 18"
    - c. Corridors and hallways – 18"
    - d. Electrical and mechanical rooms – 18"
    - e. Restrooms – 18"
    - f. Exterior walls – 18"
  - 3. Where the wall and partitions are of unplastered brick or masonry, the height of wall outlets as given above shall be adjusted so that one horizontal edge of the box lines up with a horizontal joint in the masonry.
- J. Provide circuit identification at devices as specified in Section 16000.
- K. Photo electric sensors shall be placed facing north whenever possible.

3.02 REPLACEMENT

- A. Lamps (except for H.I.D.) used during the building construction, prior to 2 weeks from completion of the work, shall be removed and replaced with new lamps.

3.03 CLEANING UP

- A. Plastic dust cover bags to be provided with new parabolic reflector lighting fixtures shall be removed after all construction activity that may cause dust formation on reflector surfaces has been completed.
- B. All fixtures shall be left in a clean condition, free of dirt and defects, before acceptance by the ENGINEER.

END OF SECTION

SECTION 16502  
LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Provide a complete lightning protection system for the following buildings and structures at JEA Greenland Water Treatment Plant: Ground Storage Tank No. 2 and Stair Tower. The system shall be UL Master Labeled and shall be designed and installed in compliance with provisions of UL 96A and NFPA 780.
- B. The CONSTRUCTION CONTRACTOR shall employ the services of a licensed lightning protective systems engineering company to design and install the lightning protection system and prepare detailed installation drawings and material specifications. These drawings and specifications shall be submitted for review in accordance with Section 01300.
- C. The lightning protection system shall be checked by a UL field inspector upon completion of the installation. The CONSTRUCTION CONTRACTOR shall assume full responsibility for the correctness of the installation and shall make any and all corrections and additions deemed necessary by the UL inspector. The CONSTRUCTION CONTRACTOR shall pay for all costs of the UL inspection and any subsequent re-inspections as required.
- D. The lightning protection system for the buildings shall consist of conductors, air terminals and accessories which shall be grounded to the building structural steel or ground grid at regular intervals. The CONSTRUCTION CONTRACTOR may submit alternate methods of lightning protection with his proposal, provided the alternate provides equal or greater lightning protection than specified.
- E. The lightning protection system contractor shall coordinate his work with the electrical contractor.
- F. Each bidder or his authorized representatives shall, before preparing his proposal, visit all area of the existing buildings and structures in which work under this section is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that he or his representative has visited the buildings and noted the locations and conditions under which the work will be performed and that he takes full responsibility for a complete knowledge of all factors governing his work.

1.02 RELATED WORK

- A. Refer to Section 16660 for Grounding Systems.

1.03 SUBMITTALS

- A. CONSTRUCTION CONTRACTOR shall submit to the ENGINEER/ OWNER for review the facility lightning protection system. The submittal data shall contain the following minimum information.
  - 1. Plan view of site showing buildings and structures, locations of air terminals, and associated zone of protection for each air terminal; show all equipment on roofs which require protection.

2. Schematic diagram of lightning protection system showing air terminals, conductors, and other connectors or fittings required for the complete system. Provide details showing bonding requirements to structural steel, water piping, etc.
3. Locations of connection points of lightning protection system to facility grounding system.
4. Bill-of-materials.

#### 1.04 REFERENCE STANDARDS

- A. Underwriters Laboratories (UL)
  1. UL 96 – Standard for Lightning Protection Components
  2. UL 96A – Standard for Installation Requirements for Lightning Protection Systems
- B. National Fire Protection Association (NFPA)
  1. NFPA 780 – Standard for the Installation of Lightning Protection Systems
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. All materials shall be new and shall comply in weight, size, and composition with the requirements of UL and NFPA.
- B. Grounding materials and methods shall be equal to those specified under Section 16660.
- C. The following is a brief description of the various items of material.
  1. Air Terminals
    - a. Buildings 75 feet and less in height shall use Class I air terminals. Aluminum air terminals shall be solid aluminum, 1/2" minimum diameter. Copper air terminals shall be nickel plated solid copper, 3/8" minimum diameter. Length 18".
    - b. Buildings over 75 feet tall shall use Class II air terminals. Aluminum air terminals shall be solid aluminum, 5/8" minimum diameter. Copper air terminals shall be nickel plated solid copper, 1/2" minimum diameter. Length 18".
    - c. Air terminal type shall be copper unless the following applies. Copper lightning protection materials shall not be installed on aluminum roofing, siding or other aluminum surfaces.
    - d. Air terminal base supports shall be specifically designed for the surface where used. All air terminal bases shall be cast bronze with stainless steel bolt pressure cable connectors. Air terminal bases for flat roof areas shall be of the adhesive type.

2. Conductors
  - a. Buildings 75 feet and less in height shall use Class I conductors. Main conductors shall be either aluminum 14 AWG, 28 strand (weighing 105 lbs. per 1,000 feet) or tinned copper 17 AWG, 32 strand (weighing 220 lbs. per 1,000 feet).
  - b. Buildings over 75 feet tall shall use Class II conductors. Main conductors shall be either aluminum 13 AWG, 37 strand (weighing 200 lbs. per 1,000 feet) or tinned copper 14 AWG, 28 strand (weighing 380 lbs. per 1,000 feet).
  - c. Conductor type shall be copper unless the following applies. Copper lightning protection materials shall not be installed on aluminum roofing, siding or other aluminum surfaces. Aluminum lightning protection materials shall not be embedded in concrete, masonry, or on or below copper surfaces.
3. Fasteners
  - a. Conductor fasteners shall be an approved type of non-corrosive metal and have ample strength to support conductors.
4. Cable Connectors
  - a. All cable connectors shall be per NFPA standards, cast bronze with screw pressure type stainless steel bolts and nuts. For buried and non-accessible connections, exothermic weld process shall be used.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. All materials shall be installed by a UL listed lightning protection contractor. The lightning protection system shall be installed per approved shop drawings and UL and NFPA recommended practices.
- B. The lightning protection system engineering company shall provide jobsite assistance and supervision of the installation as required, and shall be present during the UL inspection.
- C. Lightning Protection System shall be installed in a neat and inconspicuous manner.
- D. All mounting and penetration of roof surface shall be coordinated with roofing contractor to assure maximum roofing guarantee. All through-roof penetration flashings shall be furnished, sealed and guaranteed by a licensed roofing contractor.
- E. Excavate and backfill as required. Finish grade and restore to original condition.
- F. All metal bodies within 6 feet of the conductor shall be bonded to the system with approved fittings and conductors. Connections between dissimilar metals shall be made with approved bimetallic connections.
- G. As the work progresses, legibly record all field changes on a set of project contract drawings. When the project is complete, furnish a complete set of reproducible "As-built" drawings for the Project Record Documents per Section 01720.

H. Air Terminals:

1. Air terminals shall be spaced so as not to exceed 20 feet apart around the outside perimeter of the roof or ridge and not over 50 feet apart through the center of flat roof areas.
2. Air terminals shall not project more than 24 inches nor less than 10 inches above the protected object.

I. Conductor Routing:

1. All main conductors shall maintain a downward or horizontal course, free from "U" or "V" pockets.
2. Conductors shall not form an angle of less than 90 degrees nor less than an 8-inch radius bend.
3. Metal roofing and siding, eave downspouts or other metal parts subject to displacement will not be permitted as substituted parts of the lightning conductor system.
4. Fasteners shall be spaced not more than 3 feet horizontally or vertically and shall be the same material as the conductor.
5. Bimetallic fittings shall be used for all connections between dissimilar metals.

J. Down Conductors:

1. Down conductors shall follow the most direct patch possible between roof conductors and ground terminals.
2. All buildings, with a ground perimeter less than 250 feet shall have a minimum of two down conductors installed at the diagonally opposed corners of the building.
3. Any building with a ground perimeter in excess of 250 feet shall have down conductors installed so that the distance between the conductors does not exceed 100 feet.
4. Within the building, the down conductors shall be placed in Schedule 80 PVC conduit in the wall. Care shall be taken not to damage the conductors. Connections through roof shall be made with through-roof connectors.
5. Splices will not be permitted on conductors embedded in concrete.
6. Down conductors shall be installed concealed. When conductors cannot be concealed they shall be substantially guarded to prevent mechanical injury or displacement. The guards shall protect the conductor from grade level to a height of at least 6 feet. All conduit used for physical protection of down conductors shall be Schedule 80 PVC.

K. Roof Conductors:

1. Roof conductors shall interconnect and provide a two-way path from all air terminals.

2. Roof conductors shall bond together all air terminals and shall be installed exposed except that where connections are made to equipment located under roof.
3. Conductors on perimeters of flat roofs shall form closed loops.
4. Dead end air terminals shall not be permitted.
5. All interconnecting cables from air terminals to roof conductors or metal roof decks shall be similar to roof conductor.

L. Pitch Pockets:

1. CONSTRUCTION CONTRACTOR shall subcontract all pitch pocket work to a qualified roofing contractor.

M. Grounding System:

1. Ground rods shall be provided at each down conductor and they shall be installed a minimum of 3 feet away from the foundation walls.
2. The ground rods shall be in addition to the ground rods provided for the system grounding grid.
3. Connectors used to connect ground rods to the down conductors shall make contact with the ground rods for a distance of 1-1/2" measured parallel to the ground rod. In addition, ground terminals shall be interconnected with the grounding grid, and all grounding mediums. This shall include electric and telephone service grounds and underground metallic piping systems.
4. Bonding of down conductors to the system grounding grid and splicing of conductors in concealed work shall be made by an exothermic weld process.
5. Where conductors are bonded to structural steel or metal roof decks, a bolted-on bonding plate shall be used. All other bonding of the lightning protection system shall be made with pressure clamps.
6. CONSTRUCTION CONTRACTOR shall notify design ENGINEER prior to concealment for ENGINEER's inspection.

3.02 TESTING

A. General:

1. The Lightning Protection System shall be tested for continuity of all conductors and air terminals.
2. Maximum resistance of system shall not exceed five (5) ohms unless otherwise specified or scheduled.
3. CONSTRUCTION CONTRACTOR shall submit written test results to the ENGINEER.

B. Indicators:

1. Stamped metal tags shall be attached to, or adjacent to, each down conductor indicating in feet the exact vertical depth in the ground of each ground terminal.
  - a. Down leads connected to water pipes shall also be indicated.
  - b. Tags shall be of a corrosion resistant metal and shall be placed at a height of 5 feet above finish grade.

END OF SECTION

SECTION 16600  
UNDERGROUND SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install a complete underground system of raceways, manholes and handholes as shown on the Drawings and as specified herein. This work includes all underground raceways which are direct buried or concrete encased.

1.02 RELATED WORK

- A. All concrete and reinforcing steel shall be as specified in Division 3, but the responsibility of furnishing and installing the material shall be that of this Section.
- B. All trenching, excavation and backfilling, including gravel and sand bedding and surface restoration shall be as specified in Division 2, but the responsibility of furnishing and installing the material shall be that of this Section.
- C. Conduit, fittings, installation, etc., shall be as specified in Section 16110.
- D. Ground rods and other grounding materials and methods shall be as specified in Section 16660.
- E. Precast electrical concrete manholes and handholes shall be furnished under Division 16 and shall be in compliance with precast concrete structures as specified in Section 02605.

1.03 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Section 01300, shop drawings and product data, for the following:
  - 1. Manholes and handholes.
  - 2. Plastic duct spacers.
  - 3. Manhole and handhole frames and covers.
  - 4. Buoyancy calculations for manholes.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cable racks, supports, pulling-in irons, manhole steps and hardware shall be hot dipped galvanized steel as manufactured by Line Materials Co. or equal.
- B. Precast concrete manholes and handholes shall be heavy duty type, designed for a Class H20 wheel load. Precast manholes and handholes shall be as manufactured by Brooks Products Co.
- C. Manhole frames and covers shall be cast iron heavy duty type for class H-20 wheel loading, and shall be as manufactured by Neenah, or equal. Manhole covers shall be marked "ELECTRIC".

- D. Handhole covers and frames shall be hot dipped galvanized and designed for a Class H-20 wheel load. Handhole covers and hatches shall have 316 stainless steel security bolts. Handhole covers shall be marked "ELECTRIC".
- E. Bell ends and plastic duct spacers shall be as manufactured by Carlon or equal.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install raceways to drain away from buildings. Raceways between manholes or handholes shall drain toward the manholes or handholes. Raceway slopes shall not be less than 3-in per 100-ft.
- B. Reinforce raceway banks as shown on the Drawings.
- C. Lay raceway lines in trenches on a clean backfill bedding not less than 6 inches thick and well graded and compacted.
- D. Use plastic spacers located not more than 4-ft apart to hold raceways in place. Spacers shall provide not less than 2-in clearance between raceways.
- E. The minimum cover for raceway banks shall be 30-in unless otherwise permitted by the ENGINEER.
- F. Make raceway entrances to buildings and vaults with rigid aluminum conduit not less than 10-ft long. Conduits which are not concrete encased for runs below floor slabs in slab-on-grade construction shall be rigid aluminum conduit. Conduits which are concrete encased for runs below floor slabs in slab-on-grade construction shall be encased under the slab to their respective equipment.
- G. Raceway terminations at manholes shall be with end bells for PVC conduit and insulated throat grounding bushings with lay-in type lugs for metal conduit.
- H. For bends in 2 inch and larger raceways, long radius elbows, sweeps and offsets shall be used.
- I. All 2 inch and larger raceways shall have a mandrel drawn through followed by a swab to clean out any obstructions which may cause cable abrasions. The mandrel shall be 12 inches in length and the diameter 1/2 inch less than the inside diameter of the raceway. All 1-1/2 inch and smaller raceways shall be swabbed clean before installing cables.
- J. Plug spare raceways and seal them watertight at all buildings and structures.
- K. Raceways in use shall be sealed watertight at all buildings and structures.
- L. Install pulling-in irons opposite all raceway entrances to manholes.
- M. Cables shall be trained in manholes and supported on racks and hooks at intervals not greater than 3 feet-0 inches and supports shall be installed on each side of all splices. Furnish inserts on all manhole walls for mounting future racks as well as racks required for present installation. Branch circuit conductors shall not be run in manholes.

- N. All joints shall be made so as to prevent the passage of concrete inside the conduit to form obstructions or cause cable abrasions.
- O. Manhole covers in streets shall finish flush with finished paving and in other areas shall finish 3 inches above crown of adjacent roadway. Floor elevations of manholes shall be so set that the center line of the lowest conduit entering will be not less than 1-foot above the floor and center line of the highest conduit entering will be not less than 1 foot below the roof slab.
- P. Concrete monuments shall be provided at each stubbed conduit location. Monuments shall be as shown on the Drawings and shall be installed in the same manner outlined for manhole covers.
- Q. A #6 bare copper wire (stranded) shall be installed in each 4-inch PVC conduit containing control cable unless otherwise noted.
- R. A 3/4-inch by 10-foot copperclad ground rod shall be driven in the bottom of each manhole. All bond wires, galvanized conduits and metal cable racks shall be bonded to the ground rod.
- S. Polyethylene warning tape shall be provided for all underground raceways, duct banks etc. Tape shall be placed along the raceways entire length and shall be installed 18" above the raceways on compacted backfill material.
- T. Spare and empty conduits shall have a pull wire (3/16 inch polypropylene) installed.
- U. As-built drawings shall be furnished showing each conduit terminations, elevations, locations, manholes, handholes, etc.

END OF SECTION

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## SECTION 16660 GROUNDING SYSTEM

### PART 1 GENERAL

#### 1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install a complete grounding system in strict accordance with Article 250 of the National Electrical Code (NEC), as shown on the Drawings and as specified herein.
- B. All raceways, conduits and ducts shall contain equipment grounding conductors sized in accordance with the NEC. Minimum sizes shall be No. 12 AWG.

#### 1.02 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Section 01300, shop drawings and product data, for the following:
  - 1. Manufacturer's name and catalog data for ground rods, materials and exothermic welding methods and materials.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Conduit shall be as specified under Section 16110.
- B. Wire shall be as specified under Section 16120.
- C. Ground rods shall be 3/4-in diameter by 10-ft copper clad steel and constructed in accordance with UL 467. The minimum copper thickness shall be 0.25 mm (10 mil). Ground rods shall be Copperweld or equal.
- D. Grounding conduit hubs shall be malleable iron type, manufactured by Thomas & Betts Co.; Catalog No. 3940 (3/4-in conduit size), similar to Burndy; O.Z./Gedney Co. or equal, and of the correct size for the conduit.
- E. Waterpipe ground clamps shall be cast bronze saddle type, manufactured by Thomas & Betts Co. Cat. No. 2 (1/2-in, 3/4-in, or 1-in size), similar by Burndy; O.Z./Gedney Co. or equal, and of the correct size for the pipe.
- F. Buried grounding connections shall be by Cadweld process, or equal exothermic welding system.
- G. Ground Enhancement Material (GEM) shall be a low-resistance, non-corrosive, carbon dust based material that improves grounding effectiveness. GEM shall contain cement, which hardens when set to provide a permanent, maintenance-free, low-resistant grounding system that never leaches or washes away. GEM shall be suitable for installation in trenches or backfilling around ground rods. GEM shall have a resistivity of no more than 20 ohm-cm. GEM shall be ERICO Part No. GEM25A or equivalent.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. The service entrance equipment ground bus shall be grounded to a ¾-inch cold water pipe and to the ground as indicated on the Drawings. Run grounding electrode conductors in Schedule 80 PVC conduits and seal conduits watertight. Do not allow water pipe connections to be painted. If the connections are painted, disassemble them and re-make them with new fittings.
- B. Install equipment grounding conductors with all feeders and branch circuits.
- C. Bond all steel building columns in new structures together with ground wire in rigid conduit and connect to the distribution equipment ground bus, as shown on the Drawings.
- D. Ground wire connections to structural steel columns shall be made by exothermic welding.
- E. Metal conduits stubbed into a motor control center shall be terminated with insulated grounding bushings and connect to the motor control center ground bus. Bond boxes mounted below motor control centers to the motor control center ground bus. Size the grounding wire in accordance with NEC Table 250.122, except that a minimum No. 12 AWG shall be used.
- F. Ground bus in all motor control centers and unit substations shall be connected to the service entrance equipment ground bus with a No. 1/0 conductor or as noted on the Drawings.
- G. Ground transformer neutrals to the nearest available grounding electrode with a minimum conductor sized in accordance with NEC Article 250 or as shown on the drawings.
- H. Grounding electrodes shall be installed vertically and not allowed to be deformed or driven at an angle. Where driving is difficult or where rock is encountered, CONSTRUCTION CONTRACTOR shall use purpose-designed drilling equipment, install the rod into the drilled hole and backfill around rod using ground enhancement material (GEM) mixed with water to form a slurry in accordance with the Manufacturer's instructions.
- I. Install ground grids as shown on the Drawings.
- J. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel and all other equipment and materials required by the NEC to be grounded, shall be grounded and bonded in accordance with the NEC.
- K. Seal exposed connections between different metals with No-Oxide Paint Grade A or equal.
- L. Lay all underground grounding conductors slack and, where exposed to mechanical injury, protect by pipes or other substantial guards. If guards are iron pipe, or other magnetic material, electrically connect conductors to both ends of the guard. Make connections as specified herein.
- M. Care shall be taken to ensure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.
- N. All grounding type receptacles shall be grounded to the outlet boxes with a No. 12 green conductor (insulation type to match phase conductor listed in Section 16120) connected to the ground terminal of the receptacle and fastened to the outlet box by means of a grounding screw.

