ATTACHMENT B

CONTRACT DOCUMENTS

CITY OF PALM BAY

SOUTH REGIONAL WATER TREATMENT PLANT EXPANSION - 4 MGD TO 6 MGD

TECHNICAL SPECIFICATIONS

VOLUME II OF II

June 2020

Prepared For:

Palm Bay Utilities

Prepared By:

TETRA TECH

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Orlando, FL 32801
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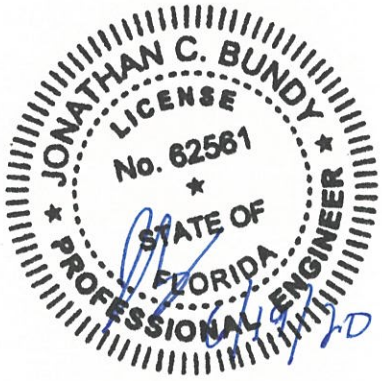
Tetra Tech #200-08507-19001

Bid Set

CITY OF PALM BAY
SOUTH REGIONAL WATER TREATMENT PLANT 4 MGD TO 6 MGD
CONTRACT DOCUMENTS

Portion of Engineering Documents for Which Responsible	Name and License Number	Company Name, Address, and Business No.	Signature, Seal, and Date
General	Jonathan C. Bundy, PE FL PE #62561	Tetra Tech, Inc. 201 E. Pine St., Suite 1000 Orlando, FL 32801 Engineering Business No. 2429	
Process	Jonathan C. Bundy, PE FL PE #62561	Tetra Tech, Inc. 201 E. Pine St., Suite 1000 Orlando, FL 32801 Engineering Business No. 2429	
Civil	Burl D. Reardon, PE FL PE #64037	Tetra Tech, Inc. 201 E. Pine St., Suite 1000 Orlando, FL 32801 Engineering Business No. 2429	

Palm Bay Utilities

CITY OF PALM BAY
SOUTH REGIONAL WATER TREATMENT PLANT 4 MGD TO 6 MGD
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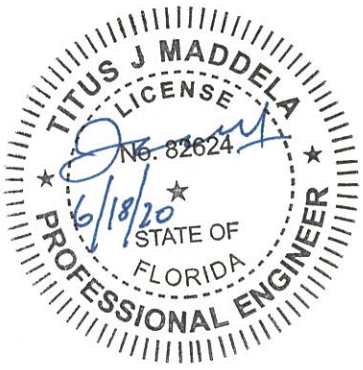
Portion of Engineering Documents for Which Responsible	Name and License Number	Company Name, Address, and Business No.	Signature, Seal, and Date
Structural	Titus J. Maddela, PE FL PE #82624	Tetra Tech, Inc. 201 E. Pine St., Suite 1000 Orlando, FL 32801 Engineering Business No. 2429	

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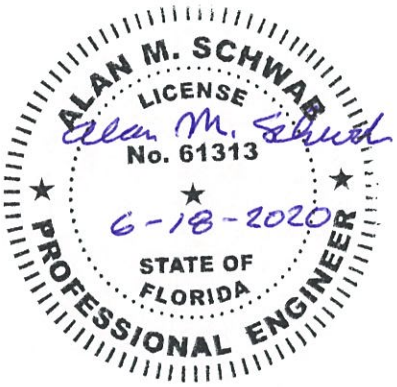
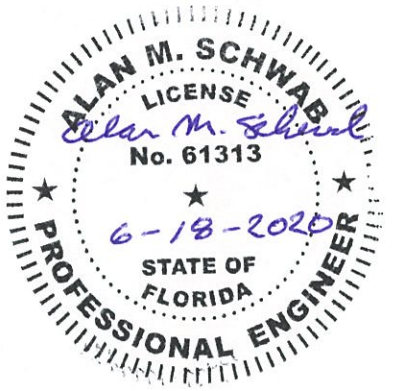
Portion of Engineering Documents for Which Responsible	Name and License Number	Company Name, Address, and Business No.	Signature, Seal, and Date
Electrical	Alan M. Schwab, PE FL PE #61313	Wade Trim 3790 Dixie Hwy NE Palm Bay, FL 32905	
Instrumentation	Alan Schwab, PE FL PE #61313	Wade Trim 3790 Dixie Hwy NE Palm Bay, FL 32905	

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SECTION 11213

VERTICAL TURBINE WELL PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Furnish all labor, materials, equipment and incidentals required and install, place in operation, and field test vertical turbine well pumps, and motors as hereinafter specified.

2. 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 application. It is, 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 complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.

3. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not, as required for an installation incorporating the highest standards for this type of service.

B. Related Work Described Elsewhere

1. Concrete work is included in Division 3.

2. Painting, except as specified herein, is included in Division 9.

3. Mechanical piping, valves, pipe hangers and supports are included in their respective Sections of Division 15.

4. Electrical work and motors, except as hereinafter specified, is included in Division 16.

5. Concrete bases for pumps and pump motors and installation of anchor bolts is included in Division 3, but anchor bolts shall be furnished under this Section.

C. General Design

1. One (1) vertical turbine well pumping unit is required for this Contract. The pump will be of the above base discharge, and will be of the constant speed

type. The pumping unit shall be located and arranged as shown on the Drawings. The pumping unit will draw raw water from the Floridan Aquifer which is under Artesian pressure.

2. All working parts of identical pumps and motors, such as bearings, wearing rings, shafts, sleeves, motors, etc., shall be of standard dimension built to limit gauges or formed to templates such that parts will be interchangeable between like units and such that the Owner may at any time in the future obtain replacement and repair parts for those furnished in the original machines. All parts shall be properly stamped for identification and location in the machines as shown on the Operation and Maintenance Manuals furnished.

3. All equipment, coatings, and materials that come in contact with the raw water shall comply with ANSI-NSF Standard 61, and the manufacturer shall provide documentation to demonstrate compliance.

1.02 QUALITY ASSURANCE

A. Qualifications

1. To assure unity of responsibility, the motors shall be furnished and coordinated by the pump manufacturer. The Contractor shall assume full responsibility for the satisfactory installation and operation of the entire pumping system including pumps and motors.

2. The pumps covered by these Specifications are intended to be standard pumping equipment of proven ability as manufactured by a reputable manufacturer having a minimum 10-years experience in the production of such pumps. The pumps furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed. Pumps shall be manufactured in accordance with the Hydraulic Institute Standards.

3. All equipment furnished under this Specification shall be new and unused and shall be the standard product of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein.

B. Manufacturers

1. The naming or reference to a specific manufacturer does not indicate that the manufacturer's standard equipment is acceptable in lieu of the specified component features. This reference is only an indication that the named manufacturers may have the capability of supplying the equipment as specified.

2. The pumps shall be as manufactured by:

a. Afton

b. Xylem Goulds Water Technology
c. Weir Floway
d. National

3. The motors shall be as manufactured by:

a. U.S. Motor
b. General Electric
c. Hitachi

1.03 SUBMITTALS

A. Materials and Shop Drawings

Copies of all materials required to establish compliance with the specifications shall be submitted in accordance with the provisions of Section 01340: Shop Drawings, Working Drawings and Samples. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.

2. Descriptive literature, bulletins, and/or catalogs of the equipment.

3. Long term storage requirements.

4. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves, based on actual shop tests of each of the units, which show that they meet the specified requirements for head, capacity, efficiency, NPSHR, and horsepower. Curves shall be submitted on 8-1/2-inch by ll-inch sheets, at as large a scale as is practical. Curves shall be plotted from no flow at shut off head to pump capacity at minimum specified total head.

5. Data including principle dimensions, materials of construction, space required, clearances, piping and electrical connections and requirements, controls, type of finish, installation instructions and other pertinent information.

6. A complete total bill of materials of all equipment including the weights of equipment furnished.

7. A list of the manufacturer's recommended spare parts in addition to those specified in Paragraph 2.04, with the manufacturer's current price for each item. Include gaskets, packing, etc., on the list. List bearings by the bearing manufacturer's numbers only.

8. Complete motor data including long term storage requirements for the motor.

9. Copies of all factory test results, as specified in PART 2 - PRODUCTS of this Section of the Specifications.

B. Additional Information

1. In the event that it is impossible to conform with certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

2. Upon receipt and review of submitted material, provide the required number of certified prints and one reproducible tracing of all Drawings as specified in Section 01340: Shop Drawings, Working Drawings and Samples.

1.04 OPERATIONS AND MAINTENANCE DATA

A. Operating and Maintenance Instructions

1. Operating and maintenance manuals shall be furnished. 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 operation and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Section 01730: Operating and Maintenance Data.

2. A factory representative of all major component manufacturers, 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. With the Owner's permission, this work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3 - EXECUTION. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.05 TOOLS AND SPARE PARTS

A. Furnish to the Owner a complete set of all special tools, including lubricating devices, required for normal operation, adjustment and maintenance of the equipment supplied. All such tools shall be furnished with a heavy duty, thermoplastic tool chest complete with a padlock and duplicate keys.

B. The manufacturer shall furnish a complete set of recommended spare parts necessary for the pumping system. Furnish for each size and type of pump the recommended spare parts, which shall include, as a minimum, the following:

1. 2 sets of gaskets and O-rings, for each pump model

2. 2 mechanical seals, for each pump model

3. 2 sets of bowl bearings and shaft bearings for each pump model

4. 1 impeller wear ring, bowl wear ring, and shaft coupling for each pump model supplied

5. One year supply of each type of lubricant required

C. All spare parts shall be furnished in containers properly labeled and identified with indelible markings as to their contents without opening the packaging. Containers shall be suitably protected for long-term storage.

1.06 PRODUCT 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 units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged storage 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. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted thereto.

E. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

F. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

G. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.07 WARRANTY AND GUARANTEES

A. Provide equipment warranty as specified in Section 01740: Warranties and Bonds.

PART 2 - PRODUCTS

2.01 GENERAL

A. The pumping unit required under this section shall be complete including proper alignment and balancing of the individual units. All parts shall be so designed and

proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the service to be performed. Ample room for inspection, repairs and adjustment shall be provided.

B. The discharge head for each pump shall be rigidly and accurately anchored into position. All necessary anchor bolts, nuts and washers shall be furnished by the pump manufacturer for installation by the contractor. Anchor bolts, nuts and washers shall be 316 stainless steel.

C. Stainless steel nameplates giving the name of the manufacturer, the rated capacity, head, speed and all other pertinent data shall be attached to each pump and motor.

D. Each pumping unit and its driving equipment shall be designed and constructed to withstand the maximum turbine run-away speed of the unit due to backflow through the pump with the maximum TDH specified available at the pump discharge flange.

E. All equipment, materials and applied coatings that come in contact with raw water shall be approved by the National Sanitation Foundation (NSF) for use with potable water, and the manufacturer shall provide documentation to demonstrate compliance.

2.02 MATERIALS AND EQUIPMENT

A. General

1. The well pump shall be of the water lubricated, open line shaft, vertical turbine type suitable to pump raw water from the Floridan aquifer with a TDS of 3,000 mg/l and chloride concentration of 1,200 mg/l. The pump will be equipped with a constant speed drive.

2. The pump shall be of standard dimensions such that parts will be interchangeable between like units and all units shall be supplied by the same manufacturer.

B. Performance requirements

1. When operating at the design output speed of it's squirrel cage induction motor each pump shall have a characteristic performance curve which meets all the minimum conditions listed in Table 11213-A. The pumps and drive motors shall be capable of operating satisfactorily under the full range of conditions as defined by Table 11213-A. The primary pump capacity, head and efficiency defined in Table 11213-A shall be the "design point". Pump efficiency as defined herein takes into consideration all losses from the pump intake suction bell to the pump discharge flange; except for the amount of lift which will vary with the water table.

2. There shall be no significant change in vibration and noise level over the entire listed range of flow for the pumping system.

3. Maximum motor speeds shall not exceed those listed in Table 11213-A to satisfy the specified hydraulic duty requirements. The pump "design speeds" shall be the motor output speed when operating at the pump primary capacity and head.

4. With the pumping units operating at full motor speed, the maximum brake horsepower required by the pumps shall not exceed the maximum horsepower listed in Table 11213-A. If the well pumping units require more than the maximum horsepower listed in Table 11213-A at the motor output shaft at any full motor speed operation point between shut-off and maximum flow at minimum head, they will be rejected.

5. Certified Factory Tests

   a. The pumps shall be given a complete performance test to include head/capacity, H.P. and efficiency to demonstrate that the pumps supplied conform to the requirements of this Specification. Factory testing shall be conducted in accordance with ASME Performance Test Code PTC 8.2 or the Hydraulic Institute Standards (ANSI/HIS 2.6), using the actual job driver. The test data shall be submitted on a 8-1/2-inch by ll-inch sheet at as large a scale as is practical. Four copies of the approved pump test curves laminated in plastic shall be provided to the Owner. The curves shall be plotted from no flow at shut off head to maximum flow at minimum head specified. No shipment of the pumps is to be made until after the Engineer's approval of the testing is obtained.

   b. In addition to the criteria above, the pump manufacturer shall have power-metering instruments in-place for continual monitoring of 480 volt, 3-phase, 60 Hertz power draw on each pumping unit. The manufacturer must demonstrate during the entire factory test that the hydraulic efficiency requirements are in complete compliance with this Section. Failure of the pumping equipment to meet the efficiency requirements will be grounds for failing the factory test. Monitoring of vibration shall be provided by the manufacturer during performance testing in accordance with the Hydraulic Institute Standards. Excessive vibration will be grounds for failing the factory test.

   c. Failed Factory Test: The failure of any pumping equipment to produce the specified flow rate over the entire test period will constitute a failed factory test. If a failed factory test occurs, manufacturer shall, at no expense to the Owner, make such modifications and perform additional tests as may be necessary to comply with the specifications.

C. Pump Construction

1. Discharge Head

a. The discharge head shall be 316L SS construction, with 150# ANSI raised face flanges, designed for above ground discharge. The head shall support the driver with a machine rabbet fit for alignment. Vibration limits will be per Hydraulic Institute standards. The head shall be fitted with a cartridge type mechanical seal, Type I, single, inside balanced with carbon on ceramic sealing face with a flushing connection. The seal shall be designed for maximum discharge pressure at shut off and adjustable externally from the pump. The gland and shaft sleeve shall be 316 SS. The headshaft shall be 316 SS, and coupled to the motor shaft with a spacer type, adjustable flanged coupling, to facilitate easy removal and replacement of the driver. The discharge flange shall have a ½" NPT connection for a pressure gauge.

b. The discharge head for the pumps shall be furnished with an ANSI #150 flat face base flange for mounting to the well head flange. A suitable rubber gasket shall be furnished to provide an airtight seal between the flanges. The anchor mounting bolts, nuts and washers shall be 316 SS.

c. Design columns, bowls and discharge heads for 150% of the pump shutoff pressure. Hydrostatically test columns, bowls and discharge heads at 150% of the pump shutoff pressure.

2. Column Assembly

a. Column Pipe

The discharge column to be furnished under these specifications shall be 316L stainless steel, Schedule 40, minimum.