### 3.02 INSPECTION AND TESTING

- A. Inspect the grounding and bonding system conductors and connections for tightness and proper installation.
- B. Use Biddle Direct Reading Earth Resistance Tester or equivalent test instrument to measure resistance to ground of the system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method. Notify the ENGINEER in writing at least two weeks prior to scheduling any testing. Provide certified calibration sheets including dates for all equipment to be used for testing with notice of scheduled testing. Calibration sheets shall also indicate that the units have been calibrated within six months of the testing date.
- C. All test equipment shall be provided under this Section and approved by the ENGINEER.
- D. Resistance to ground testing shall be performed during dry season. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.
- E. Testing shall be performed before energizing the distribution system.
- F. A separate test shall be conducted for each building or system.
- G. Dry season resistance of the system at each testing location shall not exceed five ohms. If such resistance cannot be obtained with the system, provide additional grounding, as directed by the ENGINEER, at no additional cost to the OWNER.

END OF SECTION

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SECTION 16900  
CONCRETE ELECTRICAL DUCT ENCASEMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and place concrete encasement around underground electrical ductwork as shown on the drawings and as specified herein.

1.02 RELATED WORK

- A. All trenching, excavation and backfilling, including gravel and sand bedding and surface restoration shall be as specified in Division 2, but the responsibility of furnishing and installing the material shall be that of this Section.
- B. Furnishing and installing electrical raceways are specified in Section 16110 and 16600.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement, lime, aggregate and all other concrete components shall be as specified in Section 03300 except that aggregate size shall not exceed 3/8-in. Concrete shall have a minimum compressive strength at 28 days of 2500 psi.

PART 3 EXECUTION

3.01 GENERAL

- A. Concrete shall be measured, mixed and placed, and compacted as required in Section 03300 for 2500 psi concrete and as specified below.
- B. Provide not less than 3-inches of concrete between the outside of a duct and the earth. Provide not less than 2-inches of concrete between adjacent ducts. Refer to drawings for spacing requirements.
- C. All duct line concrete pours shall be continuous between manholes or handholes and between manholes or handholes and structures.
- D. Where duct lines pass through concrete walls, concrete envelopes shall be extended through the finished flush with inside surfaces. Watertight construction joints of an approved type shall be provided.
- E. Duct banks shall be reinforced when laid on backfill covering new pipelines, roads, parking lots or any are subject to vehicular traffic. Beneath these areas, install reinforcing bars as shown on the Drawings, extending 10-ft beyond area needing protection.
- F. Duct lines shall be laid in trenches on mats of gravel not less than 6-inches thick and well graded.
- G. The minimum cover for duct banks shall be 30-inches.

H. All electrical duct banks shall be colored red for safety purposes.

END OF SECTION

SECTION 16950  
ELECTRICAL SYSTEM TESTING AND SETTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The CONSTRUCTION CONTRACTOR shall engage the services of a recognized corporately- and financially-independent testing firm and the equipment manufactures as required for the purpose of performing inspections and tests as herein specified.
- B. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
- C. It is the purpose of these tests to assure that all tested electrical equipment, both CONSTRUCTION CONTRACTOR- and OWNER-supplied, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
- D. The tests and inspections shall determine suitability for energizing equipment.
- E. Test systems and equipment furnished under Division 16 and repair or replace all defective work and equipment. Refer to the individual equipment sections for additional specific testing requirements.
- F. Field testing and commissioning shall be performed in accordance with the latest revisions of NETA Standard ATS "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" unless otherwise modified by these Sections.
- G. A typed test report for each component tested shall be submitted to the ENGINEER for the project record files as indicated.
- H. Make adjustments to the systems and instruct the OWNER's personnel in the proper operation of the systems.
- I. In addition to the specific testing requirements listed in the individual Sections, perform the additional testing, inspections and adjust settings as specified herein.
- J. Testing shall be scheduled and coordinated with the OWNER and ENGINEER at least 2 weeks in advance.
- K. Provide qualified test personnel, instruments and test equipment.
- L. Provide a test report verifying compliance with the testing requirements included under Division 16.
- M. Before proceeding with the energization of equipment, notify the OWNER and ENGINEER to schedule the start-up of the equipment.

1.02 RELATED WORK

- A. Electric motors are provided with the driven equipment under Divisions 11 and 15 and Section 16150 are specified in the individual equipment specifications and sections.

- B. Control panels are provided with the driven equipment under Divisions 11, 15 and 13 and are specified in the individual equipment specifications.

### 1.03 SUBMITTALS

#### A. Test Report

1. The test report shall include the following:
  - a. Summary of project.
  - b. Listing of equipment tested.
  - c. Test results.
  - d. Recommendations.
2. Furnish copies of the complete report to the OWNER/ENGINEER's representative as directed in the contract documents.

- B. The report shall include a Table of Content and a data sheet for each component tested. The Table of Content shall identify each component by a unique number. The Number shall appear on the technical data sheet for identification. Submit cable test results, grounding test results, circuit breaker, motor circuit protector, and protective device settings, fuse type and rating for each piece of equipment. Test report shall be submitted in a three ring binder. Three copies shall be furnished.

- C. The report shall include a Table of Contents, a technical data sheet for each component (i.e., cable, circuit breaker, transformer, relay, etc.) tested. The Table of Content shall include the name of each component, location, the major piece of equipment the component is located within, and a sheet number on which the technical information is presented. Each data sheet shall include a unique sheet number, the name of the component under test, the major piece of equipment in which the component is located and the weather conditions at the time of the test including the temperature and relative humidity at the time of the test. The firm doing the testing shall include, in the report, their opinion whether or not the equipment being tested complies with the specification and recommended measures to correct the deficiency. Any discrepancies shall be noted in the concluding summary of the report. Test report forms shall be in compliance with NETA standards. Three complete copies shall be provided. Reports shall be signed by the person in responsible charge of the field testing, an officer of the firm performing the tests and an officer of the Electrical Contracting Firm.

- D. The reports shall be submitted to the ENGINEER for review, comment and record purposes. Each report shall include a Table of Content, a technical data sheet, for each component (i.e., cable, circuit breaker, transformer, relay, etc.) tested. The Table of Content shall include the name of each component, the major piece equipment the component is located within, and a sheet number on which the technical information is presented. Each data sheet shall include a unique sheet number, the name of the component under test, The major piece of equipment in which the component is located, the weather conditions at the time of the test (i.e., temperature, humidity, sunny, rain, etc.) the tester's observation and findings, discrepancies, any remedial work performed or act to resolve problems, technical parameters obtained during the tests, as left settings of all devices, and a statement indicating the equipment is ready to be energized. The report shall contain a statement indicating the equipment was tested in accordance with the procedures outlined in the latest edition of The International Testing Association Acceptance Testing Specifications.

#### 1.04 APPLICABLE CODES, STANDARDS, AND REFERENCES

- A. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise herein:
  - 1. National Electrical Manufacturers Association - NEMA
  - 2. ASTM International - ASTM
  - 3. Institute of Electrical and Electronic Engineers - IEEE
  - 4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications (ATS) – Latest Revision
  - 5. American National Standards Institute - ANSI C2: National Electrical Safety Code
  - 6. State and local codes and ordinances
  - 7. Insulated Cable Engineers Association - ICEA
  - 8. Association of Edison Illuminating Companies - AEIC
  - 9. Occupational Safety and Health Administration - OSHA
  - 10. National Fire Protection Association - NFPA
    - a. ANSI/NFPA 70: National Electrical Code
    - b. ANSI/NFPA 70B: Electrical Equipment Maintenance
    - c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
    - d. ANSI/NFPA 78: Lightning Protection Code
    - e. ANSI/NFPA 101: Life Safety Code
- B. All inspections and tests shall utilize the following references:
  - 1. Project design specifications.
  - 2. Project design drawings.
  - 3. Project short-circuit, coordination and arc flash study.
  - 4. Manufacturer's instruction manuals applicable to each particular apparatus.
  - 5. Project list of equipment to be inspected and tested.

#### 1.05 QUALITY ASSURANCE

- A. Qualifications of testing firm
  - 1. The testing firm shall be a corporately- and financially-independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

2. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
3. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or be a Full Member company of the InterNational Electrical Testing Association.
4. The lead, on-site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.
5. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing services. Resumes of key staff proposed for the project shall be submitted to the ENGINEER for review.
6. The testing firm shall submit proof of the above qualifications with bid documents, when requested.
7. The terms used here within, such as test agency, testing laboratory, or CONSTRUCTION CONTRACTOR's test company shall be construed to mean the testing firm.

#### 1.06 DIVISION OF RESPONSIBILITY

- A. The CONSTRUCTION CONTRACTOR shall perform routine insulation-resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.
- B. The CONSTRUCTION CONTRACTOR shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.
- C. The CONSTRUCTION CONTRACTOR shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.
- D. The project electrical engineer is responsible for obtaining and approving a short-circuit analysis and coordination study prepared by an independent testing firm or consulting engineer.
- E. The project electrical engineer shall supply a short-circuit analysis and coordination study, a protective device setting sheet, a complete set of electrical plans, specifications, and any pertinent change orders to the testing firm prior to commencement of testing.
- F. The testing firm shall notify the OWNER/ENGINEER's representative prior to commencement of any testing.
- G. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported to the OWNER/ENGINEER's representative.
- H. The testing firm shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

I. Safety and Precautions

1. Safety practices shall include, but are not limited to, the following requirements:
  - a. Occupational Safety and Health Act (OSHA).
  - b. Accident Prevention Manual for Industrial Operations, National Safety Council (NSC).
  - c. Applicable state and local safety operating procedures.
  - d. OWNER's safety practices (Lockout/Tagout).
  - e. National Fire Protection Association - NFPA 70E.
  - f. National Fire Protection Association – NFPA 79.
  - g. American National Standards for Personnel Protection.
2. All tests shall be performed with apparatus de-energized. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.
3. The testing firm shall have a designated safety representative on the project to supervise the testing operations with respect to safety.

1.07 TEST EQUIPMENT REQUIREMENTS

A. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.
2. Selection of metering equipment should be based on a knowledge of the waveform of the variable being measured. Digital multimeters may be average or RMS sensing and may include or exclude the dc component. When the variable contains harmonics or dc offset and, in general, any deviation from a pure sine wave, average sensing and average measuring RMS scaled meters may be misleading. Use of RMS measuring meters is recommended.
3. Field test metering used to check power system meter calibration must have an accuracy higher than that of the instrument being checked.
4. Accuracy of metering in test equipment shall be appropriate for the test being performed.
5. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

B. Test Instrument Standards

1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:
  - a. Maintained in good visual and mechanical condition.
  - b. Maintained in safe operating condition.
2. Test equipment should have operating accuracy equal to, or better than, the following limits:
  - a. Portable multimeters should be true RMS measuring.
  - b. Multimeters should have the following accuracy limits, or better:
    - 1) AC voltage ranges: .75% +/-3 last single digits @ 60 Hz.

- 2) AC current ranges: .90% +/-3 last single digits @ 60 Hz, including adapters, transducers.
- 3) DC voltage ranges: .25% +/-1 last single digit.
- 4) DC current ranges: .75% +/-1 last single digit.
- 5) Resistance ranges: .50% +/-1 last single digit.
- 6) Frequency range: .10% +/-1 last single digit @ 60 Hz.
- c. Clamp-on ammeters: ac current +/-3% of range +/-1 last single digit @ 60 Hz
- d. Dissipation/power factor field equipment
  - 1) +/-0.1% power factor for power factor values up to 2.0%.
  - 2) 5% of the reading for power factor values above 2.0%.
- e. Low-range dc resistance equipment: 1.0% of reading, +/-2 last single digits
- f. Transformer turns-ratio test equipment: 0.5% or better @ 60 Hz
- g. Ground electrode test equipment: +/-2% of range
- h. Insulation test sets: 0-1000V dc +/-20% of reading at mid-scale
- i. Electrical load survey equipment
  - 1) +/-5% total error, including sensors.
  - 2) 1% resolution.
  - 3) Current transformers +/-2% of range @ 60 Hz.
  - 4) Voltage transformers +/-0.5% of range @ 60 Hz.
- j. Liquid dielectric strength test equipment: +/-2% of scale
- k. Infrared scanning equipment: sensitivity of 2 degrees C
- l. Phase shifting equipment: +/-1.0 degree C over entire range
- m. High-current test equipment: +/-2% of range
- n. DC high potential test equipment: +/-2% of full scale
- o. AC high potential test equipment (60 Hz): +/-2% of full scale

#### C. Test Instrument Calibration

1. The testing firm shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.
3. Instruments shall be calibrated in accordance with the following frequency schedule:
  - a. Field instruments: 6 months maximum.
  - b. Laboratory instruments: 12 months.
  - c. Leased specialty equipment: 12 months (Where accuracy is guaranteed by lessor).
  - d. Dated calibration labels shall be visible on all test equipment.
  - e. Records, which show date and results of instruments calibrated or tested, must be kept up-to-date and available upon request.
  - f. Up-to-date instrument calibration instructions and procedures shall be maintained for each test instrument.
  - g. Calibrating standard shall be of higher accuracy than that of the instrument tested.

#### PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Testing shall be scheduled and coordinated with the OWNER and ENGINEER at least 2 weeks in advance.

### 3.02 ACCEPTANCE TESTING

- A. Provide acceptance testing for all equipment provided under Division 16 in accordance with the individual specification sections.
- B. Provide acceptance testing for all motors provided under Divisions 11 and 15.
- C. Test all electrical equipment, both CONSTRUCTION CONTRACTOR- and OWNER-supplied, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications prior to energizing equipment.
- D. Test systems and equipment furnished under Division 16 and repair or replace all defective work and equipment. Refer to the individual equipment sections for additional specific testing requirements.
- E. Make adjustments to the systems and instruct the OWNER's personnel in the proper operation of the systems.
- F. Mechanical inspection, testing and settings of circuit breakers, protective relays, disconnect switches, motor starters, overload relays, control circuits and equipment for proper operation.
- G. Check and record the full load current draw of each motor. Where power factor correction capacitors are provided the capacitor shall be in the circuit at the time of the measurement. Check ampere rating of thermal overloads for motors and submit a typed record to the ENGINEER of the same, including MCC cubicle location and driven load designation, motor service factor, horsepower, and Code letter. If incorrectly sized thermal overloads are installed replace same with the correct size overload.
- H. Check power and control power fuses for the correct type and ratings. Replace fuses if they are found to be of the incorrect size.
- I. Check settings of the motor circuit protectors. Adjust settings to lowest setting that will allow the motor to be started when under load conditions.
- J. Check motor nameplates for correct phase and voltage.
- K. Check rotation of motors prior to testing the driven load. Disconnect the driven equipment if damage could occur due to wrong rotation. If the rotation of the motor shaft is not correct, for the driven equipment, change the motor connections at the motor terminal box.
- L. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by control schematic and wiring diagrams.

- M. Inspect each piece of equipment in areas designated as HAZARDOUS to ensure that equipment of proper rating is installed. In the case where HAZARDOUS rated equipment is installed outdoors or in "WET" locations, verify that equipment furnished is also rated for use in WET locations and that conduit and equipment drains are provided. If equipment is not properly rated advise the ENGINEER and OWNER.
- N. Verify proper phase sequence connection at transformers, equipment, and panels by producing a 1, 2, 3 / A, B, C phase rotation from left to right.
- O. Verify all circuit breaker ratings and settings are as required by the Contract Documents or as amended during shop drawing review. Advise the ENGINEER of discrepancies and make changes as directed by the ENGINEER.
- P. Verify proper operation of automatic and manual transfer switches, accessories devices and associated motor interlocks provided to either delay or prevent motor starting after transfer. Verify that the upstream protective device for each automatic and manual transfer switch is of the proper type and rating to achieve the specified short-circuit withstand rating. If a specific upstream protective device is required to obtain the proper short circuit withstand rating, verify that the proper signage is installed on the upstream protective device and on the automatic/manual transfer switch enclosures indicating the proper replacement parts. If signage is not installed on both the upstream protective device and the transfer switch advise the ENGINEER and OWNER and provide the signage as specified in the transfer switch specification section.
- Q. Assist in the testing of the emergency/standby engine generator(s). The Electrical Contractor shall provide a journeymen electrician for the duration of the test to assist in the setup and operation of the emergency/standby engine generator(s) test(s).
- R. Provide load bank and assist in the testing of the emergency/standby engine generator(s). The testing firm shall provide the load bank, transformer, cooling system, cables and ancillary equipment required to test the emergency generator. The Electrical Contractor shall provide a journeymen electrician for the duration of the test to assist in the setup, connection and operation of the emergency/standby engine generator(s) test(s).
- S. Verify grounding of instrumentation equipment and line surge protection equipment.
- T. Test and calibrate protective relays and circuit breakers.
- U. Perform over potential, high potential, insulation resistance and shield continuity test for all medium voltage cables. Megger test all low voltage power system cable.
- V. Assist in performing a complete plant power outage test to will demonstrate that the automatic power transfer equipment, individual equipment programming and the plant's process control system reestablishes plant operations in the proper sequence once normal or standby power is established. The test shall be repeated until proper plant restoration is demonstrated.

END OF SECTION

**Final Report of Geotechnical Exploration  
For  
JEA Greenland Water Treatment Plant Expansion**

***MAE Project No. 0011-0019  
March 13, 2019***

**Prepared for:**



***8381 Dix Ellis Trail, Suite 400  
Jacksonville, FL 32256***



**Prepared by:**



**8936 Western Way, Suite 12  
Jacksonville, Florida 32256  
Phone (904) 519-6990  
Fax (904) 519-6992**

March 13, 2019

CDM Smith, Inc.  
8381 Dix Ellis Trail, Suite 400  
Jacksonville, Florida 32256



Attention: Mr. Yanni Polematidis, P.E.

Reference: FINAL Report of Geotechnical Exploration  
JEA Greenland Water Treatment Plant Expansion  
Jacksonville, Florida  
MAE Project No. 0011-0019

Dear Mr. Polematidis:

**Meskel & Associates Engineering, PLLC (MAE)** has completed a geotechnical exploration for the subject project. Our work was performed in general accordance with our subcontractor agreement with CDM Smith, Inc. dated August 27, 2018. The purpose of the geotechnical exploration was to evaluate the general subsurface conditions within the area of the proposed Ground Storage Tank (GST), the new diesel Generator/Fuel Tank, the new production Well No. 3 site, and the new Raw Water Main pipe route to provide recommendations for foundation support and design, and site preparation. This report supersedes our Draft report dated November 14, 2018 in its entirety.

In summary, the soil borings encountered predominately sand soils throughout the depth of the borings that appear to be adaptable for support of the proposed construction. Site preparation recommendations include clearing and stripping of existing topsoil, compaction of the underlying existing subgrade soil, and placement and compaction of any suitable import fill in controlled lifts. The purpose of these recommendations is to provide a more uniform subgrade for support of the structures and reduce the potential for excessive settlement.

We appreciate this opportunity to be of service as your geotechnical consultant on this phase of the project. If you have any questions, or if we may be of any further service, please contact us.

Sincerely,

**MESKEL & ASSOCIATES ENGINEERING, PLLC**  
MAE FL Certificate of Authorization No. 28142

P. Rodney Mank, State of Florida, Professional Engineer, License No. 41986. This item has been electronically signed and sealed by P. Rodney Mank, P.E. on 03/13/2019 using a Digital Signature. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

W. Josh Mele, E.I.  
Staff Engineer

P. Rodney Mank, P.E.  
Principal Engineer  
Licensed, Florida No. 41986

Distribution: Mr. Yanni Polematidis, P.E. – CDM Smith, Inc.