The discharge column shall be furnished in interchangeable sections not over ten (10) feet in length and shall be coupled with flanged couplings.

b. Line Shaft Bearings

The column assembly bearing guides shall be 316 stainless steel and aligned by rabbet bits and clamped between the column flanges. Each bearing guide shall contain a ground carbon, self lubricating bearing. Bearing spacing shall be selected to insure operation at a minimum of 15% minus the critical speed.

c. Line Shaft

The line shaft shall be of Type 316 stainless steel ground and polished with a surface finish not to exceed 40 rms. Diameter will be sized to conform with AWWA E101, latest revision, specification for required horsepower. It shall be of ample size to operate the pump without distortion or vibration and shall be capable of carrying the maximum horsepower that may be generated by the motor. The butting ends shall be machined, faced and recessed square to the axis of the shaft. To insure accurate alignment, the shaft shall be straight within 0.003 inches total indicator reading over the total shaft length. The ends of the shaft shall be flanged or threaded for connection. The length of the shaft shall be such as to match properly the length of the discharge column. The shaft shall be furnished in interchangeable sections not over ten (10) feet in length.

3. Bowl Assembly

a. General

1) Pump bowls, suction and discharge cases shall be of 316 stainless steel, without imperfections, accurately machined and fitted to close dimensions.

2) Impeller shaft shall be of sufficient diameter to transmit the pump horsepower with a liberal safety factor and rigidly support the impellers between the bowl or case bearings. The impeller shaft material shall be Type 316 stainless steel.

b. Vertical Turbine Pumps

1) The suction case and intermediate bowls shall be fitted with replaceable lateral wear rings. Wear rings shall have the minimum practical clearance to the mating cylindrical surface of the impeller to provide adequate sealing to restrict the leakage of flow at the impeller skirt independent of vertical positioning of the impellers. The impeller shaft shall be supported in the bowl by a graphitar, vesconite or babbitted carbon bearing.

2) The suction bowl shall have a graphitar or vesconite, self lubricating, bearing positioned in a housing supported by four vanes. The discharge case shall have vanes to deliver the flow of water with minimum turbulence.

3) Impeller shall be of the enclosed type, machined, perfectly balanced mechanically and hydraulically, and filed for optimum performance and minimum vibration. The design shall be non-overloading for the capacity of the motor selected. The impeller should be keyed to the pump shaft by means of a

straight key and circular key which bolts to the back of the impeller or monel collet.

D. Motors

1. General

a. Motors should be vertical solid shaft type with 0.001 total indicator runout of the shaft to the mounting flange.

b. Motors must be designed to accept all upthrust loads imposed by pump during starting and running.

c. All motors shall be built in accordance with latest NEMA, IEEE, ANSI and AFBMA standards where applicable.

d. Motors shall conform to all requirements stipulated in PART I GENERAL of this Section of the Specifications unless modified in this paragraph.

2. Performance Requirements

a. Motors shall be premium efficiency rated 460 volts, 3 phase, 60 Hertz.

b. Each motor shall have a 1.15 service factor.

c. Motors shall have horsepower, full load output speed ratings and efficiencies as listed in Table 11213-A.

d. Motors shall be free of objectionable noise and vibration. Vibration level measured on the bearing housing shall be in accordance with values shown in NEMA and Hydraulic Institute Standards.

e. Maximum temperature rise of the motor windings shall not exceed 80°C as measured by resistance, when motor is operated continuously at rated horsepower, rated voltage and frequency in ambient air temperature of 40°C.

f. Tests

1) All motors shall be completely assembled at the factory and shall be given routine tests conducted in accordance with NEMA Standards MG1-20.46 and MG1-20.47 which includes the following non-witnessed tests:

a) No load current.
b) Winding resistance.
c) High potential dielectric tests.
d) Bearing inspection.

2) Copies of the test results for each motor shall be certified by a responsible test engineer. The test results shall be furnished to the Engineer for review before shipment of the motors as required by Paragraph 1.03.

3. Construction

a. The motor for the vertical turbine well pumps shall be of the TEFC type. The motor type varies with the wells and is listed in Table 11213-A.

b. Motor frames and end shields shall be heavy fabricated steel or cast iron on such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed. Openings for ventilation shall be uniformly spaced around the motor frame.

c. Space heaters shall be provided to operate on 120 volt, single phase power. Leads shall be brought out to a terminal block enclosed in an accessory box rated NEMA 4 for housed well pumps and NEMA 4 for exterior well pumps. Motors shall be provided with a metallic foil or plastic warning label with red background and white letters which has the following legend: "WARNING - ELECTRICAL SHOCK HAZARD, Motor Equipped with Strip Heaters. Strip Heater Circuit remains Energized when Main Disconnect for Pump is OFF".

d. 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.

e. Stator cores shall be made of low loss, non-aging electrical sheet steel with insulated laminations.

f. Stators shall be random wound and insulated with glass and mica applied directly to the coils. Motors shall have a Class F rise non-hygroscopic epoxy sealed or encapsulated insulation system limited to the temperature rise specified in 2.03.B.5. All connections shall be silver soldered with no crimp connections used except for terminals. A coil bracing system for stator end turns shall be utilized to minimize coil movement during starting and running conditions.

g. Rotors shall be made from high grade steel laminations adequately fastened together, and to the shaft. Rotor squirrel cage may be of cast-aluminum or copper alloy bar-type construction with brazed end rings.

h. Bearings shall be grease lubricated antifriction type with an AFBMA average bearing life of 20 years. Bearing design shall include over-grease protection. Oil lubricated bearings are acceptable.

i. The motor thrust bearing shall have ample capacity to carry the weight of all the rotating parts plus the hydraulic thrust of the pump impellers, and have an ample safety factor. This factor should be based on an average life expectancy of five years operation at 24 hours per day.

j. All motors shall have an interior coating of chemical resistant corrosion and fungus protective coating on all interior surfaces. Exterior prime coating shall be compatible with the field applied finish coating.

k. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all motors capable of supporting the weight of the motor. Enclosures shall have stainless steel screen and shall be protected against corrosion, fungus and insects.

l. All fittings, bolts, nuts and screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads.

m. The main terminal box shall be NEMA 12 for housed pumps and NEMA 4X for exterior well pumps and provide ample room for connections.

n. Motors shall be provided with a non-reverse ratchet coupling assembly.

E. Pump and Motor Coupling Guard

1. Provide a coupling guard on the pump base to prevent personal injury from the rotating pump and motor coupling. The guard shall be manufactured of stainless steel heavy wire fabric or expanded metal and shall have a stainless steel frame which bolts to the discharge head and completely covers the windows and shall comply with all applicable OSHA requirements. The guard shall be bolted or screwed to the pump base with stainless steel bolts and nuts or screws and shall be easily removable for access to the pump and motor coupling.

2.03 ACCESSORIES

A. Gauges

1. Each pump shall be equipped with a discharge pressure gauge. The pressure gauge shall be mounted on the discharge piping with the centerline of the gauge tap on the centerline of the pump discharge.

2. Gauges for the pumps shall be as specified in Section 13615: Process Instrumentation & Control Products and shall be calibrated as listed in Table 11213-A.

3. Gauges shall be equipped with a surge suppression snubber and diaphragm seals. Each gauge shall be equipped with a lever handle gauge cock and union.

4. Connection of the gauges to the pressure taps in the pump discharge shall be with screwed stainless steel pipe neatly installed with straight runs and right angle bends.

B. Strainer: The suction bell case shall be fitted with a 316 stainless steel cone type strainer. Strainer shall be provided by the pump manufacturer.

C. Fasteners: All pumps and column fasteners shall 316 stainless steel.

2.04 QUALITY CONTROL

A. Functional Tests: Conduct on each pump.

1. Alignment: Test compete assemblies for correct rotation, proper alignment and connection, and quiet operation.

2. Flow Output: Measured by field instrumentation.

B. Performance Test: In accordance with Hydraulic Institute Standards.

C. Perform Manufacturer and Supplier product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION

A. Shop Painting

1. Before exposure to weather and prior to shop painting all surfaces shall be thoroughly cleaned, dry and free from all mill-scale, rust, grease, dirt and other foreign matter.