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  - Key to Boring Logs
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- Appendix B. Summary of Laboratory Test Results
  - Laboratory Test Procedures

## 1.0 PROJECT INFORMATION

### 1.1 General

Project information was provided to us by Mr. Yanni Polematidis, P.E., and Mr. Jeremy O’Neal with CDM Smith, Inc. via several emails and telephone conversations. We were provided with three undated plan sheets prepared by CDM Smith, titled, “*Greenland Water Treatment Plant Expansion from 6.0 to 9.0 MGD, Well Site No. 3, Proposed 16” Watermain Route, and Proposed Site/Yard Piping Plan*” that denoted the requested soil boring locations. This document was referenced for the Ground Storage Tank (GST); however, the pipeline alignment had several variations during the design phase. At a later date, we were provided with version 4 of the *Proposed 16” Water Main Route* to be used as reference in locating the requested soil borings.

### 1.2 Project Description

The site for the subject project is located at 6850 Energy Center Drive in Jacksonville, Florida. The general site location is shown on Figure 1.

Based on the provided information and our discussions with Mr. Polematidis and Mr. O’Neal, it is our understanding the existing Greenland Water Treatment Plant will be expanded. The expansion will include an additional Ground Storage Tank (GST) adjacent to the existing GST, a diesel Generator/Fuel Tank, a new production Well Number 3, and new Raw Water Main pipeline to the production well site. We understand the GST will be a prestressed concrete tank with a diameter of 80 feet and a capacity of 1.14 million gallons (MG). In addition to the additional GST, we understand a stand-alone stair tower will be located between the two tanks. The plan received from CDM shows the generator/fuel tank pad to be about 15 feet by 30 feet in plan area. For the purpose of our analyses, we have assumed that both the GST and the Generator/Fuel Tank will be supported on monolithic concrete slab-on-grade foundation systems. The stair tower has been assumed to be supported on a concrete slab-on-grade that is structurally separate of the 2 adjacent GST’s. Grading plans were not provided at the time of our evaluation; however, we have assumed the GST and new diesel Generator/Fuel Tank grades will roughly match those currently existing at the site. Furthermore, we have assumed the concrete slab foundation that will support the equipment for Well No. 3 will be supported on one to 2 feet of fill.

If actual project information varies from these conditions, then the recommendations in this report may need to be re-evaluated. Any changes in these conditions should be provided so the need for re-evaluation of our recommendations can be assessed prior to final design.

## 2.0 FIELD EXPLORATION

A field exploration for the planned GST and Generator/Fuel Tank was performed during the period of September 21 through 25, 2018. A field exploration for the planned Well and the Raw Water Main was performed on October 15, 2018. A copy of the plans provided to us, which shows the approximate boring locations, is included as the *Boring Location Plan*, Figures 2A through 2C. GPS coordinates for the boring locations were obtained by overlaying the provided plans in Google Earth. Prior to starting our field exploration, a utility locate request was submitted to the Sunshine State One-Call Center. Once the site utilities were located and marked, our field crew mobilized to the site. Our field personnel then located each boring using a Garmin GPSMAP 78 hand-held GPS receiver; therefore, the boring locations should

be considered accurate only to the degree implied by the method of measurement used.

## 2.1 SPT Borings

To explore the subsurface conditions within the area of the GST and Generator/Fuel Tank structures, and the Well and Raw Water Main alignment, we located and performed 11 Standard Penetration Test (SPT) borings, drilled to depths of approximately 15 feet (Raw Water Main), 20 feet (Well No. 3 and Generator/Fuel Tank), 45 feet (GST perimeter), and 70 feet (GST center) below the existing ground surface, in general accordance with the methodology outlined in ASTM D 1586. Split-spoon soil samples recovered during performance of the borings were visually described in the field and representative portions of the samples were transported to our laboratory for further evaluation.

## 3.0 LABORATORY TESTING

Representative soil samples obtained during our field exploration of the Raw Water Main alignment were packaged and transferred to our laboratory for classification using the AASHTO Soil Classification System in general accordance with ASTM D 3282. The representative samples obtained from the borings within the proposed Well, GST and Generator/Fuel Pad areas were classified using the Unified Soil Classification System (USCS) in accordance with ASTM D 2488. A *Key to the Soil Classification System* is included in Appendix A.

Quantitative laboratory testing was performed on selected samples of the soils encountered during the field exploration to better define the composition of the soils encountered and to provide data for correlation to their anticipated strength and compressibility characteristics. The laboratory testing determined the natural moisture content, the percent passing a U.S. No. 200 sieve (percent fines), and the organic content of selected soil samples. The results of the laboratory testing are shown in the *Summary of Laboratory Test Results* table included in Appendix B. Also, these results are shown on the *Generalized Soil Profiles*, Figures 3 through 7, and on the *Log of Boring* records at the respective depths from which the tested samples were recovered.

## 4.0 GENERAL SUBSURFACE CONDITIONS

### 4.1 General Soil Profile

Graphical presentation of the generalized subsurface conditions is presented on the *Generalized Soil Profiles* sheets, Figures 3 through 7. Detailed boring records are included in Appendix A. When reviewing the soil profiles sheets and soil boring logs, it should be understood that the soil conditions will vary between the boring locations.

#### 4.1.1 Well No. 3 Site

The boring encountered a surficial topsoil layer approximately 6 inches thick, underlain by loose to medium dense fine sands (SP) to an approximate depth of 8 feet, followed by medium dense fine sands with silt (SP-SM) to the boring termination depth of 20 feet below the existing ground surface.

#### 4.1.2 Raw Water Main Alignment

The borings generally encountered a surficial topsoil layer approximately 4 inches thick, underlain by loose to medium dense fine sands and fine sands with silt (A-3) to the boring termination depths of 15 feet

below the existing grade. Occasional samples of sands containing trace to little amounts of organic fines and and/or root fragments were encountered within the vertical depths explored.

#### 4.1.3 Ground Storage Tank

In general, the borings encountered a surficial topsoil layer approximately 2 to 4 inches thick, underlain by apparent fill soils consisting of loose to dense fine sands with silt (SP-SM) containing trace to few amounts of gravel (rock fragments) and trace amounts of organic fines and root fragments. Trace amounts of debris (glass) were encountered at boring B-10 within the fill soil. The fill continued to depths of about 4 to 6 feet below the existing ground surface. Below the fill soils, the borings encountered medium dense to very dense fine sands (SP) and fine sands with silt (SP-SM) containing trace to few amounts of roots and organic fines to depths of 12 to 14 feet below the existing grade, underlain by very dense fine sands with silt (SP-SM) (hardpan) to depths of about 17 to 22 feet below existing grade. Starting at a depth of 8 to 12 feet and continuing to up to a depth of approximately 20 feet, the borings encountered a layer of very dense fine sands (SP) and fine sands with silt (SP-SM), typically with trace to few amounts of organic fines. Below the apparent hardpan soils, the borings encountered medium dense to very dense fine sands (SP), fine sands with silt (SP-SM), and silty fine sands (SM) to the boring termination depths of 45 feet (tank perimeter) and 70 feet (tank center) below the existing ground surface.

#### 4.1.4 Generator/Fuel Tank

The boring encountered a surficial topsoil layer approximately 3 inches thick, underlain by apparent fill soils consisting of loose to medium dense fine sands with silt (SP-SM) containing trace to few amounts of organic fines, root fragments and gravel (rock fragments) to a depth of approximately 6 feet below the existing ground surface. Below the fill soils, the boring encountered medium dense fine sands with silt (SP-SM) containing trace amounts of organic fines and root fragments to a depth of about 14 feet, followed by very dense fine sands with silt (SP-SM) (hardpan) to a depth of about 17 feet below existing grade. Below the hardpan soil, the boring encountered medium dense fine sands with silt (SP-SM) to the boring termination depth of 20 feet below the existing grade.

### 4.2 Groundwater Level

The groundwater level was encountered at each of the boring locations and recorded at the time of drilling. Groundwater was encountered at the Well Number 3 location (boring B-1) at a depth of about 6 feet below existing grade. Groundwater was encountered along the proposed pipeline route at depths of approximately 4 feet to 6 feet 4 inches (borings B-2 to B-4) to 8 feet 1 inch (boring B-5) below the existing ground surface. Groundwater was encountered at the GST and Generator/Fuel Tank locations at depths of 6 feet to 8 feet 3 inches below the existing ground surface. However, it should be anticipated that the groundwater levels will fluctuate seasonally and with changes in climate. As such, we recommend that the water table be re-measured prior to construction. The measured groundwater levels are shown on the *Generalized Soil Profiles* sheets (Figures 3 through 7) and on the soil boring logs.

### 4.3 Review of the USDA Web Soil Survey Map

The results of a review of the USDA Soil Conservation Service (SCS) Web Soil Survey of Duval County are shown in the table below. The predominant pre-development soil map unit within the proposed GST and fuel tank/generator areas Cassia fine sand and Leon fine sand. The remaining soil map units in the table below were shown to be near or crossed by the proposed pipeline and at the water well location. The

soil map unit name and number, drainage class, hydrologic group, and estimated seasonal high groundwater levels reported in the Web Soil Survey are as follows:

| Map Unit Symbol | Map Unit Name   | Drainage Class          | Hydrologic Group | Depth to the Water Table <sup>(1)</sup> (inches) |
|-----------------|---|-------------------------|------------------|--|
| 2t2v2           | Cassia fine sand, 0 to 2% slopes                                    | Somewhat Poorly Drained | A                | 18 to 42   |
| 24              | Hurricane and Ridgewood soils, 0 to 5% slopes                       | Somewhat Poorly Drained | A                | 24 to 42   |
| 32              | Leon fine sand, 0 to 2% slopes                                      | Poorly Drained          | A/D              | 6 to 18  |
| 35              | Lynn Haven fine sand, 0 to 2% slopes                                | Poorly Drained          | A/D              | 0 to 6   |
| 46              | Ortega fine sand, 0 to 5% slopes                                    | Moderately Well Drained | A                | 42 to 72   |
| 62              | Rutledge mucky fine sand, 0 to 2 percent slopes, frequently flooded | Very Poorly Drained     | A/D              | 0 to 6   |

<sup>(1)</sup>The “Water Table” above refers to a saturated zone in the soil which occurs during specified months, typically the summer wet season. Estimates of the upper limit shown in the Web Soil Survey are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

#### 4.4 Seasonal High Groundwater Level

In estimating seasonal high groundwater level, a number of factors are taken into consideration including antecedent rainfall, soil redoximorphic features (i.e., soil mottling), stratigraphy (including presence of hydraulically restrictive layers), vegetative indicators, effects of development, and relief points such as drainage ditches, low-lying areas, etc.

Based on our interpretation of the current site conditions, including the boring logs and review of published data, we estimate the seasonal high groundwater level in the areas of the GST and the generator/fuel tank to be generally 1 to 2 feet above the groundwater levels measured at the time of our field work. We estimate the seasonal high groundwater level at the Well Number 3 site (boring B-1) to be 18 to 24 inches below the existing ground surface. The seasonal high groundwater levels along the proposed pipeline route are estimated to vary from 12 to 18 inches (borings B-2 and B-3) to 18 to 24 inches (boring B-4) and 24 to 30 inches (boring B-5). These depths to the seasonal high groundwater level estimates are relative to the existing ground surface.

It is possible that groundwater levels may exceed the estimated seasonal high groundwater level as a result of significant or prolonged rains. Therefore, we recommend that design drawings and specifications account for the possibility of groundwater level variations, and construction planning should be based on the assumption that such variations will occur.

## **5.0 DESIGN RECOMMENDATIONS**

### **5.1 General**

The following evaluation and recommendations are based on the provided project information as presented in this report, results of the field exploration and laboratory testing performed, and the construction techniques recommended in Section 6.0 below. If the described project conditions are incorrect or changed after this report, or subsurface conditions encountered during construction are different from those reported, MAE should be notified so these recommendations can be re-evaluated and revised, if necessary. We recommend that MAE review the foundation plans and earthwork specifications to verify that the recommendations in this report have been properly interpreted and implemented.

### **5.2 GST Foundation Design Recommendations**

We understand that the prestressed concrete tank will be supported on a 4-inch-thick concrete slab-on-grade. The slab will be thickened at the tank edge to support the tank walls and the tank dome. Based on the results of our exploration, we consider the subsurface conditions at the site adaptable for support of the proposed GST structure when constructed on a properly designed shallow foundation system. Provided the site preparation and earthwork construction recommendations outlined in Section 6.0 of this report are performed, the following parameters may be used for foundation design.

#### **5.2.1 Bearing Pressure**

Based on the 1.14 million-gallon storage capacity and the tank diameter of 80 feet, we calculated a water storage height of approximately 30 feet. Therefore, we estimate the load applied to the subsurface soils to be on the order of 1,900 pounds per square foot (psf).

The maximum allowable net soil bearing pressure for use in design of the tank foundation should not exceed 2,500 psf. Net bearing pressure is defined as the soil bearing pressure at the foundation bearing level in excess of the natural overburden pressure at that level. The foundations should be designed based on the maximum load that could be imposed by all loading conditions.

#### **5.2.2 Foundation Size**

The minimum width of the perimeter footing supporting the tank walls should be 18 inches. Even though the maximum allowable soil bearing pressure may not be achieved, this width recommendation should control the size of the foundation.

#### **5.2.3 Bearing Depth**

The minimum embedment depth for the thickened edge footing portion of the slab is 12 inches below the adjacent outside finished grades. It is recommended that surface grades adjacent to the tank structure be graded to divert surface water away from the tank to reduce the possibility of erosion beneath the thickened edge slab.

#### **5.2.4 Bearing Material**

The tank slab including the thickened-edge portion may bear on either the compacted existing site soils, or on compacted import structural fill if needed to raise the site grade. The bearing level soils, after

compaction, should exhibit densities equivalent to 98 percent of the modified Proctor maximum dry density (ASTM D 1557), to a depth of at least 2 feet below the foundation bearing levels.

### 5.2.5 Settlement Estimates

Post-construction settlements of the tank structure will be influenced by several interrelated factors, such as (1) subsurface stratification and strength/compressibility characteristics; (2) the size of the tank foundation and the bearing level, the applied loads, and the resulting bearing pressures beneath the foundation; and (3) site preparation and earthwork construction techniques used by the contractor. The settlement estimates presented below are based on the results of our field exploration at the site, laboratory test results, and the use of the site preparation/earthwork construction techniques as recommended in this report. Any deviation from these recommendations could result in an increase in the estimated post-construction settlements of the storage tank structure.

Using the estimated load to be applied to the foundation soils by the full water tank, and the field and laboratory test data that we have correlated to geotechnical strength and compressibility characteristics of the subsurface soils, we estimate that the total settlement of the tank structure at the tank center to be approximately 1.25 inches. Differential settlements result from differences in applied bearing pressures and variations in the compressibility characteristics of the subsurface soils. Because of the general uniformity of the subsurface conditions, and assuming the recommended site preparation and earthwork construction techniques outlined in Section 6.0 are followed, we estimate the differential settlement between the center and perimeter of the tank to be approximately 0.75-inch. We recommend that piping, tank nozzles, and other attachments be designed with adequate consideration for the anticipated settlement.

The soil borings encountered predominately sandy soils within the expected stress zone of influence for the tank structure. Therefore, we expect the majority of the estimated total and differential settlement to occur in an elastic manner during construction and initial filling of the tank. The remainder of the estimated settlement will likely occur within approximately 2 weeks once the tank is constructed and filled to its design water level, as pore water pressures within the foundation soils recede.

### 5.2.6 Tank Slab

The tank slab can be constructed as a slab-on-grade bearing on the existing site soils and designed for a modulus of subgrade reaction of 200 pci. The surficial topsoil and other unsuitable material should be removed as discussed in Section 6.1.1 below. Any import structural fill needed to raise the site grade should be placed and compacted as outlined in Section 6.1.4. It is recommended that the tank slab bearing soils be covered with an impervious membrane to reduce moisture entry and floor dampness. A 6-mil thick plastic membrane is commonly used for this purpose. Care should be exercised not to tear large sections of the membrane during placement of reinforcing steel and concrete. In addition, we recommend that a minimum separation of 2 feet be maintained between the tank slab bearing level and the estimated seasonal high groundwater level.

## 5.3 Generator/Fuel Tank and Well No. 3 Slab Foundations Recommendations

Based on the results of our exploration, we consider the subsurface conditions at the site adaptable for support of the proposed Generator/Fuel Tank structure and Well Equipment on slab-on-grade foundations designed for a modulus of subgrade reaction of 200 pci. Provided the site preparation and earthwork construction recommendations outlined in Section 6.0 of this report are performed, the

following parameters may be used for foundation design.

### **5.3.1 Bearing Pressure**

The maximum allowable net soil bearing pressure for use in slab-on-grade design should not exceed 2,000 psf. Net bearing pressure is defined as the soil bearing pressure at the foundation bearing level in excess of the natural overburden pressure at that level. The slab-on-grade should be designed based on the maximum load that could be imposed by all loading conditions.

### **5.3.2 Bearing Depth**

The slab-on-grade should bear at a depth of at least 12 inches below the exterior final grades. It is recommended that stormwater be diverted away from these slabs to reduce the possibility of erosion beneath the slabs.

### **5.3.3 Bearing Material**

The surficial topsoil and other unsuitable material should be removed within the construction area of both slabs as defined in Section 6.1.1 below and replaced with compacted structural fill as outlined in Section 6.1.4. These soils should be compacted to at least 98 percent of the soil's modified Proctor Maximum Dry Density (ASTM D-1557) to a depth of at least one foot below the slab bearing levels. Control of the soil's moisture content will be necessary to achieve the required level of compaction.

### **5.3.4 Settlement Estimates**

Post-construction settlements of the generator/fuel tank slab and well number 3 slab will be influenced by several interrelated factors, such as (1) subsurface stratification and strength/compressibility characteristics; (2) the area of each slab and the bearing level, the applied loads, and the resulting bearing pressures beneath the slabs; and (3) site preparation and earthwork construction techniques used by the contractor. The settlement estimates presented below are based on the results of our field exploration at the site, laboratory test results, and the use of the site preparation/earthwork construction techniques as recommended in this report. Any deviation from these recommendations could result in an increase in the estimated post-construction settlements of the structures.

Using the recommended bearing pressure applied to the slab subgrade soils, and the field and laboratory test data that we have correlated to geotechnical strength and compressibility characteristics of the subsurface soils, we estimate that the total settlement of each slab to be less than one inch. Differential settlements result from differences in applied bearing pressures and variations in the compressibility characteristics of the subsurface soils. Because of the general uniformity of the subsurface conditions, and assuming the recommended site preparation and earthwork construction techniques outlined in Section 6.0 are followed, we estimate the differential settlement across the slab length to be 0.5 -inch or less. We recommend that any piping or other attachments be designed with adequate consideration for the anticipated settlement.

The soil borings encountered predominately sandy soils within the expected stress zone of influence for the generator/fuel tank and well number 3 structures. Therefore, we expect the majority of the estimated total and differential settlement to occur in an elastic manner during construction as the load is applied.

## **5.4 Raw Water Pipeline Support Recommendations**

Based on the results of the subsurface explorations, laboratory testing, and provided information, as

included in this report, we consider the subsurface conditions at the site adaptable for supporting the proposed below-grade pipeline and associated structures when constructed upon properly prepared subgrade soils.

Provided the site preparation and earthwork construction recommendations outlined in Section 6.0 of this report are performed, the following parameters may be used for design of below-grade utilities.