2. All exposed portions of the pumps and motors shall be shop primed, with primer compatible with field painting as specified in Division 9.

3. All nameplates shall be properly protected during painting.

4. Gears, bearing 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 periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.

5. Certify coatings in contact with drinking water meet NSF Standard 61.

B. Field Painting

1. Field painting is specified under Section 09961: High Performance Paints and Coatings. Motors shall be supplied with the manufacturer's standard primer and top coat.

2. All nameplates shall be properly protected during painting.

3. Pumps are stainless steel and do not require painting.

3.02 INSTALLATION

A. Installation shall be in strict accordance with the Manufacturer's instructions and recommendations in the locations shown on the Drawings. The manufacturer's service representative shall hook up the line shaft couplings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the Manufacturer's recommendations. Anchor bolts shall be set in accordance with the Manufacturer's recommendations.

B. The Contractor shall submit a certificate from the equipment manufacturer stating that the installation of the 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.

C. The Contractor shall be responsible for supplying, installing, removal and restoration of temporary discharge piping required in order to dispose of raw Floridan water during pump installation, testing, development, and disinfection. Temporary piping shall be supplied to convey the water from the well to a nearby drainage facility suitable for discharge in accordance with an existing FDEP Generic Permit for Discharge of Produced Groundwater from any Non-Contaminated Site Activity or routed through existing easements and right-of-ways to the point of discharge. **Contractor is responsible for contacting FDEP and obtaining permission and/or applicable permits or permit modifications as required for discharge/disposal of raw Floridan water during pump testing and development activities.**

3.03 WELL DEVELOPMENT, DISINFECTION, AND CLEARANCE

A. No raw water shall be discharged into the raw water piping system until the well has been redeveloped, disinfected, and cleared for service by the Florida Department of Environmental Protection.

B. After the permanent well pump has been installed, the well shall be developed with the well pump at a flow rate of no less than the primary operating flow listed in Table 11213-A for a period of up to 20 hours. The turbidity of the raw water shall be monitored by the Contractor during development. Development shall be considered complete when the turbidities are less than 0.5 NTU for at least an hour based upon measurements taken every ten minutes and the turbidities are not decreasing more than twenty percent from the beginning to end of the hour.

C. After the well has been successfully redeveloped, the Contractor shall disinfect the well and well pump installation and clear bacteriologically as required by the Florida Department of Environmental Protection (FDEP). Disinfection shall be in accordance with the latest revision of AWWA Deep Well Standards A-100 and as set forth in chapter 62-555.315, Florida Administrative Code (F.A.C.). The Contractor shall introduce sufficient chlorine solution into the well and permanent discharge piping to produce a chlorine residual of 50 mg/l in accordance with AWWA C651 and C654. The Contractor shall submit his procedures for disinfection to the Engineer for review and comment prior to proceeding with disinfection. The chlorine residual shall be measured until it drops to zero, at which time the well shall be pumped to waste for a minimum of 15 minutes and turbidities checked to be less than those specified in 3.03B, the well shall be ready for bacteriological evaluation.

D. The Contractor shall furnish the necessary labor and equipment to assist the City in obtaining daily bacteriological sample for 20 consecutive days or twice daily, not less than six hours apart, for 10 consecutive days. The samples shall be obtained using the permanent pump and taken after 20 to 30 minutes of pumping. If all 20 samples show the absence of coliform bacteria, the Engineer shall submit the results to FDEP and request clearance of the well for services. After receipt of clearance from the FDEP, the Contractor shall connect the well discharge piping to the raw water mains and proceed with final testing of the well installation.

E. If the wells fail the initial bacteriological evaluation, the Contractor shall redisinfect the well in accordance with 3.03C and assist the Owner in obtaining additional bacteriological samples as described in 3.03D, all at no additional cost to the Owner. If the second effort to clear the well fails, the Contractor may request a change order for the additional work required to obtain clearance of the well for service.

3.04 INSPECTION AND TESTING

A. General

1. The equipment manufacturer shall furnish the services of a competent and experienced representative who has complete knowledge of proper operation and maintenance of the equipment to inspect the installed equipment, supervise the initial test run, and to provide instructions to the plant personnel. The first visit will be for installation assistance, checking, and inspecting the equipment after it is installed. The second visit will be to operate and supervise the initial field test. At least one (1) day shall be allocated solely to

the instruction of plant personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten days in advance with the Owner and shall take place prior to plant start-up and acceptance by the Owner. The final copies of operation and maintenance manuals specified in Section 01730: Operation and Maintenance Data must have been delivered to the Engineer prior to scheduling the instruction period with the Owner. With the permission of the Engineer, these services may be combined with those provided under Paragraph 1.03.C.

2. Field tests shall not be conducted until such time that the entire installation is complete and ready for testing.

B. Pumps

1. After all pumps have been completely installed, and working under the direction of the Manufacturer, conduct in the presence of the Engineer, such tests as are necessary to indicate that the pumping system operates satisfactorily and generally meets the conditions of service specified. The factory witnessed tests are the basis of equipment efficiency demonstration, the field test shall demonstrate correct mechanical operation after pump start-up. Field tests shall include all pumps included under this section. Supply all labor, equipment and incidentals required to complete the field tests.

2. If the pump performance does not meet the Specifications, corrective measures shall be taken or pumps shall be removed and replaced with pumps which satisfy the conditions specified. A 24-hour operating period of the pumps will be required before acceptance.

C. Motors

1. 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.

2. The Contractor shall check all motors for correct clearances and alignment and for correct lubrication in accordance with Manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections if necessary.

3.05 START-UP AND INSTRUCTION

A. Manufacturer's Representative: Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. Three (3) person-days for installation assistance and inspection.

2. One (1) person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation and one (1) person-day for prestartup classroom or site training.

B. See Section 01650 - Start-Up and Demonstration.

TABLE 11213-A

WELL PUMPING UNIT DESIGN REQUIREMENTS

Item/Design Conditions	**Production Well No. 4**
Pump Tag Number	WP-104
Pump Type	Vertical Turbine
Well Casing Inside Diameter (in)	20.687"
Max. Motor Full Load Speed (rpm)	1,800
Maximum Motor (hp)	100
Motor Type	TEFC
Maximum Number of Stages	3
Pump Column Diameter (inches)	10
Discharge Diameter, min. (inches)	12
Minimum Pump Shut-Off Head (feet)	200
Design Capacity (gpm)	1750
TDH at Design Capacity (feet)	140
Minimum Efficiency at Design Capacity (%)	76
Pressure Gauge Range (psi)	75
Length of Column Pipe (ft)	50

END OF SECTION

SECTION 11214

VERTICAL TURBINE HIGH SERVICE AND TRANSFER PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Furnish all labor, materials, equipment and incidentals required and install, place in operation, and field test vertical turbine pumps, and motors as hereinafter specified and as shown in the Drawings.

2. 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 application. It is, 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 complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.

3. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not, as required for an installation incorporating the highest standards for this type of service.

B. Related Work Described Elsewhere

1. Concrete work is included in Division 3.

2. Painting, except as specified herein, is included in Division 9.

3. Mechanical piping, valves, pipe hangers and supports are included in their respective Sections of Division 15.

4. Electrical work and motors, except as hereinafter specified, is included in Division 16.

5. Concrete bases for pumps and pump motors and installation of anchor bolts is included in Division 3, but anchor bolts shall be furnished under this Section.

C. General Design

1. One (1) finished water transfer pumping unit is required for this contract. This pump shall be of the above base discharge vertical turbine type. The pumping unit shall be located and arranged as shown in the Drawings. The finished water

transfer pump shall be installed on top of transfer pump wet well located in the clearwell structure from which they will take suction as shown on the Drawings. The finished water transfer pump shall be constant speed with soft start.