#### 5.4.1 Lateral Pressure Design Parameters

Any below-grade walls associated with the pipeline that are backfilled on one side and restrained against rotation at the top, should be designed to resist lateral pressures from soil and groundwater based on the following equivalent fluid unit weights:

- Above Water Table - Equivalent Fluid Density 60 lb/ft<sup>3</sup>
- Below Water Table - Equivalent Fluid Density 90 lb/ft<sup>3</sup>

For the design of lateral loads on below-grade walls, we recommend that the groundwater level be assumed to be at the ground surface. Lateral pressure distributions in accordance with the above do not take into account forces from construction equipment, wheel loads or other surcharge loads. To account for this loading, a pressure equal to 0.5 times the anticipated surface surcharge should be applied over the full height of all walls.

#### 5.4.2 Resisting Lateral Forces

Horizontal forces that act on pipeline structures such as thrust and anchor blocks can be resisted to some extent by the earth pressures that develop in contact with the buried perpendicular face of the block structure, and by shearing resistance mobilized along the block structures base and subgrade interface. Allowable passive earth pressure resistance may be determined using the following equivalent fluid densities:

- Above Water Table - Equivalent Fluid Density 100 lb/ft<sup>3</sup>
- Below Water Table - Equivalent Fluid Density 60 lb/ft<sup>3</sup>

A factor of safety of 3 was used for the above values. It is assumed the block structures are surrounded by well compacted structural backfill, as described in Section 6.0 below, extending at least 5 feet horizontally beyond the vertical bearing face. In addition, it is presumed that the block structures can withstand horizontal movements on the order of 0.5-inch before mobilizing full passive resistance.

The allowable sliding shearing resistance mobilized along the base of the block structure may be determined by the following formula:

$$P = \frac{1}{3}V \tan \left( \frac{2}{3}\Phi \right)$$

Where: P = Allowable shearing resistance force  
V = Net vertical force (total weight of block and soil overlying the structure minus hydrostatic uplift forces)  
Φ = Angle of internal friction = 30°

The following unit weights can be used to calculate the weight of the overburden soil:

- Compacted Moist Soil 110 lb/ ft<sup>3</sup>
- Saturated Soil 120 lb/ ft<sup>3</sup>

### 5.4.3 Hydrostatic Uplift Resistance

It is anticipated that the buried structures will exert little or no net downward pressure on the soils, rather, the structures may be subject to hydrostatic uplift pressure when empty. Below grade structures should be designed to resist hydrostatic uplift pressures appropriate for their depth below existing grade and the normal seasonal high groundwater table. Hydrostatic uplift forces can be resisted in several ways including:

- Addition of dead weight to the structure.
- Mobilizing the dead weight of the soil surrounding the structure through extension of footings outside the perimeter of the structure.

A moist compacted soil unit weight of 110 lb/ft<sup>3</sup> may be used in designing structures to resist buoyancy.

## 5.5 Seismic Site Classification

We have reviewed the 2018 International Building Code (IBC), Section 1613 Earthquake Loads, for the Seismic Site Classification for the site. The Code indicates that the Maximum Considered Earthquake Ground Motion Response Acceleration Contours of Spectral Response vary across Florida as follows:

**0.2-Second Period Spectral Response Acceleration:** (Figure 1613.2.1(1)): Contour 5 (South Florida) to Contour 10 (Northern Florida)

**1-Second Period Spectral Response Acceleration** (Figure 1613.2.1(2)): Contour 2 (South Florida) to Contour 6 (Northern Florida/Southern Georgia)

For this site, based on a review of the 2018 IBC, Section 1613, the seismic classifications for the subsurface materials as encountered at the GST boring locations were estimated as shown below.

**Site Classification:** Site Class D based on the average N-value between 15 and 50.<sup>(1)</sup>

**Earthquake Spectral Response Acceleration at Short Periods:**  $S_s = 10\%g$  (as determined in Section 1613.5.1)<sup>(2)</sup>

**Earthquake Spectral Response Acceleration at 1-second Period:**  $S_1 = 6\%g$  (as determined in Section 1613.5.1)<sup>(3)</sup>

## 6.0 SITE PREPARATION AND EARTHWORK RECOMMENDATIONS

Site preparation as outlined in this section should be performed to provide more uniform foundation bearing conditions and to reduce the potential for post-construction settlements of the planned structures and pipeline.

### 6.1 Structures

#### 6.1.1 Clearing and Stripping

Prior to construction, the location of existing underground utility lines within the construction area should be established. Provisions should then be made to relocate interfering utilities to appropriate locations.

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1 IBC, 2018: Section 1613.2.2 referring to Chapter 20, ASCE 7 Table 20.3-1 Site Classification

2 IBC, 2018: Figure 1613.2.1(1) – 0.2 second response acceleration (5% of critical damping)

3 IBC, 2006: Figure 1613.2.1(2) – 1.0 second response acceleration (5% of critical damping)

It should be noted that, if underground pipes are not properly removed or plugged, they may serve as conduits for subsurface erosion, which may subsequently lead to excessive settlement of overlying structures.

The "footprint" of the proposed GST, Generator/Fuel Tank slab and Well Number 3 equipment slab, plus a minimum additional margin of 5 feet, should be stripped of all surface vegetation, stumps, debris, organic topsoil, or other deleterious materials. During grubbing operations, roots with a diameter greater than 0.5-inch, stumps, or small roots in a concentrated state, should be grubbed and completely removed.

Based on the results of our field exploration, it should be anticipated that 2 to 6 inches of topsoil and soils containing significant amounts of organic materials may be encountered at the structure/slab areas. The actual depths of unsuitable soils and materials should be determined by MAE using visual observation and judgment during earthwork operations. Any topsoil removed from the structure areas can be stockpiled and used subsequently in areas to be grassed.

### **6.1.2 Temporary Groundwater Control**

The groundwater level at the structure locations was encountered at depths varying from 6 feet to 8 feet 3 inches below the existing ground surface at the time of our exploration. Should groundwater control measures become necessary, the dewatering method should be determined by the contractor. We recommend the groundwater control measures, if necessary, maintain the groundwater level at least 2 feet below the compacted surface and remain in place until compaction of the existing soils is completed. The site should be graded to direct surface water runoff from the construction area.

### **6.1.3 Compaction**

After completing the clearing and stripping operations, and after installing the temporary groundwater control measures if required, the exposed surface area should be compacted with a vibratory drum roller having a minimum static, at-drum weight, on the order of 5 to 10 tons. Typically, the soils should exhibit moisture contents within  $\pm 2$  percent of the modified Proctor optimum moisture content (ASTM D 1557) during the compaction operations. Several overlapping passes should be made in both directions across the footprint area of the planned structures, with each pass overlapping the previous pass by at least 30 percent. Compaction should continue until densities of at least 98 percent of the modified Proctor maximum dry density (ASTM D 1557) have been achieved within the upper 2 feet of the compacted existing soils at the site.

Should the bearing level soils experience pumping and soil strength loss during the compaction operations, compaction work should be immediately terminated. The disturbed soils should be removed and backfilled with dry structural fill soils as defined in Section 6.1.4 below, which are then compacted, or the excess moisture content within the disturbed soils should be allowed to dissipate before recompacting.

Care should be exercised to avoid damaging any nearby structures while the compaction operation is underway. Prior to commencing compaction, occupants of adjacent structures should be notified, and the existing conditions of the structures should be documented with photographs and survey. Compaction should cease if deemed detrimental to adjacent structures, and MAE should be contacted immediately.

It is recommended that the vibratory roller remain a minimum of 75 feet from existing structures. Within this zone, use of a track-mounted bulldozer or a vibratory roller, operating in the static mode, is

recommended. If such methods are deemed necessary, then it may be necessary to excavate the top foot of soil subgrade, following site clearing, and compact the underlying soils to the specified level of compaction, followed by re-placement and compaction of the excavated soil.

#### **6.1.4 Structural Backfill and Imported Fill Soils**

Any structural backfill or fill required for site development should be placed in loose lifts not exceeding 12 inches in thickness and compacted by the use of the above described vibratory drum roller. The lift thickness should be reduced to 8 inches if the roller operates in the static mode or if track-mounted compaction equipment is used. If hand-held compaction equipment is used, the lift thickness should be further reduced to 6 inches.

Imported structural fill is defined as a non-plastic, inorganic, granular soil having less than 12 percent material passing the No. 200 mesh sieve and containing less than 4 percent organic material. The existing site soils consisting of fine sands and fine sands with silt, without roots or debris, as encountered in the borings, are also considered suitable as fill and backfill and, with proper moisture control, should densify using conventional compaction methods.

It should be noted that soils with more than 12 percent passing the No. 200 sieve will be more difficult to compact, due to their nature to retain soil moisture, and may require drying. Typically, the material should exhibit moisture contents within  $\pm 2$  percent of the modified Proctor optimum moisture content (ASTM D 1557) during the compaction operations. Compaction should continue until densities of at least 98 percent of the modified Proctor maximum dry density (ASTM D 1557) have been achieved within each lift of the compacted structural fill.

#### **6.1.5 Foundation Areas**

After satisfactory surface compaction and placement and compaction of any additional imported structural fill, the foundation areas may be excavated to the planned bearing levels. The foundation bearing level soils, after compaction, should exhibit densities equivalent to 98 percent of the modified Proctor maximum dry density (ASTM D 1557), to a depth of two feet below the bearing level. For confined areas, such as the footing excavations, any additional compaction operations can probably best be performed by the use of a lightweight vibratory sled or roller having a total weight on the order of 500 to 2000 pounds.

### **6.2 Raw Water Main**

#### **6.2.1 Clearing**

Prior to construction, the location of existing underground utility lines within the construction area should be established. Provisions should then be made to relocate interfering utilities to appropriate locations. It should be noted that if underground pipes are not properly removed or plugged, they may serve as conduits for subsurface erosion which may subsequently lead to excessive settlement of overlying structures.

Based on the results of our field exploration, it should be anticipated that 2 to 6 inches of topsoil and soils containing significant amounts of organic materials may be encountered across the site. The actual depths of unsuitable soils and materials should be determined by MAE using visual observation and judgment during earthwork operations. Any topsoil removed from the structure areas can be stockpiled and used subsequently in areas to be grassed.

Based on the results of our field exploration, it should be anticipated that 2 to 6 inches of topsoil and soils containing significant amounts of organic materials will be encountered along the planned pipeline route. The actual depths of unsuitable soils and materials should be determined by MAE using visual observation and judgment during earthwork operations. These soils are not considered suitable for reuse as backfill material within the pipeline or structure excavations. However, they can be stockpiled and used subsequently in areas to be grassed.

### **6.2.2 Temporary Groundwater Control**

The groundwater level was encountered at the boring locations along the proposed pipeline route at depths varying from 4 feet to 8 feet 1 inch below the existing ground surface at the time of our exploration. Because of the need for excavation to the pipeline bearing levels, followed by compaction of the bedding and backfill soils, it may be necessary to install temporary groundwater control measures to dewater the area to facilitate the excavation and compaction processes. The groundwater control measures should be determined by the contractor but can consist of sumps or wellpoints (or a combination of these or other methods) capable of lowering the groundwater level to at least 3 feet below the required depth of excavation. The dewatering system should not be decommissioned until excavation, compaction, and fill placement is complete, and sufficient deadweight exists on the structures to prevent uplift.

### **6.2.3 Preparation of Foundation Soils**

For pipelines that are anticipated to bear in the existing sandy soils (SP, SP-SM), the soils should be excavated to the proposed bearing elevation and the exposed excavation surface should be compacted as outlined in the following sections. Once the pipe is installed, the trench should be backfilled with compacted structural backfill to final grade.

### **6.2.4 Compaction of Excavation Bottom**

After installing the temporary groundwater control measures, and achieving the required depth of excavation, the exposed sandy soil pipe bedding should be compacted with appropriate compaction equipment. Typically, the pipe bedding soil should exhibit moisture contents within  $\pm 2$  percent of the modified Proctor optimum moisture content (AASHTO T-180) during the compaction operations. Compaction should continue until densities of at least 95 percent of the modified Proctor maximum dry density (AASHTO T-180) have been achieved within the upper one foot below the exposed surface within the pipeline excavation.

Should the bearing level soils experience pumping and soil strength loss during the compaction operations, compaction work should be immediately terminated and (1) the disturbed soils removed and backfilled with dry structural fill soils as defined in Section 6.2.5 that are then compacted, or (2) the excess moisture content within the disturbed soils allowed to dissipate before recompacting.

Care should be exercised to avoid damaging any nearby structures while the compaction operations are underway. Compaction should cease if deemed detrimental to adjacent structures.

### **6.2.5 Excavation Protection**

Excavation work for the Raw Water Main construction will be required to meet OSHA Excavation Standard Subpart P regulations for Type C Soils. The use of excavation support systems will be necessary where there is not sufficient space to allow the side slopes of the excavation to be laidback to at least 2H:1V (2 horizontal to 1 vertical) to provide a safe and stable working area and to facilitate adequate compaction

along the sides of the excavation. In addition, it should be anticipated that an excavation support system may be necessary to protect adjacent existing structures, pavement and/or utilities that are located along the proposed pipeline alignment.

The method of excavation support should be determined by the contractor but can consist of a trench box, drilled-in soldier piles with lagging, interlocking steel sheeting or other methods. The support structure should be designed according to OSHA sheeting and bracing requirements by a Florida registered Professional Engineer. Where pipeline excavations and the construction of excavation support systems are within 50 feet of existing structures, the existing structures should be monitored for adverse reactions to construction vibrations and dewatering activities.

#### **6.2.6 Structural Backfill and Compaction of Structural Backfill**

Structural backfill should be placed around and above the pipeline in loose lifts not exceeding six inches in thickness and compacted by the use of hand-operated compaction equipment. At elevations greater than 12 inches above the top of pipe, structural backfill may be placed in loose lifts not exceeding 12 inches in thickness and compacted by hand-operated compaction equipment. Structural backfill placed within 5 feet of any structure walls should be placed in 6-inch-thick loose lifts and compacted with hand-held equipment. Outside of this 5-foot zone, backfill may be placed in 12-inch-thick lifts and compacted with appropriate equipment. Care should be taken not to damage the structure walls.

Import structural backfill is defined as a non-plastic, granular soil having less than 12 percent material passing the No. 200 mesh sieve and containing less than 4 percent organic material. The sandy soils (SP, SP-SM) without roots, as encountered in the borings, may also be used as structural backfill. Typically, the backfill material should exhibit moisture contents within  $\pm 2$  percent of the modified Proctor optimum moisture content (AASHTO T-180) during the compaction operations. Compaction should continue until densities of at least 95 percent of the modified Proctor maximum dry density (AASHTO T-180) have been achieved within each 6- or 12-inch-thick lift of the compacted structural backfill.

We recommend that soils excavated from the pipeline trenches that will be reused as backfill be stockpiled a safe distance from the excavations and in such a manner that promotes runoff away from the open trenches and limits saturation of the materials.

## **7.0 QUALITY CONTROL TESTING**

For all structures, a representative number of field in-place density tests should be made in the upper 2 feet of compacted existing site soils, in each lift of compacted backfill and fill, in the upper 12 inches of compacted subgrade soil in the foundation areas. The density tests are considered necessary to verify that satisfactory compaction operations have been performed. We recommend density testing be performed at one location for every 5,000 square feet of tank or slab foundation area, with a minimum of 2 test locations per structure.

For the raw water pipeline, a representative number of field in-place density tests should be made in the upper 2 feet of compacted pipe bedding soils, in each lift of compacted backfill and fill, and in the upper 12 inches below the bearing levels in the pipeline excavations. The density tests are considered necessary to verify that satisfactory compaction operations have been performed. We recommend density testing be performed at a minimum of one location for every 300 feet of pipeline.

## 8.0 REPORT LIMITATIONS

This report has been prepared for the exclusive use of CDM Smith, Inc. and the JEA for specific application to the design and construction of the *JEA Greenland Water Treatment Plant Expansion* project. An electronically signed and sealed version, and a version of our report that is signed and sealed in blue ink, may be considered an original of the report. Copies of an original should not be relied on unless specifically allowed by MAE in writing. Our work for this project was performed in accordance with generally accepted geotechnical engineering practice. No warranty, express or implied, is made.

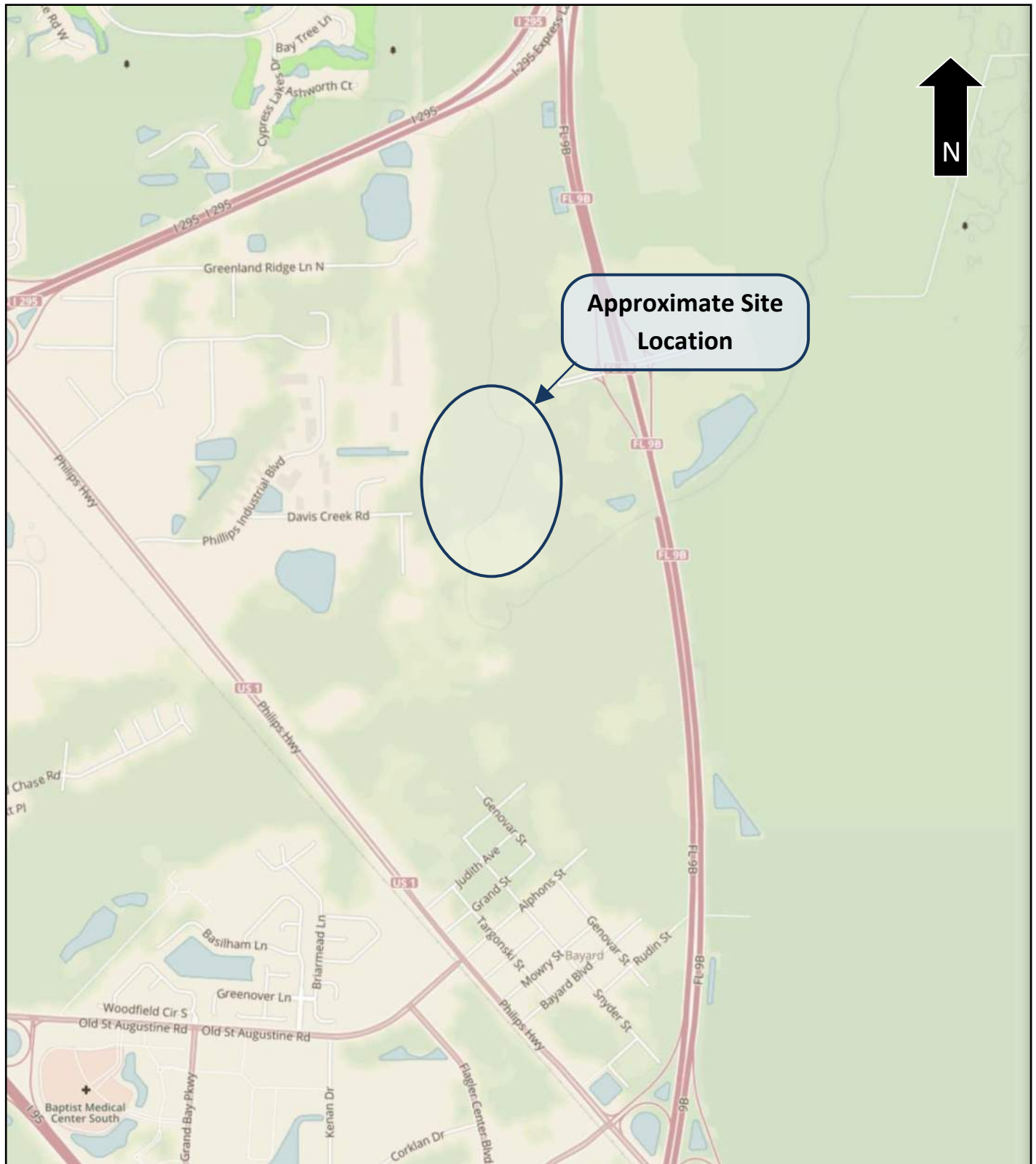
The analyses and recommendations contained in this report are based on the data obtained from this project. This testing indicates subsurface conditions only at the specific locations and times, and only to the depths explored. These results do not reflect subsurface variations that may exist away from the boring locations and/or at depths below the boring termination depths. Subsurface conditions and water levels at other locations may differ from conditions occurring at the tested locations. In addition, it should be understood that the passage of time may result in a change in the conditions at the tested locations. If variations in subsurface conditions from those described in this report are observed during construction, the recommendations in this report must be re-evaluated.