2. Two (2) finished water high service pumping units are required for this contract. These pumps shall be of the above base discharge vertical turbine type. The pumping units shall be located and arranged as shown in the Drawings. The finished water high service pumps shall be installed inside the existing RO Building High Service Pump Room which they will take suction as shown on the Drawings. All finished water high service pumps shall be variable speed design.

3. All working parts of identical pumps and motors, such as bearings, wearing rings, shafts, sleeves, motors, etc., shall be of standard dimension built to limit gauges or formed to templates such that parts will be interchangeable between like units and such that the Owner may at any time in the future obtain replacement and repair parts for those furnished in the original machines. All parts shall be properly stamped for identification and location in the machines as shown on the Operation and Maintenance Manuals furnished.

4. All equipment, coatings, and materials that come in contact with drinking water shall comply with ANSI-NSF Standard 61, and the manufacturer shall provide documentation to demonstrate compliance.

1.02 QUALITY ASSURANCE

A. Qualifications

1. To assure unity of responsibility, the motors shall be furnished and coordinated by the pump manufacturer. The Contractor shall assume full responsibility for the satisfactory installation and operation of the entire pumping system including pumps, and motors.

2. The pumps covered by these Specifications are intended to be standard pumping equipment of proven ability as manufactured by a reputable manufacturer having a minimum of 10 years experience in the production of such pumps. The pumps furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed. Pumps shall be manufactured in accordance with the Hydraulic Institute Standards.

3. All equipment furnished under this Specification shall be new and unused and shall be the standard product of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein.

B. Manufacturers

1. The naming or reference to a specific manufacturer does not indicate that the manufacturer's standard equipment is acceptable in lieu of the specified component features. This reference is only an indication that the named manufacturers may have the capability of supplying the equipment as specified.

2. The pumps shall be manufactured by:

   a. Afton
   b. Xylem Goulds Water Technology
   c. Weir Floway
   d. National

3. The motors shall be manufactured by:

   a. U.S. Motor
   b. General Electric
   c. Hitachi

1.03 SUBMITTALS

A. Materials and Shop Drawings

Copies of all materials required to establish compliance with the specifications shall be submitted in accordance with the provisions of Section 01340: Shop Drawings, Working Drawings and Samples of these Specifications. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.

2. Descriptive literature, bulletins, and/or catalogs of the equipment.

3. Long term storage requirements.

4. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves, based on actual shop tests of similar units, which show that they meet the specified requirements for head, capacity, efficiency, NPSHR, 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 no flow at shut off head to pump capacity at minimum specified total head.

5. Data including principle dimensions, materials of construction, space required, clearances, piping and electrical connections and requirements, controls, type of finish, installation instructions and other pertinent information.

6. A complete total bill of materials of all equipment including the weights of equipment furnished.

7. A list of the manufacturer's recommended spare parts in addition to those specified in Paragraph 2.04, with the manufacturer's current price for each item. Include gaskets, packing, etc., on the list. List bearings by the bearing manufacturer's numbers only.

8. Complete motor data including long term storage requirements for the motor.

9. Copies of all factory test results, as specified in PART 2 - PRODUCTS of this Section of the Specifications.

B. Submit detailed pump structural frequency analysis for each variable speed pump system:

1. The pump supplier shall provide an analysis of each vertical variable speed pump system to ensure that no damaging critical or resonant frequencies or multiplies of resonant frequencies occur from 10% above to 30% below the proposed speed range necessary for the pump to meet the specified operating conditions.

2. A computer program shall be used to generate the pump structural natural frequencies based on a comprehensive procedure. This procedure shall be applicable for vertical pumps.

3. The frequency analysis shall include but not be limited to:

   a. The combined rotational stiffness of the discharge head flange, discharge head flange bolting, base plate/sole plate, and anchor bolting of a vertical pump.

   b. The rotational dynamics of the motor.

4. The analysis shall be performed and certified by a registered professional engineer and calculations shall be provided to the Engineer with submittal data. The registered professional engineer shall certify the pump when operating from 70% full speed to 110% full speed does not come within 20% of the first or second critical harmonic speed.

C. Additional Information

1. In the event that it is impossible to conform with certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

2. Upon receipt and review of submitted material, provide the required number of certified prints and one reproducible tracing of all Drawings as specified in Section 01340: Shop Drawings, Working Drawings and Samples.

1.04. OPERATIONS AND MAINTENANCE DATA

A. Operating and Maintenance Instructions

1. Operating and maintenance manuals shall be furnished. 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 operation and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Section 01730: Operating and Maintenance Data.

2. A factory representative of all major component manufacturers, 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. With the Owner's permission, this work may be conducted in conjunction with the inspection of 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 cost to the Owner.

1.05 TOOLS AND SPARE PARTS

A. Furnish to the Owner a complete set of all special tools, including lubricating devices, required for normal operation, adjustment and maintenance of the equipment supplied, including at a minimum one (1) spanner wrench for each size pump. All such tools shall be furnished with a heavy duty, thermoplastic tool chest complete with a padlock and duplicate keys.

B. The manufacturer shall furnish a complete set of recommended spare parts necessary for each pumping system. Furnish for each size and type of pump the recommended spare parts, which shall include, as a minimum, the following:

1. 2 sets of gaskets and O-rings, for each pump model.

2. 2 mechanical seals, for each pump model.

3. 2 sets of bowl bearings and shaft bearings for each pump model.

4. 1 impeller wear ring, bowl wear ring, and shaft coupling for each pump model supplied.

5. One year supply of each type of lubricant required.

C. All spare parts shall be furnished in containers properly labeled and identified with indelible markings as to their contents without opening the packaging. Containers shall be suitably protected for long-term storage.

1.06 PRODUCT 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 units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged storage 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. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted thereto.

E. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

F. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

G. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.07 WARRANTY AND GUARANTEES

A. Provide equipment warranty as specified in Section 01740: Warranties and Bonds.

PART 2 - PRODUCTS

2.01 GENERAL

A. The pumping units required under this section shall be complete including proper alignment and balancing of the individual units. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the service to be performed. Ample room for inspection, repairs and adjustment shall be provided.

B. The discharge head for each pump shall be rigidly and accurately anchored into position. All necessary anchor bolts, nuts and washers shall be furnished by the pump manufacturer for installation by the contractor. Anchor bolts, nuts and washers shall be 316 stainless steel.

C. Stainless steel nameplates giving the name of the manufacturer, the rated capacity, head, speed and all other pertinent data shall be attached to each pump and motor.

D. Each pumping unit and its driving equipment shall be designed and constructed to withstand the maximum turbine run-away speed of the unit due to backflow through the pump with the maximum TDH specified available at the pump discharge flange.

E. All materials, equipment, and applied coatings that come in contact with the finished water shall be approved by the National Sanitation Foundation (NSF) for use with potable water.

2.02 MATERIAL AND EQUIPMENT

A. General

1. The finished water transfer pump shall be constant speed with soft start, water lubricated, open line shaft, vertical turbine type suitable to pump finished water from the transfer pump wet well to the existing and proposed finished water ground storage tanks.

2. The high service pumps shall be variable speed, water lubricated, open line shaft, vertical turbine type suitable to pump finished water from the finished water ground storage tanks to the existing distribution system.

3. The pumps shall be of standard dimensions such that parts will be interchangeable between like units and all units shall be supplied by the same manufacturer.

B. Performance Requirements

1. When operating at the design output speed of its squirrel cage induction motor each pump shall have a characteristic performance curve which meets all the minimum conditions listed in Table 11214-B. The pumps and drive motors shall be capable of operating satisfactorily under the full range of conditions as defined by Table 11214-B. The primary pump capacity, head and efficiency defined in Table 11214-B shall be the "design point". Pump efficiency as defined herein takes into consideration all losses from the pump intake suction bell to the pump discharge flange. When the pump is mounted in a can, the pump efficiency shall take into consideration all losses from the can suction flange to the pump discharge flange.