The scope of our services did not include any environmental assessment or testing for the presence or absence of hazardous or toxic materials in the soil, groundwater, or surface water within or beyond the subject site. Any statements made in this report, and/or notations made on the generalized soil profiles or boring logs, regarding odors or other potential environmental concerns are based on observations made during execution of our scope of services and as such are strictly for the information of our client. No opinion of any environmental concern of such observations is made or implied. Unless complete environmental information regarding the site is already available, an environmental assessment is recommended.


If changes in the design or location of the structures or pipeline occur, the conclusions and recommendations contained in this report may need to be modified. We recommend that these changes be provided to us for our consideration. MAE is not responsible for conclusions, interpretations, opinions or recommendations made by others based on the data contained in this report.

*Figures*

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## Site Location Map

| PREPARED BY   |  | PROJECT NAME   |            |
|---|--|--|------------|
|  |  | <b>JEA Greenland WTP Expansion<br/>Jacksonville, Florida</b> |            |
|   |  | REFERENCE  | SCALE      |
| PREPARED FOR  |  | USGS/Topo View   | NTS        |
| <b>CDM Smith, Inc.</b>  |  | MAE PROJECT NO.  | FIGURE NO. |
|   |  | 0011-0019  | 1          |

LEGEND:



SPT BORING

NOTE: Well Site No.3 Plan Sheet No. C-2 dated August 2018 was provided by CDM Smith, Inc.

| REVISIONS |    |             |      |    |             |
|-----------|----|-------------|------|----|-------------|
| DATE      | BY | DESCRIPTION | DATE | BY | DESCRIPTION |
|           |    |             |      |    |             |

P. RODNEY MANK, P.E. P.E. NO.: 41986  
**10 YEARS MAE**  
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FL Certificate of Authorization No. 28142  
8936 Western Way, Suite 12, Jacksonville, FL 32256

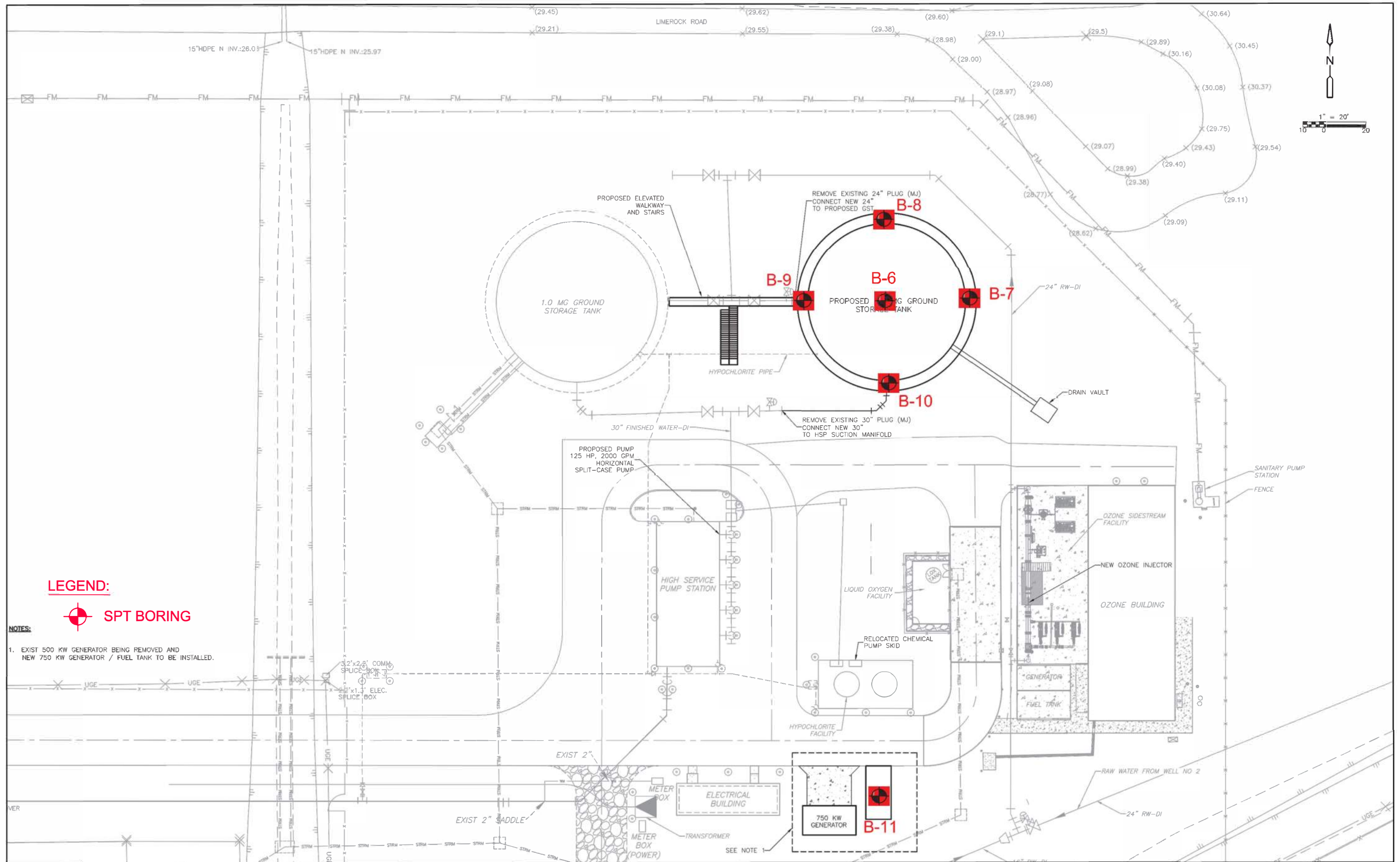
|                                   |                               |
|-----------------------------------|-------------------------------|
| CLIENT:<br><b>CDM Smith, Inc.</b> |                               |
| DATE:<br>11/13/2018               | MAE PROJECT NO.:<br>0126-0001 |

|   |                   |
|---|-------------------|
| SHEET TITLE:<br><b>BORING LOCATION PLAN</b>                           |                   |
| PROJECT NAME:<br>JEA Greenland WTP Expansion<br>Jacksonville, Florida | FIGURE NO.:<br>2A |



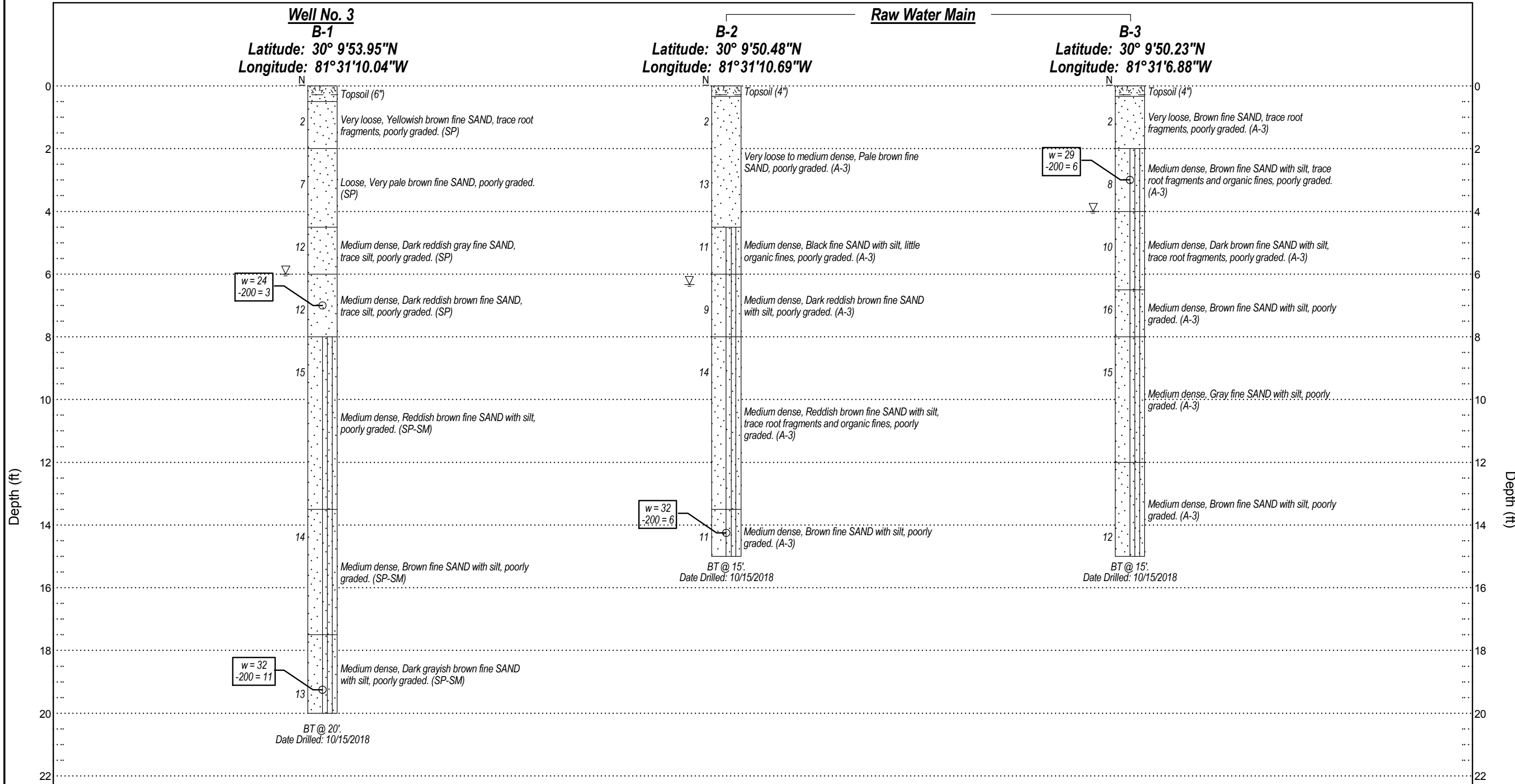
NOTE: Proposed 16" Water Main Route Figure 4-1 dated August 2018 was provided by CDM Smith, Inc.

| REVISIONS |    |             |      |    |             | P. RODNEY MANK, P.E. P.E. NO.: 41986   |  | CLIENT: CDM Smith, Inc. |                  | SHEET TITLE: BORING LOCATION PLAN                                  |  |
|-----------|----|-------------|------|----|-------------|--|--|-------------------------|------------------|--|--|
| DATE      | BY | DESCRIPTION | DATE | BY | DESCRIPTION | <br><small>Meskel &amp; Associates Engineering<br/>Geotechnical • Environmental • Inspection • Testing<br/>FL Certificate of Authorization No. 28142<br/>8936 Western Way, Suite 12, Jacksonville, FL 32256</small> |  | DATE:                   | MAE PROJ. CT NO. | PROJECT NAME: JEA Greenland WTP Expansion<br>Jacksonville, Florida |  |
|           |    |             |      |    |             |  |  | 11/13/2018              | 0126-0001        | FIGURE NO. 2B  |  |



NOTE: Proposed Site/Yard Piping Plan Sheet No. C-6 dated August 2018 was provided by CDM Smith, Inc.

| REVISIONS |    |             |      |    |             | <div>P. RODNEY MANK, P.E.   P.E. NO.: 41986</div> <div><br/>Meskel &amp; Associates Engineering<br/>Geotechnical • Environmental • Inspection • Testing<br/>FL Certificate of Authorization No. 28142<br/>8936 Western Way, Suite 12, Jacksonville, FL 32256</div> | CLIENT:         |                 | SHEET TITLE:   |            |  |
|-----------|----|-------------|------|----|-------------|---|-----------------|-----------------|--|------------|--|
| DATE      | BY | DESCRIPTION | DATE | BY | DESCRIPTION |   | CDM Smith, Inc. |                 | BORING LOCATION PLAN                                 |            |  |
|           |    |             |      |    |             |   | DATE:           | MAE PROJECT NO. | PROJECT NAME:  |            |  |
|           |    |             |      |    |             |   | 11/13/2018      | 0126-0001       | JEA Greenland WTP Expansion<br>Jacksonville, Florida | FIGURE NO. |  |
|           |    |             |      |    |             |   |                 |                 |  | 2C         |  |



**Legend**

Topsoil

Fine Sand

Fine Sand with Silt

N Standard Penetration Resistance, Blows/Foot

BT Boring Terminated at Depth Below Existing Grade

(SP) Unified Soil Classification System (USCS)

(A-3) AASHTO Soil Classification System

W Natural Moisture Content (%)

-200 % Passing No. 200 U.S. Standard Sieve

Depth to Groundwater at Time of Drilling

| REVISIONS |    |             |      |    |             | <div><p>P. RODNEY MANK, P.E.   P.E. NO.: 41986</p><p>Mankel &amp; Associates Engineering<br/>Geotechnical • Environmental • Inspection • Testing</p><p>FL Certificate of Authorization No. 28142<br/>8936 Western Way, Suite 12, Jacksonville, FL 32256</p></div> | CDM Smith, Inc. |                 | SHEET TITLE:   |  |
|-----------|----|-------------|------|----|-------------|--|-----------------|-----------------|--|--|
| DATE      | BY | DESCRIPTION | DATE | BY | DESCRIPTION |  | DATE:           | MAE PROJECT NO. | Generalized Soil Profiles                            |  |
|           |    |             |      |    |             |  |                 |                 | PROJECT NAME:  |  |
|           |    |             |      |    |             |  |                 |                 | JEA Greenland WTP Expansion<br>Jacksonville, Florida |  |
|           |    |             |      |    |             |  | 11/14/2018      | 0011-0019       | 3  |  |

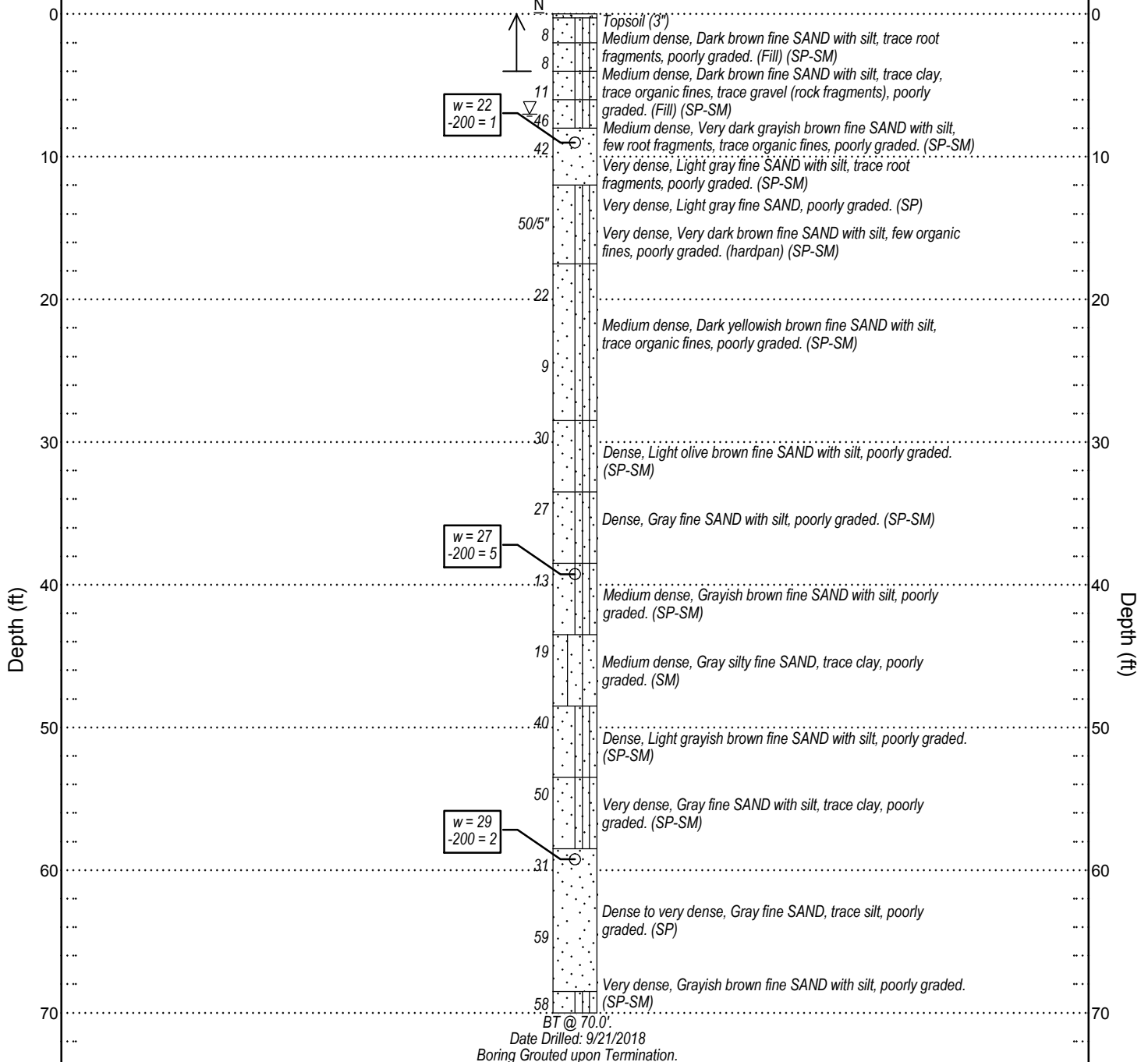


# Ground Storage Tank (1.5 MG)

B-6

Latitude: 30° 9'28.38"N

Longitude: 81°30'51.45"W



## Legend



Topsoil



Fine Sand



Fine Sand with Silt



Silty Fine Sand

N Standard Penetration Resistance, Blows/Foot

(SP) Unified Soil Classification System

BT Boring Terminated at Depth Below Grade

▽ Depth to Groundwater at Time of Drilling

w Natural Moisture Content (%)

-200 % Passing No. 200 U.S. Standard Sieve

50/5" Indicates 50 Hammer blows drove split spoon sampler 5 inches.

↑ Apparent Fill Soil

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CDM Smith, Inc.