2. There shall be no significant change in vibration and noise level over the entire listed range of flow for the pumping system.

3. Maximum motor speeds shall not exceed those listed in Table 11214-B to satisfy the specified hydraulic duty requirements. The pump "design speeds" shall be the motor output speed when operating at the pump primary capacity and head.

4. With the pumping units operating at full motor speed, the maximum brake horsepower required by the pumps shall not exceed the maximum horsepower listed in Table 11214-B. If the pumping units require more than the maximum horsepower listed in these tables at the motor output shaft at any full motor speed operation point between shut-off and primary discharge head, they will be rejected.

5. Certified Factory Tests

   a. The pumps shall be given a complete non-witnessed factory performance test to include head/capacity, H.P. and, efficiency to demonstrate that the pumps supplied conform to the requirements of this Specification. Factory testing shall be conducted in accordance with ASME Performance Test Code PTC 8.2 or the Hydraulic Institute Standard (ANSI/HIS 2.6), using the actual job driver. The test data shall be submitted on a 8-1/2-inch by 11-inch sheet at as large a scale as is practical. Four copies of the approved pump test curves laminated in plastic shall be provided to the Owner. The curves shall be plotted from no flow at shut off head to maximum flow at minimum head specified. No shipment of the pumps is to be made until after the Engineer's approval of the testing is obtained.

   b. In addition to the criteria above, the pump manufacturer shall have power-metering instruments in-place for continual monitoring of 480 volt, 3-phase, 60 Hertz power draw on each pumping unit. The manufacturer must demonstrate during the entire factory test that the hydraulic efficiency requirements are in complete compliance with this Section. Failure of the pumping equipment to meet the efficiency requirements will be grounds for failing the factory test. Monitoring of vibration shall be provided by the manufacturer during performance testing in accordance with the Hydraulic Institute Standards. Excessive vibration will be grounds for failing the factory test.

   c. Failed Factory Test: The failure of any pumping equipment to produce the specified flow rate over the entire test period will constitute a failed factory test. If a failed factory test occurs, manufacturer shall, at no expense to the Owner, make such modifications and perform additional tests as may be necessary to comply with the specifications.

C. Pump Construction

1. Discharge Head

a. The high service pump and finished water transfer pump discharge heads shall be designed for above ground discharge as specified in Table 11214-A. The head shall support the driver with a machine rabbet fit for alignment. Vibration limits will be per Hydraulic Institute standards. The head shall be fitted with a cartridge type mechanical seal, Type I, single, inside balanced with carbon on ceramic sealing face and provided with a flushing connection. The seal shall be designed for maximum discharge pressure at shut off and adjustable externally from the pump. The gland and shaft sleeve shall be 316 SS. The headshaft shall be 316 SS, and coupled to the motor shaft with a spacer type, adjustable flanged coupling, to facilitate easy removal and replacement of the seal assembly. Lifting lugs shall be provided with the capacity to support the weight of the entire pumping unit.

b. The outlet shall be equipped with a flanged above grade discharge elbowand drilled to match ANSI 150 lb cast iron flanges. The discharge nozzle shall be constructed with a vertical vane for reduction of turbulence. Also, the discharge flange shall have a 1/2" NPT connection for a pressure gauge.

c. The design shall permit the drive shaft to be coupled above the stuffing box to facilitate easy removal and replacement of the driver.

d. Design columns, bowls and discharge heads for 150% of the pump shutoff pressure. Hydrostatically test columns, bowls and discharge heads at 150% of the pump shutoff pressure.

e. The discharge head shall be furnished with an integral-mounting ring of adequate design with registered fit to match the mounting dimensions of the drive and to support the drive weight and hydraulic thrust of the pump. The pump discharge heads shall be mounted on a separate base plate and be anchored to a concrete equipment pad.

2. Column Assembly

a. Column Pipe

The discharge column to be furnished under these specifications shall be as specified in Table 11214-A.

The discharge column shall be furnished in interchangeable sections not over ten (10) feet in length and shall be coupled with flanged-type couplings.

b. Line Shaft Bearings

The column assembly bearing guides shall be aligned by rabbet bits and clamped between the column flanges. Each bearing guide shall contain a ground carbon, self-lubricating bearing designed for vertical turbine pump service. Bearing spacing shall be selected to insure operation at a minimum of 15% minus the critical speed.

c. Line Shaft

The line shaft shall as specified in Table 11214-A. Diameter will be sized to conform to AWWA E101, latest revision, specification for required horsepower. It shall be of ample size to operate the pump without distortion or vibration and shall be capable of carrying the maximum horsepower that may be generated by the motor. The butting ends shall be machined, faced and recessed square to the axis of the shaft. To insure accurate alignment, the shaft shall be straight within 0.003 inches total indicator reading over the total shaft length. The length of the shaft shall be such as to match properly the length of the discharge column. Couplings, when required, shall be 316 SST, threaded with center locating drill through. See Table 11214-A for materials.

3. Bowl Assembly

a. General

1. Pump bowls, suction and discharge cases shall be without imperfections, accurately machined and fitted to close dimensions and as specified in Table 11214-A.

2. Impeller shaft shall be of sufficient diameter to transmit the pump horsepower with a liberal safety factor and rigidly support the impellers between the bowl or case bearings. The impeller shaft material shall be as specified in Table 11214-A.

b. Vertical Turbine Pumps

1. The suction case and intermediate bowls shall be fitted with replaceable lateral wear rings Wear rings shall have the minimum practical clearance to the mating cylindrical surface of the impeller to provide adequate sealing to restrict the leakage of flow at the impeller skirt independent of vertical positioning of the impellers. The impeller shaft shall be supported in the bowl by a bronze bearing for the high service and finished water transfer pumps.

2. The suction bowl shall have a self-lubricating bearing positioned in a housing supported by four vanes. The discharge case shall

have vanes to deliver the flow of water with minimum turbulence.

3. Impeller shall be of the enclosed type, machined, perfectly balanced dynamically and hydraulically, and filed for optimum performance and minimum vibration. The design shall be non-overloading for the capacity of the motor selected. The impeller shall be double keyed or stainless steel collet mounted to the impeller shaft.

D. Motors

1. General

a. The motors for the pumps shall be of the vertical solid shaft squirrel cage induction type. The motors shall be equipped with bearing isolators to protect motor bearing from stray currents generated by the VFDs.

b. Motors must be designed to accept all upthrust loads imposed by pump during starting and running.

c. All motors shall be built in accordance with latest NEMA, IEEE, ANSI and AFBMA standards where applicable.

d. Motors shall conform to all requirements stipulated in PART 1 GENERAL of this Section of the Specifications unless modified in this paragraph.

2. Performance Requirements

a. Motors shall be premium efficiency rated 460 volts, 3 phase, 60 Hertz. Motors for VFD application shall be inverter duty.

b. Each motor shall have a 1.15 service factor.

c. Motors shall have horsepower, full load output speed ratings and efficiencies as listed in Table 11214-B.

d. Motors shall be free of objectionable noise and vibration. Vibration level measured on the bearing housing shall be in accordance with values shown in NEMA and Hydraulic Institute Standards.

e. Maximum temperature rise of the motor windings shall not exceed 80°C as measured by resistance, when motor is operated continuously at rated horsepower, rated voltage and frequency in ambient air temperature of 40°C.

f. Tests

i. All motors shall be completely assembled at the factory and shall be given routine tests conducted in accordance with NEMA Standards MG1-20.46 and MG1-20.47 which includes the following non-witnessed tests:

1) No load current.

2) Winding resistance.