DATE  
11/14/2018

MAE PROJECT NO.  
0011-0019

SHEET TITLE:

Generalized Soil Profile

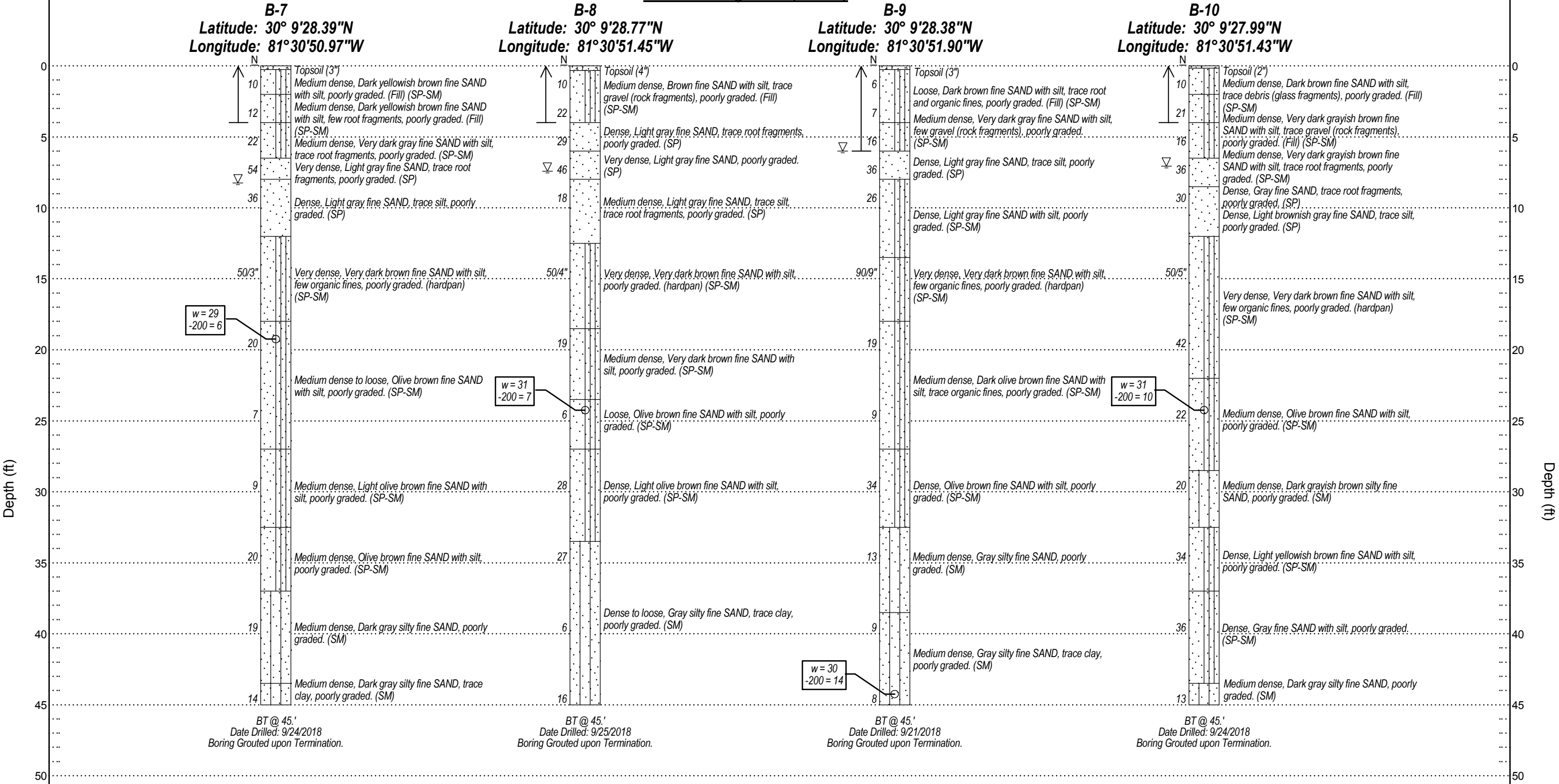
PROJECT NAME:

JEA Greenland WTP Expansion  
Jacksonville, Florida

FIGURE NO.

5

Ground Storage Tank (1.5 MG)



Legend



Topsoil



Fine Sand with Silt



Fine Sand



Silty Fine Sand

N

Standard Penetration Resistance, Blows/Foot

BT

Boring Terminated at Depth Below Existing Grade

(SP) Unified Soil Classification System (USCS)

▽ Depth to Groundwater at Time of Drilling



Apparent Fill Soil

w Natural Moisture Content (%)

-200 % Passing No. 200 U.S. Standard Sieve

50/4" Indicates 50 Hammer blows drove split spoon sampler 4 inches.

| REVISIONS |    |             |      |    |             |
|-----------|----|-------------|------|----|-------------|
| DATE      | BY | DESCRIPTION | DATE | BY | DESCRIPTION |
|           |    |             |      |    |             |

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| CDM Smith, Inc. |                 |
|-----------------|-----------------|
| DATE:           | MAE PROJECT NO. |
| 11/14/2018      | 0011-0019       |

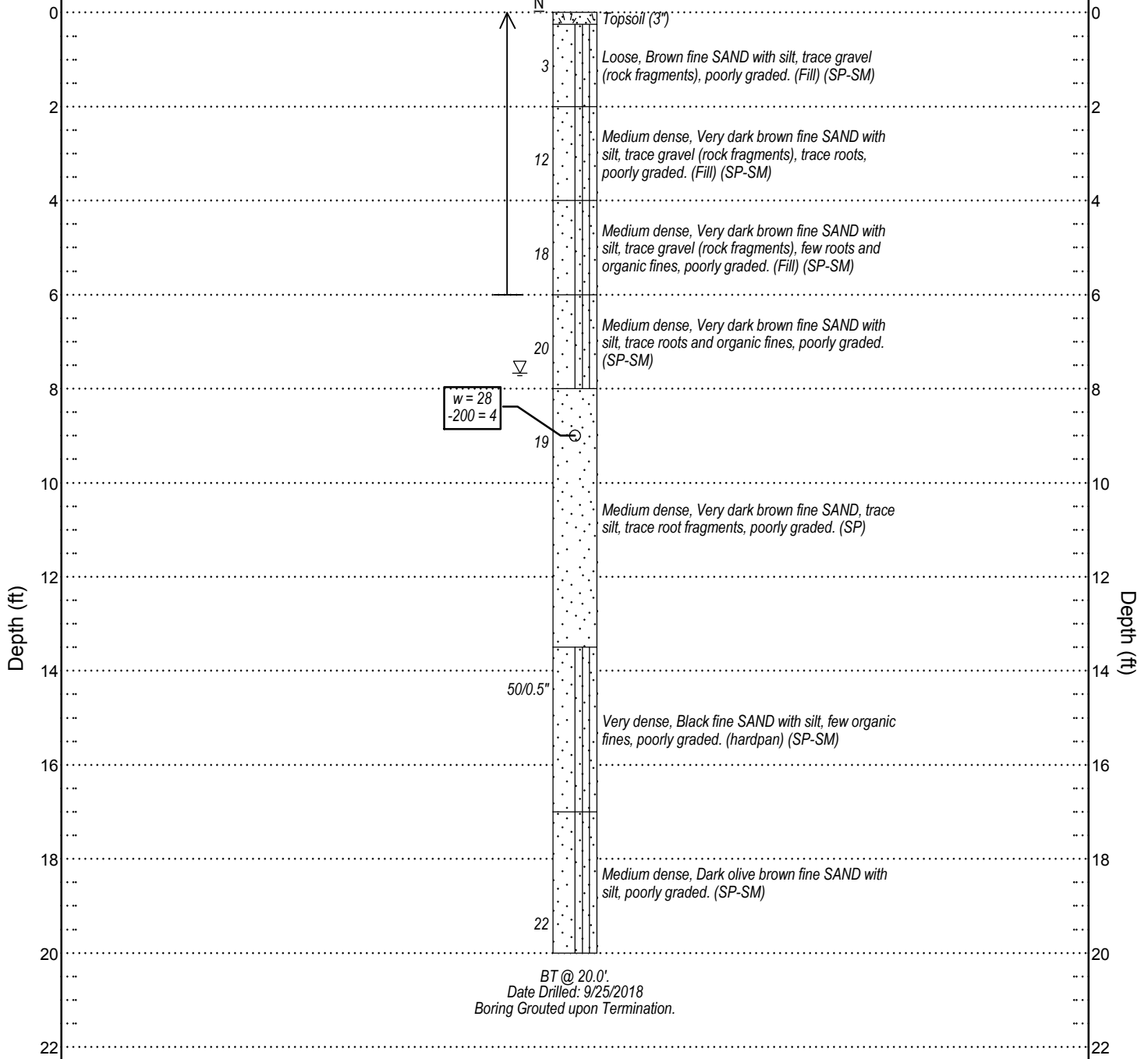
|               |  |  |
|---------------|--|--|
| SHEET TITLE:  | Generalized Soil Profiles                            |  |
| PROJECT NAME: | JEA Greenland WTP Expansion<br>Jacksonville, Florida |  |
| FIGURE NO.    | 6  |  |

# Diesel Generator/Fuel Tank

**B-11**

**Latitude: 30° 9'26.03"N**

**Longitude: 81° 30'51.49"W**



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**CDM Smith, Inc.**

DATE  
11/14/2018

MAE PROJECT NO.  
0011-0019

SHEET TITLE:

**Generalized Soil Profile**

PROJECT NAME:

**JE A Greenland WTP Expansion  
Jacksonville, Florida**

FIGURE NO.

**7**



P: (904)519-6990 F: (904)519-6992



## PAGE 1 OF 1

PROJECT NO. 0011-0019

**HAMMER TYPE** Automatic

| DEPTH (ft)                     | SAMPLE DEPTH NUMBER | MATERIAL DESCRIPTION  | USCS  | GRAPHIC LOG | BLOW COUNTS  | N-VALUE | MOISTURE CONTENT (%) | FINES CONTENT (%) | ORGANIC CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | POCKET PEN. (tsf) | RECOVERY % (RQD) | REMARKS |
|--------------------------------|---------------------|---|-------|-------------|--|---------|----------------------|-------------------|---------------------|--------------|------------------|-------------------|------------------|---------|
| 0                              |                     | Topsoil (6")  |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 1                              | 1                   | Very loose, Yellowish brown fine SAND, trace root fragments, poorly graded. | SP    |             | 1<br>1<br>1<br>1                                   | 2       |                      |                   |                     |              |                  |                   |                  |         |
| 2                              | 2                   | Loose, Very pale brown fine SAND, poorly graded.                            | SP    |             | 1<br>3<br>4<br>6                                   | 7       |                      |                   |                     |              |                  |                   |                  |         |
| 3                              | 3                   | Medium dense, Dark reddish gray fine SAND, trace silt, poorly graded.       | SP    |             | 3<br>5<br>7<br>10                                  | 12      |                      |                   |                     |              |                  |                   |                  |         |
| 4                              | 4                   | Medium dense, Dark reddish brown fine SAND, trace silt, poorly graded.      | SP    |             | 4<br>6<br>6<br>9                                   | 12      | 24                   | 3                 |                     |              |                  |                   |                  |         |
| 5                              | 5                   |   |       |             | 3<br>6<br>9<br>11                                  | 15      |                      |                   |                     |              |                  |                   |                  |         |
| 6                              | 6                   | Medium dense, Reddish brown fine SAND with silt, poorly graded.             | SP-SM |             | 5<br>6<br>8  | 14      |                      |                   |                     |              |                  |                   |                  |         |
| 7                              | 7                   | Medium dense, Brown fine SAND with silt, poorly graded.                     | SP-SM |             | 3<br>6<br>7  | 13      | 32                   | 11                |                     |              |                  |                   |                  |         |
| 8                              |                     | Medium dense, Dark grayish brown fine SAND with silt, poorly graded.        | SP-SM |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 9                              |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 10                             |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 11                             |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 12                             |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 13                             |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 14                             |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 15                             |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 16                             |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 17                             |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 18                             |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 19                             |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 20                             |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| Bottom of borehole at 20 feet. |                     |   |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| NOTES _____<br>_____<br>_____  |                     |   |       |             | GROUND WATER LEVELS                                |         |                      |                   |                     |              |                  |                   |                  |         |
|                                |                     |   |       |             | ∇ AT TIME OF DRILLING 6 ft 0 in * ∇ END OF DAY --- |         |                      |                   |                     |              |                  |                   |                  |         |

TEN YEARS  
**10 MAE**  
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## PAGE 1 OF 1

PROJECT NO. 0011-0019

**PROJECT LOCATION** Jacksonville, Florida

**CLIENT** CDM Smith, Inc.

DATE STARTED 10/15/18

**COMPLETED** 10/15/18

**LATITUDE** 30° 9'50.48"N

**LONGITUDE** 81°31'10.69"W

DRILLING CONTRACTOR MAE, PLLC

**DRILLING METHOD** Standard Penetration Test

**LOGGED BY** P.R.Young

**CHECKED BY** W. Josh Mele

### GROUND ELEVATION

**HAMMER TYPE** Automatic

[illegible]

## NOTES

## GROUND WATER LEVELS

▽ AT TIME OF DRILLING 6 ft 4 in      \*▽ END OF DAY ---

NEW MAE LOG AASTHO LAT LONG - NEW TEMPLATE 7-30-12.GDT - 10/19/18 09:44 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

P: (904)519-6990 F: (904)519-6992



## PAGE 1 OF 1

PROJECT NO. 0011-0019

**HAMMER TYPE** Automatic

NEW MAE LOG AASTHO LAT LONG - NEW TEMPLATE 7-30-12.GDT - 10/19/18 09:45 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

▽ AT TIME OF DRILLING 4 ft 0 in      \*▽ END OF DAY ---

**Meskel & Associates Engineering, PLLC**  
 FL Certificate of Authorization No. 28142  
 8936 Western Way, Suite 12  
 Jacksonville, FL 32256  
 P: (904)519-6990 F: (904)519-6992



# BORING B-4

PAGE 1 OF 1

PROJECT NO. 0011-0019

**PROJECT NAME** JEA Greenland WTP Expansion  
**PROJECT LOCATION** Jacksonville, Florida **CLIENT** CDM Smith, Inc.  
**DATE STARTED** 10/15/18 **COMPLETED** 10/15/18 **LATITUDE** 30° 9'48.35"N **LONGITUDE** 81°31'3.18"W  
**DRILLING CONTRACTOR** MAE, PLLC **DRILLING METHOD** Standard Penetration Test  
**LOGGED BY** P.R.Young **CHECKED BY** W. Josh Mele **GROUND ELEVATION** — **HAMMER TYPE** Automatic

NEW MAE LOG AASTHO LAT\_LONG - NEW TEMPLATE 7-30-12.GDT - 10/19/18 09:45 - F:\GINTGINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

| DEPTH (ft) | SAMPLE DEPTH NUMBER | MATERIAL DESCRIPTION  | AASHTO | GRAPHIC LOG | BLOW COUNTS       | N-VALUE | MOISTURE CONTENT (%) | FINES CONTENT (%) | ORGANIC CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | POCKET PEN. (tsf) | RECOVERY % (RQD) | REMARKS |
|------------|---------------------|---|--------|-------------|-------------------|---------|----------------------|-------------------|---------------------|--------------|------------------|-------------------|------------------|---------|
| 0          |                     | Topsoil (4")  |        |             | 1                 |         |                      |                   |                     |              |                  |                   |                  |         |
|            | 1                   | Very loose, Brown fine SAND, poorly graded.   | A-3    |             | 1<br>1<br>1<br>3  | 2       |                      |                   |                     |              |                  |                   |                  |         |
|            | 2                   | Medium dense, Light gray fine SAND with silt, poorly graded.                                      | A-3    |             | 1<br>3<br>5<br>6  | 8       |                      |                   |                     |              |                  |                   |                  |         |
| 5          | 3                   | Medium dense, Black fine SAND with silt, few organic fines, poorly graded.                        | A-3    |             | 2<br>4<br>4<br>7  | 8       | 25                   | 6                 | 4.9                 |              |                  |                   |                  |         |
|            | 4                   | Medium dense, Black fine SAND with silt, with organic fines, trace root fragments, poorly graded. | A-3    |             | 3<br>5<br>8<br>10 | 13      |                      |                   |                     |              |                  |                   |                  |         |
|            | 5                   |   |        |             | 2<br>5<br>7<br>10 | 12      |                      |                   |                     |              |                  |                   |                  |         |
| 10         |                     | Medium dense, Brown fine SAND with silt, poorly graded.   | A-3    |             |                   |         |                      |                   |                     |              |                  |                   |                  |         |
|            | 6                   |   |        |             | 3<br>4<br>4       | 8       |                      |                   |                     |              |                  |                   |                  |         |
| 15         |                     | Bottom of borehole at 15 feet.  |        |             |                   |         |                      |                   |                     |              |                  |                   |                  |         |

**NOTES** \_\_\_\_\_  
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## GROUND WATER LEVELS

▽ AT TIME OF DRILLING 4 ft 0 in \*▽ END OF DAY ---

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## PAGE 1 OF 1

PROJECT NO. 0011-0019

**HAMMER TYPE** Automatic

NEW MAE LOG AASTHO LAT LONG - NEW TEMPLATE 7-30-12.GDT - 10/19/18 09:45 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

▽ AT TIME OF DRILLING 8 ft 1 in      \*▽ END OF DAY ---

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**BORING B-6**

PAGE 1 OF 3

PROJECT NO. 0011-0019

**PROJECT NAME** JEA Greenland WTP Expansion**PROJECT LOCATION** Jacksonville, Florida**CLIENT** CDM Smith, Inc.**DATE STARTED** 9/21/18**COMPLETED** 9/21/18**LATITUDE** 30° 9'28.38"N**LONGITUDE** 81°30'51.45"W**DRILLING CONTRACTOR** MAE, PLLC**DRILLING METHOD** Standard Penetration Test**LOGGED BY** P.R.Young**CHECKED BY** W. Josh Mele**GROUND ELEVATION** —**HAMMER TYPE** Automatic

| DEPTH (ft)   | SAMPLE DEPTH NUMBER | MATERIAL DESCRIPTION  | USCS  | GRAPHIC LOG  | BLOW COUNTS          | N-VALUE | MOISTURE CONTENT (%) | FINES CONTENT (%) | ORGANIC CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | POCKET PEN. (tsf) | RECOVERY % (RQD) | REMARKS |
|--|---------------------|---|-------|--|----------------------|---------|----------------------|-------------------|---------------------|--------------|------------------|-------------------|------------------|---------|
| 0  |                     | Topsoil (3")  |       |  |                      |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 1                   | Medium dense, Dark brown fine SAND with silt, trace root fragments, poorly graded. (Fill)   | SP-SM |  | 2<br>4<br>4<br>5     | 8       |                      |                   |                     |              |                  |                   |                  |         |
|  | 2                   | Medium dense, Dark brown fine SAND with silt, trace clay, trace organic fines, trace gravel (rock fragments), poorly graded. (Fill) | SP-SM |  | 3<br>4<br>4<br>6     | 8       |                      |                   |                     |              |                  |                   |                  |         |
| 5  | 3                   | Medium dense, Very dark grayish brown fine SAND with silt, few root fragments, trace organic fines, poorly graded.                  | SP-SM |  | 3<br>3<br>8<br>10    | 11      |                      |                   |                     |              |                  |                   |                  |         |
|  | 4                   | ▽ Very dense, Light gray fine SAND with silt, trace root fragments, poorly graded.  | SP-SM |  | 9<br>16<br>30<br>30  | 46      |                      |                   |                     |              |                  |                   |                  |         |
| 10   | 5                   | Very dense, Light gray fine SAND, poorly graded.  | SP    |  | 10<br>16<br>26<br>31 | 42      | 22                   | 1                 |                     |              |                  |                   |                  |         |
| 15   | 6                   | Very dense, Very dark brown fine SAND with silt, few organic fines, poorly graded. (hardpan)  | SP-SM |  | 50/5"                | 50/5"   |                      |                   |                     |              |                  |                   |                  |         |
| 20   | 7                   |   |       |  | 7<br>7<br>15         | 22      |                      |                   |                     |              |                  |                   |                  |         |
|  | 8                   | Medium dense, Dark yellowish brown fine SAND with silt, trace organic fines, poorly graded.   | SP-SM |  | 8<br>5<br>4          | 9       |                      |                   |                     |              |                  |                   |                  |         |
| 25   |                     |   |       |  |                      |         |                      |                   |                     |              |                  |                   |                  |         |
| <b>NOTES</b> 50/5" Indicates 50 hammer blows drove split spoon sampler 5 inches. |                     |   |       | <b>GROUND WATER LEVELS</b>                         |                      |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       | ▽ AT TIME OF DRILLING 7 ft 0 in * ▽ END OF DAY --- |                      |         |                      |                   |                     |              |                  |                   |                  |         |

NEW MAE LOG LAT/LONG-EOD - NEW TEMPLATE 7-30-12.GDT - 9/28/18 09:31 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

(Continued Next Page)

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**BORING B-6**

PAGE 2 OF 3

PROJECT NO. 0011-0019

PROJECT NAME JEA Greenland WTP Expansion

PROJECT LOCATION Jacksonville, Florida

CLIENT CDM Smith, Inc.