3) High potential dielectric tests.

4) Bearing inspection.

ii. Copies of the test results for each motor shall be certified by a responsible test engineer. The test results shall be furnished to the Engineer for review before shipment of the motors as required by Paragraph 1.03.

iii. Motors shall be refined balance and balance documented.

3. Construction

a. The finished water transfer pump and high service pump motors shall be of the totally enclosed fan cooled (TEFC) design as shown in Table 11214-B.

b. Motor frames and end shields shall be heavy fabricated steel or cast iron on such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed. Openings for ventilation shall be uniformly spaced around the motor frame.

c. Space heaters shall be provided to operate on 120 volt, single phase power. Leads shall be brought out to a terminal block enclosed in a NEMA 4 accessory box. Motors shall be provided with a metallic foil or plastic warning label with red background and white letters which has the following legend: "WARNING - ELECTRICAL SHOCK HAZARD, Motor Equipped with Strip Heaters. Strip Heater Circuit remains Energized when Main Disconnect for Pump is OFF".

d. 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.

e. Stator cores shall be made of low loss, non-aging electrical sheet steel with insulated laminations.

f. Stators shall be random wound and insulated with glass and mica applied directly to the coils. Motors shall have a Class F rise non-hygroscopic epoxy sealed or encapsulated insulation system limited to the temperature rise specified in 2.02E2. All connections shall be silver soldered with no crimp connections used except for terminals. A coil bracing system for stator end turns shall be utilized to minimize coil movement during starting and running conditions.

g. Rotors shall be made from high grade steel laminations adequately fastened together, and to the shaft. Rotor squirrel cage may be of cast-aluminum or copper alloy bar-type construction with brazed end rings.

h. Bearings shall be grease lubricated antifriction type with an AFBMA average bearing life of 20 years. Bearing design shall include over-grease protection. Motors shall incorporate bearing isolators. Oil lubricated bearings are acceptable.

i. The motor thrust bearing shall have ample capacity to carry the weight of all the rotating parts plus the hydraulic thrust of the pump impellers, and have an ample safety factor. This factor should be based on an average life expectancy of five years operation at 24 hours per day.

j. All motors shall have an interior coating of chemical resistant corrosion and fungus protective coating on all interior surfaces. Exterior prime coating shall be compatible with the field applied finish coating.

k. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all motors capable of supporting the weight of the motor. Enclosures shall have stainless steel insert screens.

l. All fittings, bolts, nuts and screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads.

m. The main terminal box shall be NEMA 4X and provide ample room for connections.

n. Motors shall be provided with a non-reverse ratchet coupling assembly.

E. Pump and Motor Coupling Guard

1. Provide a coupling guard on the pump base to prevent personal injury from the rotating pump and motor coupling. The guard shall be manufactured of galvanized heavy wire fabric or expanded metal for the finished water transfer pumps and high service pumps and and shall comply with all applicable OSHA requirements. The guard shall be bolted, hinged, or screwed to the pump base with stainless steel bolts and nuts or screws and shall be easily removable for access to the pump and motor coupling.

2.03 ACCESSORIES

A. Gauges

1. Each pump shall be equipped with a discharge pressure gauge. The pressure gauge shall be mounted on the pump discharge pipe with the centerline of the gauge tap on the centerline of the pump discharge.

2. Gauges for the pumps shall be as specified in Section 13615: Process Instrumentation and Control Products and shall be calibrated as listed in Table 11214-B.

3. Gauges shall be equipped with a surge suppression snubber and diaphragm seals. Each gauge shall be equipped with a lever handle gauge cock and union.

4. Connection of the gauges to the pressure taps in the pump discharge shall be with screwed stainless steel pipe neatly installed with straight runs and right angle bends.

B. Fasteners: All pumps and column fasteners shall be 316 stainless steel.

2.04 QUALITY CONTROL

A. Functional Tests: Conduct on each pump.

1. Alignment: Test compete assemblies for correct rotation, proper alignment and connection, and quiet operation.

2. Flow Output: Measured by plant instrumentation and storage volumes.

B. Performance Test: In accordance with Hydraulic Institute Standards.

C. Perform Manufacturer and Supplier product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION

A. Shop Painting

1. Before exposure to weather and prior to shop painting all surfaces shall be thoroughly cleaned, dry and free from all mill-scale, rust, grease, dirt and other foreign matter.

2. All exposed portions of the pumps and motors shall be shop primed, with primer compatible with field painting as specified in Division 9.

3. All nameplates shall be properly protected during painting.

4. Gears, bearing 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 periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.

5. Certify coatings in contact with drinking water meet NSF Standard 61.

B. Field Painting

1. Field painting is specified under Section 09961: High Performance Paints and Coatings. The primer and paint used in the shop shall be products of the same manufacturer as the field paint to assure compatibility.

2. All nameplates shall be properly protected during painting.

3.02 INSTALLATION

A. Installation shall be in strict accordance with the Manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the Manufacturer's recommendations. Anchor bolts shall be set in accordance with the Manufacturer's recommendations.

B. The Contractor shall submit a certificate from the equipment manufacturer stating that the installation of the 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.

3.03 INSPECTION AND TESTING

A. General

1. The equipment manufacturer shall furnish the services of a competent and experienced representative who has complete knowledge of proper operation and maintenance of the equipment to inspect the installed equipment, supervise the initial test run, and to provide instructions to the plant personnel. The first visit will be for checking and inspecting the equipment after it is installed. The second visit will be to operate and supervise the initial field test. At least two (2) days shall be allocated solely to the instruction of plant personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten days in advance with the Owner and shall take place prior to plant start-up and acceptance by the Owner. The final copies of operation and maintenance manuals specified in Section 01730: Operation and Maintenance Data must have been delivered to the Engineer prior to scheduling the instruction period with the Owner. With the permission of the Engineer, these services may be combined with those provided under Paragraph 1.03C.

2. Field tests shall not be conducted until such time that the entire installation is complete and ready for testing.

B. Pumps

1. After all pumps have been completely installed, and working under the direction of the Manufacturer, conduct in the presence of the Engineer, such tests as are necessary to indicate that the pumping system operates satisfactorily and generally meets the conditions of service specified. The factory witnessed tests are the basis of equipment efficiency demonstration, the field test shall demonstrate correct mechanical operation after pump start-up. Field tests shall include all pumps included under this section. Supply all labor, equipment and incidentals required to complete the field tests.

2. If the pump performance does not meet the Specifications, corrective measures shall be taken or pumps shall be removed and replaced with pumps which satisfy the conditions specified. A 24-hour operating period of the pumps will be required before acceptance.

C. Motors

1. 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.

2. The Contractor shall check all motors for correct clearances and alignment and for correct lubrication in accordance with Manufacturer's instructions. The

Contractor shall check direction of rotation of all motors and reverse connections if necessary.

3.04 START-UP AND INSTRUCTION

A. Manufacturer's Representative: Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. Two (2) person-days for installation assistance and inspection.

2. One (1) person-day for functional and performance testing and completion of Manufacturer's Certificate or Proper Installation and one (1) person-day for pre-startup classroom or site training.

B. See Section 01650 - Start-Up.

C. The Contractor shall disinfect the pump and all suction piping and discharge piping in accordance with FDEP regulations.