NEW MAE LOG LAT/LONG-EOD - NEW TEMPLATE 7-30-12.GDT - 9/28/18 09:31 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

| DEPTH (ft) | SAMPLE DEPTH NUMBER | MATERIAL DESCRIPTION  | USCS  | GRAPHIC LOG  | BLOW COUNTS    | N-VALUE | MOISTURE CONTENT (%) | FINES CONTENT (%) | ORGANIC CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | POCKET PEN. (tsf) | RECOVERY % (RQD) | REMARKS |
|------------|---------------------|---|-------|--|----------------|---------|----------------------|-------------------|---------------------|--------------|------------------|-------------------|------------------|---------|
| 25         |                     | Medium dense, Dark yellowish brown fine SAND with silt, trace organic fines, poorly graded. (continued) | SP-SM |  |                |         |                      |                   |                     |              |                  |                   |                  |         |
| 30         | 9                   |   |       |  | 8<br>11<br>19  | 30      |                      |                   |                     |              |                  |                   |                  |         |
|            |                     | Dense, Light olive brown fine SAND with silt, poorly graded.  | SP-SM |  |                |         |                      |                   |                     |              |                  |                   |                  |         |
| 35         | 10                  |   |       |  | 16<br>13<br>14 | 27      |                      |                   |                     |              |                  |                   |                  |         |
|            |                     | Dense, Gray fine SAND with silt, poorly graded.   | SP-SM |  |                |         |                      |                   |                     |              |                  |                   |                  |         |
| 40         | 11                  |   |       |  | 4<br>6<br>7    | 13      | 27                   | 5                 |                     |              |                  |                   |                  |         |
|            |                     | Medium dense, Grayish brown fine SAND with silt, poorly graded.   | SP-SM |  |                |         |                      |                   |                     |              |                  |                   |                  |         |
| 45         | 12                  |   |       |  | 8<br>9<br>10   | 19      |                      |                   |                     |              |                  |                   |                  |         |
|            |                     | Medium dense, Gray silty fine SAND, trace clay, poorly graded.  | SM    |  |                |         |                      |                   |                     |              |                  |                   |                  |         |
| 50         | 13                  |   |       |  | 11<br>14<br>26 | 40      |                      |                   |                     |              |                  |                   |                  |         |
|            |                     | Dense, Light grayish brown fine SAND with silt, poorly graded.  | SP-SM |  |                |         |                      |                   |                     |              |                  |                   |                  |         |
| NOTES      |                     |   |       | GROUND WATER LEVELS                                |                |         |                      |                   |                     |              |                  |                   |                  |         |
|            |                     |   |       | ∇ AT TIME OF DRILLING 7 ft 0 in * ∇ END OF DAY --- |                |         |                      |                   |                     |              |                  |                   |                  |         |

(Continued Next Page)



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# BORING B-7

PAGE 1 OF 2

PROJECT NO. 0011-0019

**PROJECT NAME** JEA Greenland WTP Expansion  
**PROJECT LOCATION** Jacksonville, Florida **CLIENT** CDM Smith, Inc.  
**DATE STARTED** 9/24/18 **COMPLETED** 9/24/18 **LATITUDE** 30° 9'28.39"N **LONGITUDE** 81°30'50.97"W  
**DRILLING CONTRACTOR** MAE, PLLC **DRILLING METHOD** Standard Penetration Test  
**LOGGED BY** P.R.Young **CHECKED BY** W. Josh Mele **GROUND ELEVATION** — **HAMMER TYPE** Automatic

| DEPTH (ft) | SAMPLE DEPTH NUMBER | MATERIAL DESCRIPTION  | USCS  | GRAPHIC LOG | BLOW COUNTS | N-VALUE | MOISTURE CONTENT (%) | FINES CONTENT (%) | ORGANIC CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | POCKET PEN. (tsf) | RECOVERY % (RQD) | REMARKS |
|------------|---------------------|---|-------|-------------|-------------|---------|----------------------|-------------------|---------------------|--------------|------------------|-------------------|------------------|---------|
| 0          |                     | Topsoil (3")  |       |             | 3           |         |                      |                   |                     |              |                  |                   |                  |         |
|            | 1                   | Medium dense, Dark yellowish brown fine SAND with silt, poorly graded. (Fill)                     | SP-SM |             | 4           | 10      |                      |                   |                     |              |                  |                   |                  |         |
|            | 2                   | Medium dense, Dark yellowish brown fine SAND with silt, few root fragments, poorly graded. (Fill) | SP-SM |             | 2           | 12      |                      |                   |                     |              |                  |                   |                  |         |
|            |                     |   |       |             | 4           |         |                      |                   |                     |              |                  |                   |                  |         |
| 5          | 3                   | Medium dense, Very dark gray fine SAND with silt, trace root fragments, poorly graded.            | SP-SM |             | 3           | 22      |                      |                   |                     |              |                  |                   |                  |         |
|            |                     |   |       |             | 9           |         |                      |                   |                     |              |                  |                   |                  |         |
|            | 4                   | Very dense, Light gray fine SAND, trace root fragments, poorly graded.                            | SP    |             | 10          | 54      |                      |                   |                     |              |                  |                   |                  |         |
|            |                     |   |       |             | 21          |         |                      |                   |                     |              |                  |                   |                  |         |
|            | 5                   |   |       |             | 33          |         |                      |                   |                     |              |                  |                   |                  |         |
| 10         |                     |   |       |             | 46          |         |                      |                   |                     |              |                  |                   |                  |         |
|            | 5                   | Dense, Light gray fine SAND, trace silt, poorly graded.   | SP    |             | 12          | 36      |                      |                   |                     |              |                  |                   |                  |         |
|            |                     |   |       |             | 16          |         |                      |                   |                     |              |                  |                   |                  |         |
|            |                     |   |       |             | 20          |         |                      |                   |                     |              |                  |                   |                  |         |
|            |                     |   |       |             | 27          |         |                      |                   |                     |              |                  |                   |                  |         |
| 15         | 6                   | Very dense, Very dark brown fine SAND with silt, few organic fines, poorly graded. (hardpan)      | SP-SM |             | 40          | 50/3"   |                      |                   |                     |              |                  |                   |                  |         |
|            |                     |   |       |             | 50/3"       | 50/3"   |                      |                   |                     |              |                  |                   |                  |         |
| 20         | 7                   |   |       |             | 9           | 20      | 29                   | 6                 |                     |              |                  |                   |                  |         |
|            |                     |   |       |             | 10          |         |                      |                   |                     |              |                  |                   |                  |         |
|            |                     |   |       |             | 10          |         |                      |                   |                     |              |                  |                   |                  |         |
|            |                     | Medium dense to loose, Olive brown fine SAND with silt, poorly graded.                            | SP-SM |             |             |         |                      |                   |                     |              |                  |                   |                  |         |
| 25         | 8                   |   |       |             | 3           | 7       |                      |                   |                     |              |                  |                   |                  |         |
|            |                     |   |       |             | 3           |         |                      |                   |                     |              |                  |                   |                  |         |
|            |                     |   |       |             | 4           |         |                      |                   |                     |              |                  |                   |                  |         |

**NOTES** 50/3" Indicates 50 hammer blows drove split spoon sampler 3 inches.

## GROUND WATER LEVELS

▽ AT TIME OF DRILLING 8 ft 3 in \*▽ END OF DAY ---

NEW MAE LOG LAT/LONG-EOD - NEW TEMPLATE 7-30-12.GDT - 9/28/18 09:31 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

(Continued Next Page)

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## PAGE 2 OF 2

PROJECT NO. 0011-0019

**PROJECT LOCATION** Jacksonville, Florida

**CLIENT** CDM Smith, Inc.

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## NOTES

## GROUND WATER LEVELS

▽ AT TIME OF DRILLING 8 ft 3 in      \*▽ END OF DAY ---

NEW MAE LOG LAT\LONG-EOD - NEW TEMPLATE 7-30-12.GDT - 9/28/18 09:31 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

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**BORING B-8**

PAGE 1 OF 2

PROJECT NO. 0011-0019

**PROJECT NAME** JEA Greenland WTP Expansion**PROJECT LOCATION** Jacksonville, Florida**CLIENT** CDM Smith, Inc.**DATE STARTED** 9/25/18**COMPLETED** 9/25/18**LATITUDE** 30° 9'28.77"N**LONGITUDE** 81°30'51.45"W**DRILLING CONTRACTOR** MAE, PLLC**DRILLING METHOD** Standard Penetration Test**LOGGED BY** P.R.Young**CHECKED BY** W. Josh Mele**GROUND ELEVATION** —**HAMMER TYPE** Automatic

| DEPTH (ft)   | SAMPLE DEPTH NUMBER | MATERIAL DESCRIPTION  | USCS  | GRAPHIC LOG                                       | BLOW COUNTS | N-VALUE | MOISTURE CONTENT (%) | FINES CONTENT (%) | ORGANIC CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | POCKET PEN. (tsf) | RECOVERY % (RQD) | REMARKS |
|--|---------------------|---|-------|---|-------------|---------|----------------------|-------------------|---------------------|--------------|------------------|-------------------|------------------|---------|
| 0  |                     | Topsoil (4")  |       |   | 2           |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 1                   |   |       |   | 5           | 10      |                      |                   |                     |              |                  |                   |                  |         |
|  | 2                   | Medium dense, Brown fine SAND with silt, trace gravel (rock fragments), poorly graded. (Fill) | SP-SM |   | 5           |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 9           | 22      |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 13          |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 16          |         |                      |                   |                     |              |                  |                   |                  |         |
| 5  | 3                   | Dense, Light gray fine SAND, trace root fragments, poorly graded.                             | SP    |   | 7           | 29      |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 10          |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 19          |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 21          |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 4                   | Very dense, Light gray fine SAND, poorly graded.  | SP    |   | 10          | 46      |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 20          |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 26          |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 36          |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 5                   |   |       |   | 10          | 18      |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 9           |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 9           |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 6           |         |                      |                   |                     |              |                  |                   |                  |         |
| 10   |                     | Medium dense, Light gray fine SAND, trace silt, trace root fragments, poorly graded.          | SP    |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 6                   |   |       |   | 30          | 50/4"   |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 50/4"       | 50/4"   |                      |                   |                     |              |                  |                   |                  |         |
| 15   |                     | Very dense, Very dark brown fine SAND with silt, poorly graded. (hardpan)                     | SP-SM |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 7                   |   |       |   | 6           | 19      |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 9           |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 10          |         |                      |                   |                     |              |                  |                   |                  |         |
| 20   |                     | Medium dense, Very dark brown fine SAND with silt, poorly graded.                             | SP-SM |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 8                   | Loose, Olive brown fine SAND with silt, poorly graded.  | SP-SM |   | 3           | 6       | 31                   | 7                 |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 2           |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       |   | 4           |         |                      |                   |                     |              |                  |                   |                  |         |
| 25   |                     |   |       |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
| <b>NOTES</b> 50/4" Indicates 50 hammer blows drove split spoon sampler 4 inches. |                     |   |       | <b>GROUND WATER LEVELS</b>                        |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       | ▽ AT TIME OF DRILLING 7 ft 5 in *▽ END OF DAY --- |             |         |                      |                   |                     |              |                  |                   |                  |         |

NEW MAE LOG LAT/LONG-EOD - NEW TEMPLATE 7-30-12.GDT - 9/28/18 09:31 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

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TEN YEARS  
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PROJECT NO. 0011-0019

**PROJECT LOCATION** Jacksonville, Florida

**CLIENT** CDM Smith, Inc.

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## NOTES

## GROUND WATER LEVELS

▽ AT TIME OF DRILLING 7 ft 5 in      \*▽ END OF DAY ---

NEW MAE LOG LAT\LONG-EOD - NEW TEMPLATE 7-30-12.GDT - 9/28/18 09:31 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

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**BORING B-9**

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PROJECT NO. 0011-0019

**PROJECT NAME** JEA Greenland WTP Expansion**PROJECT LOCATION** Jacksonville, Florida**CLIENT** CDM Smith, Inc.**DATE STARTED** 9/21/18**COMPLETED** 9/21/18**LATITUDE** 30° 9'28.38"N**LONGITUDE** 81°30'51.90"W**DRILLING CONTRACTOR** MAE, PLLC**DRILLING METHOD** Standard Penetration Test**LOGGED BY** P.R.Young**CHECKED BY** W. Josh Mele**GROUND ELEVATION** —**HAMMER TYPE** Automatic

| DEPTH (ft)   | SAMPLE DEPTH NUMBER | MATERIAL DESCRIPTION   | USCS  | GRAPHIC LOG                                       | BLOW COUNTS | N-VALUE | MOISTURE CONTENT (%) | FINES CONTENT (%) | ORGANIC CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | POCKET PEN. (tsf) | RECOVERY % (RQD) | REMARKS |
|--|---------------------|--|-------|---|-------------|---------|----------------------|-------------------|---------------------|--------------|------------------|-------------------|------------------|---------|
| 0  |                     | Topsoil (3")   |       |   | 2           |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 1                   |  |       |   | 3           | 6       |                      |                   |                     |              |                  |                   |                  |         |
|  | 2                   | Loose, Dark brown fine SAND with silt, trace root and organic fines, poorly graded. (Fill)           | SP-SM |   | 2           |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 2           |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 5           | 7       |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 8           |         |                      |                   |                     |              |                  |                   |                  |         |
| 5  | 3                   | Medium dense, Very dark gray fine SAND with silt, few gravel (rock fragments), poorly graded. (Fill) | SP-SM |   | 36          | 16      |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 7           |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 9           |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 4                   | Dense, Light gray fine SAND, trace silt, poorly graded.  | SP    |   | 8           | 36      |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 16          |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 20          |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 26          |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 5                   |  |       |   | 10          | 26      |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 12          |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 14          |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 16          |         |                      |                   |                     |              |                  |                   |                  |         |
| 10   |                     | Dense, Light gray fine SAND with silt, poorly graded.  | SP-SM |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 6                   |  |       |   | 21          | 90/9"   |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 40          |         |                      |                   |                     |              |                  |                   |                  |         |
| 15   |                     | Very dense, Very dark brown fine SAND with silt, few organic fines, poorly graded. (hardpan)         | SP-SM |   | 50/3"       |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 7                   |  |       |   | 5           | 19      |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 10          |         |                      |                   |                     |              |                  |                   |                  |         |
| 20   |                     |  |       |   | 9           |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 8                   | Medium dense, Dark olive brown fine SAND with silt, trace organic fines, poorly graded.              | SP-SM |   | 5           | 9       |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |   | 5           |         |                      |                   |                     |              |                  |                   |                  |         |
| 25   |                     |  |       |   | 4           |         |                      |                   |                     |              |                  |                   |                  |         |
| <b>NOTES</b> 90/9" Indicates 90 hammer blows drove split spoon sampler 9 inches. |                     |  |       | <b>GROUND WATER LEVELS</b>                        |             |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       | ▽ AT TIME OF DRILLING 6 ft 0 in *▽ END OF DAY --- |             |         |                      |                   |                     |              |                  |                   |                  |         |

NEW MAE LOG LAT/LONG-EOD - NEW TEMPLATE 7-30-12.GDT - 9/28/18 09:31 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

(Continued Next Page)

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**BORING B-9**

PAGE 2 OF 2

PROJECT NO. 0011-0019

**PROJECT NAME** JEA Greenland WTP Expansion**PROJECT LOCATION** Jacksonville, Florida**CLIENT** CDM Smith, Inc.

| DEPTH (ft)   | SAMPLE DEPTH NUMBER | MATERIAL DESCRIPTION  | USCS  | GRAPHIC LOG | BLOW COUNTS  | N-VALUE | MOISTURE CONTENT (%) | FINES CONTENT (%) | ORGANIC CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | POCKET PEN. (tsf) | RECOVERY % (RQD) | REMARKS |
|--------------|---------------------|---|-------|-------------|--|---------|----------------------|-------------------|---------------------|--------------|------------------|-------------------|------------------|---------|
| 25           |                     | Medium dense, Dark olive brown fine SAND with silt, trace organic fines, poorly graded. (continued) | SP-SM |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| 30           | 9                   | Dense, Olive brown fine SAND with silt, poorly graded.  | SP-SM |             | 9<br>16<br>18                                      | 34      |                      |                   |                     |              |                  |                   |                  |         |
| 35           | 10                  | Medium dense, Gray silty fine SAND, poorly graded.  | SM    |             | 5<br>6<br>7  | 13      |                      |                   |                     |              |                  |                   |                  |         |
| 40           | 11                  | Medium dense, Gray silty fine SAND, trace clay, poorly graded.                                      | SM    |             | 2<br>4<br>5  | 9       |                      |                   |                     |              |                  |                   |                  |         |
| 45           | 12                  | Medium dense, Gray silty fine SAND, trace clay, poorly graded.                                      | SM    |             | 2<br>4<br>4  | 8       | 30                   | 14                |                     |              |                  |                   |                  |         |
|              |                     | Bottom of borehole at 45 feet.<br>Boring Grouted upon Termination.                                  |       |             |  |         |                      |                   |                     |              |                  |                   |                  |         |
| <b>NOTES</b> |                     |   |       |             | <b>GROUND WATER LEVELS</b>                         |         |                      |                   |                     |              |                  |                   |                  |         |
|              |                     |   |       |             | ∇ AT TIME OF DRILLING 6 ft 0 in * ∇ END OF DAY --- |         |                      |                   |                     |              |                  |                   |                  |         |

NEW MAE LOG LAT/LONG-EOD - NEW TEMPLATE 7-30-12.GDT - 9/28/18 09:31 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

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**BORING B-10**

PAGE 1 OF 2

PROJECT NO. 0011-0019

**PROJECT NAME** JEA Greenland WTP Expansion**PROJECT LOCATION** Jacksonville, Florida**CLIENT** CDM Smith, Inc.**DATE STARTED** 9/24/18**COMPLETED** 9/24/18**LATITUDE** 30° 9'27.99"N**LONGITUDE** 81°30'51.43"W**DRILLING CONTRACTOR** MAE, PLLC**DRILLING METHOD** Standard Penetration Test**LOGGED BY** P.R.Young**CHECKED BY** W. Josh Mele**GROUND ELEVATION** —**HAMMER TYPE** Automatic

| DEPTH (ft)   | SAMPLE DEPTH NUMBER | MATERIAL DESCRIPTION  | USCS  | GRAPHIC LOG                                       | BLOW COUNTS         | N-VALUE | MOISTURE CONTENT (%) | FINES CONTENT (%) | ORGANIC CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | POCKET PEN. (tsf) | RECOVERY % (RQD) | REMARKS |
|--|---------------------|---|-------|---|---------------------|---------|----------------------|-------------------|---------------------|--------------|------------------|-------------------|------------------|---------|
| 0  |                     | Topsoil (2")  |       |   |                     |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 1                   | Medium dense, Dark brown fine SAND with silt, trace debris (glass fragments), poorly graded. (Fill)             | SP-SM |   | 2<br>4<br>6<br>6    | 10      |                      |                   |                     |              |                  |                   |                  |         |
|  | 2                   | Medium dense, Very dark grayish brown fine SAND with silt, trace gravel (rock fragments), poorly graded. (Fill) | SP-SM |   | 6<br>10<br>11<br>12 | 21      |                      |                   |                     |              |                  |                   |                  |         |
| 5  | 3                   | Medium dense, Very dark grayish brown fine SAND with silt, trace root fragments, poorly graded.                 | SP-SM |   | 4<br>6<br>10<br>12  | 16      |                      |                   |                     |              |                  |                   |                  |         |
|  | 4                   | ▽ Dense, Gray fine SAND, trace root fragments, poorly graded.   | SP    |   | 6<br>15<br>21<br>24 | 36      |                      |                   |                     |              |                  |                   |                  |         |
|  | 5                   |   |       |   | 6<br>14<br>16<br>21 | 30      |                      |                   |                     |              |                  |                   |                  |         |
| 10   |                     | Dense, Light brownish gray fine SAND, trace silt, poorly graded.  | SP    |   |                     |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 6                   |   |       |   | 24<br>50/5"         | 50/5"   |                      |                   |                     |              |                  |                   |                  |         |
| 15   |                     | Very dense, Very dark brown fine SAND with silt, few organic fines, poorly graded. (hardpan)                    | SP-SM |   |                     |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 7                   |   |       |   | 0<br>13<br>29       | 42      |                      |                   |                     |              |                  |                   |                  |         |
| 20   |                     |   |       |   |                     |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 8                   | Medium dense, Olive brown fine SAND with silt, poorly graded.   | SP-SM |   | 6<br>10<br>12       | 22      | 31                   | 10                |                     |              |                  |                   |                  |         |
| 25   |                     |   |       |   |                     |         |                      |                   |                     |              |                  |                   |                  |         |
| <b>NOTES</b> 50/5" Indicates 50 hammer blows drove split spoon sampler 5 inches. |                     |   |       | <b>GROUND WATER LEVELS</b>                        |                     |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |   |       | ▽ AT TIME OF DRILLING 7 ft 1 in *▽ END OF DAY --- |                     |         |                      |                   |                     |              |                  |                   |                  |         |

NEW MAE LOG LAT/LONG-EOD - NEW TEMPLATE 7-30-12.GDT - 9/28/18 09:31 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

(Continued Next Page)

**PROJECT LOCATION** Jacksonville, Florida

**CLIENT** CDM Smith, Inc.

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## NOTES

## GROUND WATER LEVELS

▽ AT TIME OF DRILLING 7 ft 1 in      \*▽ END OF DAY ---

NEW MAE LOG LAT\LONG-EOD - NEW TEMPLATE 7-30-12.GDT - 9/28/18 09:31 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

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**BORING B-11**

PAGE 1 OF 1

PROJECT NO. 0011-0019

**PROJECT NAME** JEA Greenland WTP Expansion**PROJECT LOCATION** Jacksonville, Florida**CLIENT** CDM Smith, Inc.**DATE STARTED** 9/25/18**COMPLETED** 9/25/18**LATITUDE** 30° 9'26.03"N**LONGITUDE** 81°30'51.49"W**DRILLING CONTRACTOR** MAE, PLLC**DRILLING METHOD** Standard Penetration Test**LOGGED BY** P.R.Young**CHECKED BY** W. Josh Mele**GROUND ELEVATION** —**HAMMER TYPE** Automatic

| DEPTH (ft)   | SAMPLE DEPTH NUMBER | MATERIAL DESCRIPTION   | USCS  | GRAPHIC LOG | BLOW COUNTS                                       | N-VALUE | MOISTURE CONTENT (%) | FINES CONTENT (%) | ORGANIC CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | POCKET PEN. (tsf) | RECOVERY % (RQD) | REMARKS |
|--|---------------------|--|-------|-------------|---|---------|----------------------|-------------------|---------------------|--------------|------------------|-------------------|------------------|---------|
| 0  |                     | Topsoil (3")   |       |             |   |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 1                   | Loose, Brown fine SAND with silt, trace gravel (rock fragments), poorly graded. (Fill)   | SP-SM |             | 1<br>1<br>2<br>4                                  | 3       |                      |                   |                     |              |                  |                   |                  |         |
|  | 2                   | Medium dense, Very dark brown fine SAND with silt, trace gravel (rock fragments), trace roots, poorly graded. (Fill)                 | SP-SM |             | 3<br>6<br>6<br>9                                  | 12      |                      |                   |                     |              |                  |                   |                  |         |
| 5  | 3                   | Medium dense, Very dark brown fine SAND with silt, trace gravel (rock fragments), few roots and organic fines, poorly graded. (Fill) | SP-SM |             | 4<br>8<br>10<br>14                                | 18      |                      |                   |                     |              |                  |                   |                  |         |
|  | 4                   | Medium dense, Very dark brown fine SAND with silt, trace roots and organic fines, poorly graded.                                     | SP-SM |             | 6<br>9<br>11<br>15                                | 20      |                      |                   |                     |              |                  |                   |                  |         |
|  | 5                   |  |       |             | 4<br>6<br>13<br>20                                | 19      | 28                   | 4                 |                     |              |                  |                   |                  |         |
| 10   |                     | Medium dense, Very dark brown fine SAND, trace silt, trace root fragments, poorly graded.  | SP    |             |   |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 6                   |  |       |             | 33<br>50/5"                                       | 50/5"   |                      |                   |                     |              |                  |                   |                  |         |
| 15   |                     | Very dense, Black fine SAND with silt, few organic fines, poorly graded. (hardpan)   | SP-SM |             |   |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |             |   |         |                      |                   |                     |              |                  |                   |                  |         |
|  | 7                   | Medium dense, Dark olive brown fine SAND with silt, poorly graded.   | SP-SM |             | 6<br>10<br>12                                     | 22      |                      |                   |                     |              |                  |                   |                  |         |
| 20   |                     | Bottom of borehole at 20 feet.   |       |             |   |         |                      |                   |                     |              |                  |                   |                  |         |
| <b>NOTES</b> 50/5" Indicates 50 hammer blows drove split spoon sampler 5 inches. |                     |  |       |             | <b>GROUND WATER LEVELS</b>                        |         |                      |                   |                     |              |                  |                   |                  |         |
|  |                     |  |       |             | ▽ AT TIME OF DRILLING 7 ft 8 in *▽ END OF DAY --- |         |                      |                   |                     |              |                  |                   |                  |         |

NEW MAE LOG LAT/LONG-EOD - NEW TEMPLATE 7-30-12.GDT - 9/28/18 09:31 - F:\GINT\GINT FILES\PROJECTS\0011-0019\JEA GREENLAND WTP.GPJ

## **FIELD EXPLORATION PROCEDURES**

### **Standard Penetration Test (SPT) Borings**

The Standard Penetration Test (SPT) boring(s) are performed in general accordance with the latest revision of ASTM D1586, "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils." In some cases, the borings are advanced manually from the ground surface using a hand-held bucket auger to a depth of approximately 5 feet if there are possible shallow utility conflicts. Otherwise, the borings are advanced using rotary drilling techniques. A split-barrel sampler is inserted to the bottom of the borehole at each sampling interval. The sampler is driven 18 to 24 inches into the soil using a 140-pound hammer falling an average height of 30 inches per hammer blow. The number of hammer blows for the final 12 inches of penetration (18" sample) or for the sum of the middle 12 inches of penetration (24" sample) is termed the "penetration resistance, blow count, or N-value." This value is an index to several in-situ geotechnical properties of the material tested, such as relative density and Young's Modulus.

After driving the sampler, it was retrieved from the borehole and representative samples of the material within the split-barrel were containerized and sealed. After completing the drilling operations, the samples for each boring were transported to the laboratory where they were examined by our engineer in order to verify the field descriptions.

Once the boring is complete and the groundwater level is measured, the borehole is backfilled with soil, or it is backfilled from bottom to top with a lean cementitious grout.

# KEY TO BORING LOGS – USCS/AASHTO

## Soil Classification

Soil classification of samples obtained at the boring locations is based on the Unified Soil Classification System (USCS) or the American Association of State Highway and Transportation Officials (AASHTO) classification system. Coarse grained soils have more than 50% of their dry weight retained on a #200 sieve. Their principal descriptors are: sand, cobbles and boulders. Fine grained soils have less than 50% of their dry weight retained on a #200 sieve. They are principally described as clays if they are plastic and silts if they are slightly to non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

### BORING LOG LEGEND

| Symbol | Description  |
|--------|--|
| N      | Standard Penetration Resistance, the number of blows required to advance a standard spoon sampler 12" when driven by a 140-lb hammer dropping 30". |
| WOR    | Split Spoon sampler advanced under the weight of the drill rods  |
| WOH    | Split Spoon sampler advanced under the weight of the SPT hammer  |
| 50/2"  | Indicates 50 hammer blows drove the split spoon 2 inches; 50 Hammer blows for less than 6-inches of split spoon driving is considered "Refusal".   |
| (SP)   | Unified Soil Classification System   |
| -200   | Fines content, % Passing No. 200 U.S. Standard Sieve   |
| w      | Natural Moisture Content (%)   |
| OC     | Organic Content (%)  |
| LL     | Liquid Limit   |
| PI     | Plasticity Index   |
| NP     | Non-Plastic  |
| PP     | Pocket Penetrometer in tons per square foot (tsf)  |

### MODIFIERS

#### SECONDARY CONSTITUENTS

(Sand, Silt or Clay)

|                                       |              |
|---------------------------------------|--------------|
| Trace                                 | Less than 5% |
| With                                  | 5% to 12%    |
| Sandy, Silty or Clayey                | 12% to 35%   |
| Very Sandy, Very Silty or Very Clayey | 35% to 50%   |

#### ORGANIC CONTENT

|                             |                  |
|-----------------------------|------------------|
| Trace                       | Less than 5%     |
| Organic Soils               | 5% to 20%        |
| Highly Organic Soils (Muck) | 20% to 75%       |
| PEAT                        | Greater than 75% |

#### MINOR COMPONENTS

(Shell, Rock, Debris, Roots, etc.)

|        |              |
|--------|--------------|
| Trace  | Less than 5% |
| Few    | 5% to 10%    |
| Little | 15% to 25%   |
| Some   | 30% to 45%   |

### RELATIVE DENSITY (Coarse-Grained Soils)

| Relative Density | N-Value *       |
|------------------|-----------------|
| Very Loose       | Less than 3     |
| Loose            | 3 to 8          |
| Medium Dense     | 8 to 24         |
| Dense            | 24 to 40        |
| Very Dense       | Greater than 40 |

### CONSISTENCY (Fine-Grained Soils)

| Consistency | N-Value *       |
|-------------|-----------------|
| Very Soft   | Less than 1     |
| Soft        | 1 to 3          |
| Firm        | 3 to 6          |
| Stiff       | 6 to 12         |
| Very Stiff  | 12 to 24        |
| Hard        | Greater than 24 |

### RELATIVE HARDNESS (Limestone)

| Relative Hardness | N-Value *       |
|-------------------|-----------------|
| Soft              | Less than 50    |
| Hard              | Greater than 50 |

\* Using Automatic Hammer



# Unified Soil Classification System (USCS)

## (from ASTM D 2487)

| Major Divisions   |  |                    | Group Symbol | Typical Names   |
|---|--|--------------------|--------------|---|
| <b>Coarse-Grained Soils</b><br>More than 50% retained on the 0.075 mm (No. 200) sieve | <b>Gravels</b><br>50% or more of coarse fraction retained on the 4.75 mm (No. 4) sieve | Clean Gravels      | GW           | Well-graded gravels and gravel-sand mixtures, little or no fines              |
|   |  |                    | GP           | Poorly graded gravels and gravel-sand mixtures, little or no fines            |
|   |  | Gravels with Fines | GM           | Silty gravels, gravel-sand-silt mixtures                                      |
|   |  |                    | GC           | Clayey gravels, gravel-sand-clay mixtures                                     |
|   | <b>Sands</b><br>50% or more of coarse fraction passes the 4.75 (No. 4) sieve           | Clean Sands        | SW           | Well-graded sands and gravelly sands, little or no fines                      |
|   |  |                    | SP           | Poorly graded sands and gravelly sands, little or no fines                    |
|   |  | Sands with Fines   | SM           | Silty sands, sand-silt mixtures   |
|   |  |                    | SC           | Clayey sands, sand-clay mixtures  |
| <b>Fine-Grained Soils</b><br>More than 50% passes the 0.075 mm (No. 200) sieve        | <b>Silts and Clays</b><br>Liquid Limit 50% or less                                     |                    | ML           | Inorganic silts, very fine sands, rock four, silty or clayey fine sands       |
|   |  |                    | CL           | Inorganic clays of low to medium plasticity, gravelly/sandy/silty/lean clays  |
|   |  |                    | OL           | Organic silts and organic silty clays of low plasticity                       |
|   | <b>Silts and Clays</b><br>Liquid Limit greater than 50%                                |                    | MH           | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts |
|   |  |                    | CH           | Inorganic clays or high plasticity, fat clays                                 |
|   |  |                    | OH           | Organic clays of medium to high plasticity                                    |
| <b>Highly Organic Soils</b>   |  |                    | PT           | Peat, muck, and other highly organic soils                                    |

Prefix: G = Gravel, S = Sand, M = Silt, C = Clay, O = Organic

Suffix: W = Well Graded, P = Poorly Graded, M = Silty, L = Clay, LL < 50%, H = Clay, LL > 50%

# AASHTO Soil Classification System

(from AASHTO M 145 or ASTM D 3282)

| General Classification                                 | Granular Materials<br>(35% or less passing the 0.075 mm sieve) |        |           |                                 |        |        |        | Silt-Clay Materials<br>(>35% passing the 0.075 mm sieve) |        |              |                  |
|--|--|--------|-----------|---------------------------------|--------|--------|--------|--|--------|--------------|------------------|
| Group Classification                                   | A-1  |        | A-3       | A-2                             |        |        |        | A-4  | A-5    | A-6          | A-7              |
|  | A-1-a  | A-1-b  |           | A-2-4                           | A-2-5  | A-2-6  | A-2-7  |  |        |              | A-7-5*<br>A-7-6* |
| Sieve Analysis, % passing:                             |  |        |           |                                 |        |        |        |  |        |              |                  |
| 2.00 mm (No. 10)                                       | 50 max   | ...    | ...       | ...                             | ...    | ...    | ...    | ...  | ...    | ...          | ...              |
| 0.425 (No. 40)   | 30 max   | 50 max | 51 min    | ...                             | ...    | ...    | ...    | ...  | ...    | ...          | ...              |
| 0.075 (No. 200)  | 15 max   | 25 max | 10 max    | 35 max                          | 35 max | 35 max | 35 max | 36 min   | 36 min | 36 min       | 36 min           |
| Characteristics of fraction passing 0.425 mm (No. 40): |  |        |           |                                 |        |        |        |  |        |              |                  |
| Liquid Limit   | ...  |        | ...       | 40 max                          | 41 min | 40 max | 41 min | 40 max   | 41 min | 40 max       | 41 min           |
| Plasticity Index                                       | 6 max  |        | N.P.      | 10 max                          | 10 max | 11 min | 11 min | 10 max   | 10 max | 11 min       | 11 min           |
| Usual types of significant constituent materials       | stone fragments, gravel and sand                               |        | fine sand | silty or clayey gravel and sand |        |        |        | silty soils  |        | clayey soils |                  |
| General <i>local</i> ** rating as a subgrade           | excellent to good  |        |           | fair to poor                    |        |        |        |  |        |              |                  |

\* Plasticity index of A-7-5 subgroup is equal to or less than the LL - 30. Plasticity index of A-7-6 subgroup is greater than LL - 30

\*\* Northeast Florida

## *Appendix B*

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**SUMMARY OF LABORATORY  
TEST RESULTS**

PROJECT NO. 0011-0019

PROJECT NAME JEA Greenland WTP Expansion

DATE. 11/1/2018

PROJECT LOCATION Jacksonville, Florida

CLIENT CDM Smith, Inc.

| Borehole | Sample No. | Approx.<br>Depth<br>(ft) | %<#200<br>Sieve | Water<br>Content<br>(%) | Organic<br>Content<br>(%) | Liquid<br>Limit | Plastic<br>Limit | Plasticity<br>Index | USCS<br>AASHTO<br>Classification | Comments |
|----------|------------|--------------------------|-----------------|-------------------------|---------------------------|-----------------|------------------|---------------------|----------------------------------|----------|
| B-1      | 4          | 7                        | 3               | 24                      | ---                       | ---             | ---              | ---                 | SP                               |          |
| B-1      | 7          | 19                       | 11              | 32                      | ---                       | ---             | ---              | ---                 | SP-SM                            |          |
| B-2      | 6          | 14                       | 6               | 32                      | ---                       | ---             | ---              | ---                 | A-3                              |          |
| B-3      | 2          | 3                        | 6               | 29                      | ---                       | ---             | ---              | ---                 | A-3                              |          |
| B-4      | 3          | 5                        | 6               | 25                      | 4.9                       | ---             | ---              | ---                 | A-3                              |          |
| B-5      | 5          | 9                        | 1               | 27                      | ---                       | ---             | ---              | ---                 | A-3                              |          |
| B-6      | 5          | 9                        | 1               | 22                      | ---                       | ---             | ---              | ---                 | SP                               |          |
| B-6      | 11         | 40                       | 5               | 27                      | ---                       | ---             | ---              | ---                 | SP-SM                            |          |
| B-6      | 15         | 60                       | 2               | 29                      | ---                       | ---             | ---              | ---                 | SP                               |          |
| B-7      | 7          | 20                       | 6               | 29                      | ---                       | ---             | ---              | ---                 | SP-SM                            |          |
| B-8      | 8          | 24                       | 7               | 31                      | ---                       | ---             | ---              | ---                 | SP-SM                            |          |
| B-9      | 12         | 44                       | 14              | 30                      | ---                       | ---             | ---              | ---                 | SM                               |          |
| B-10     | 8          | 24                       | 10              | 31                      | ---                       | ---             | ---              | ---                 | SP-SM                            |          |
| B-11     | 5          | 10                       | 4               | 28                      | ---                       | ---             | ---              | ---                 | SP                               |          |

Note: "---" Untested Parameter

## **LABORATORY TEST PROCEDURES**

### **Percent Fines Content**

The percent fines or material passing the No. 200 mesh sieve of the sample tested was determined in general accordance with the latest revision of ASTM D 1140. The percent fines are the soil particles in the silt and clay size range.

### **Natural Moisture Content**

The water content of the tested sample was determined in general accordance with the latest revision of ASTM D 2216. The water content is defined as the ratio of “pore” or “free” water in a given mass of material to the mass of solid material particles.

### **Organic Loss on Ignition (Percent Organics)**

The organic loss on ignition or percent organic material in the sample tested was determined in general accordance with ASTM D 2974. The percent organics is the material, expressed as a percentage, which is burned off in a muffle furnace at  $455\pm 10$  degrees Celsius.