TABLE 11214-A

MATERIALS OF CONSTRUCTION

Component	Material
	Finished Water Transfer Pumps and High Service Pumps
Pump shafts, shaft couplings, and sleeves	Stainless Steel, A 743, Grade CF-8M or ASTM A 276, Type 410 or Type 416.
Bowl wear rings or seal rings for bowls 24" diameter and larger	Stainless Steel, A 743, Grade CF-8M or CA-15 ASTM A 276, Type 410, 420, or bronze, ASTM B 584, Alloy C 93700. Aluminum Bronze ASTM B-148
Impellers	Bronze, ASTM 584, Alloy C 93700 or C 83600 or stainless steel ASTM A 276, Type 316 Aluminum Bronze C95200
Pump bowls and suction intake	Cast Iron, ASTM A 48, Class 30
Bowl bearings	Bronze, B 584, Alloy C 93700; SAE 660 Bronze, Alloy 932.00
All parts made of fabricated steel including discharge head or motor stand, unless specified otherwise	Carbon steel, ASTM A 283, Grade B or C, or ASTM A 53, Grade B
Column pipe and shaft enclosing tube	Carbon steel, ASTM A 283, Grade B or C, or ASTM A 53, Grade B
Flanges	ASTM A 105, A 181, or A 182
Bolts and nuts for discharge head and column pipe flanges, basket strainer, coupling guard	Bolts shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M. Nuts shall be Type 316 stainless steel conforming to ASTM A 194, Grade 8M
Stuffing box gland parts	Bronze, ASTM B 584, Alloy 836, or ASTM B 62 or 416 Stainless Steel, or ASTM A226, Type 316
Gland nuts and bolts	Stainless steel, ASTM A 276, Type 316 bolts with Bronze nuts
Notes: 1. Materials of construction for components not listed shall conform to AWWA E101, Part A, Table 1, except that the materials shall be considered required, not typical. 2. Do not construct the impeller and bowl liner of the same material.	

TABLE 11214-B

PUMPING UNIT DESIGN REQUIREMENTS

Item/Design Conditions	Finished Water Transfer Pumps	Finished Water High Service Pumps
Pump Tag Numbers	TP-1102	HSP-1305 HSP-1306
Pump Type	Vertical Turbine	Vertical Turbine
Maximum Motor Full Load Speed (rpm)	1,200	1,800
Maximum Motor to be Supplied (hp)	50	125
Motor Type	TEFC	TEFC
Minimum Stages	1	2
Pump Column Diameter (inches)	16	10
Discharge Size, minimum (inches)	16	12
Minimum Pump Shut-Off Head (feet)	60	245
Design Point #1 Capacity (gpm)	3,475	2,222
TDH at Design Point #1 Capacity (feet)	36	162
Run-Out head (feet), maximum	28	115
Pressure Gauge Range (psi)	30	100

Note: Pump shall not exceed motor rating over the entire pump curve.

END OF SECTION

SECTION 11215

VERTICAL TURBINE RO FEED PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Furnish all labor, materials, equipment and incidentals required to install, place in operation, and field test vertical turbine high pressure pumps, and motors as hereinafter specified.

2. 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 application. It is, 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 complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.

3. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not, as required for an installation incorporating the highest standards for this type of service.

B. Related Work Described Elsewhere

1. Concrete work is included in Division 3.

2. Painting, except as specified herein, is included in Division 9.

3. Mechanical piping, valves, pipe hangers and supports are included in their respective Sections of Division 15.

4. Section 16150: Motors.

5. General Electrical work, except as hereinafter specified, is included in Division 16.

6. Concrete bases for pumps and pump motors and installation of anchor bolts are included in Division 3, but anchor bolts shall be furnished under this Section.

C. General Design

1. One (1) new feed pump for the RO process is required for this Contract. The pump will be of the above-base discharge, vertical turbine type. Two (2) feed pumps are required for installation, with one (1) new pump required and one (1) relocated spare pump (existing on-site) for each proposed RO skid. The RO feed pump will be of the variable frequency drive type. The new and spare pumps shall be located and arranged as shown on the Drawings. The RO feed pumps shall be installed in the existing suction cans taking suction from the pretreated filtered water line as shown on the Drawings.

2. All working parts of identical pumps and motors, such as bearings, wearing rings, shafts, sleeves, motors, etc., shall be of standard dimension built to limit gauges or formed to templates such that parts will be interchangeable between like units and such that the Owner may at any time in the future obtain replacement and repair parts for those furnished in the original machines. All parts shall be properly stamped for identification and location in the machines as shown on the Operation and Maintenance Manuals furnished.

3. All equipment, coatings, and materials that come into contact with drinking water shall comply with ANSI-NSF Standard 61, and the manufacturer shall provide documentation to demonstrate compliance.

1.02 QUALITY ASSURANCE

A. Qualifications

1. To assure unity of responsibility, the motor shall be furnished and coordinated by the pump manufacturer. The Contractor shall assume full responsibility for the satisfactory installation and operation of the entire pumping system including pumps, and motors.

2. The pumps covered by these Specifications are intended to be standard pumping equipment of proven ability as manufactured by a reputable manufacturer having a minimum 10-year experience in the production of such pumps for RO systems. The pumps furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed. Pumps shall be manufactured in accordance with the Hydraulic Institute Standards.

3. All equipment furnished under this Specification shall be new and unused and shall be the standard product of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein a minimum of ten (10) years.

B. Manufacturers

1. The naming or reference to a specific manufacturer does not indicate that manufacturer's standard equipment is acceptable in lieu of the specified component features. This reference is only an indication that the named manufacturers may have the capability of supplying the equipment as specified.

2. The high-pressure feed pumps shall be manufactured by:

   a. Afton
   b. Xylem Goulds Water Technology
   c. Weir Floway
   d. National

3. The motors shall be manufactured by:

   a. U.S. Motor
   b. General Electric
   c. Hitachi

1.03 SUBMITTALS

A. Materials and Shop Drawings

Copies of all materials required to establish compliance with the specifications shall be submitted in accordance with the provisions of Section 01340: Shop Drawings, Working Drawings and Samples. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.

2. Descriptive literature, bulletins, and/or catalogs of the equipment.

3. Data on the characteristics and performance of the pump. Data shall include guaranteed performance curves, based on actual shop tests of similar units, which show that they meet the specified requirements for head, capacity, efficiency, NPSHR, 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 no flow at shut off head to pump capacity at minimum specified total head.

4. Data including principle dimensions, materials of construction, space required, clearances, piping and electrical connections and requirements, controls, type of finish, installation instructions and other pertinent information.

5. A complete total bill of materials of all equipment including the weights of equipment furnished.

6. A list of the manufacturer's recommended spare parts, with the manufacturer's current price for each item shall be supplied in accordance with Section 01730. Include gaskets, packing, etc., on the list. List bearings by the bearing manufacturer's numbers only.

7. Complete motor data, including the following:

   a. Manufacturer.

   b. Rated full load horsepower.

   c. Rated volts.

   d. Number of phases.

   e. Frequency in hertz.

   f. Locked rotor amperes (LRA) at rated voltage or NEMA code letter.

   g. NEMA design letter.

   h. Bearing type.

   i. Service Factor.

   j. Nominal speed at full load.

   k. Full Load Amperes (FLA).

   l. Efficiency at ½, ¾ and full load.

   m. Power factor at no load, ½, ¾ and full load.

   n. NEMA insulation system classification.

   o. Corrosion duty rating.

   p. No load amperes.

   q. Safe stall time.

   r. Maximum guaranteed slip at full load.

   s. Motor manufacturer recommended maximum power factor correction capacitor KVAR.

t. Long term storage requirements for the motor.

8. Copies of all factory test results, as specified in PART 2 - PRODUCTS of this Section of the Specifications.

B. Submit detailed pump structural frequency analysis for the variable speed pump system:

1. The pump supplier shall provide an analysis of the vertical variable speed pump system to ensure that no damaging critical or resonant frequencies or multiplies of resonant frequencies occur from 20% above or below the proposed speed range necessary for the pump to meet the specified operating conditions. If the critical or resonant frequency for any of the vertical variable speed pumps is 20% above or below the proposed speed range necessary for the pump to meet the specified operating conditions, then it is the pump manufacturer's responsibility to correct the critical or resonant frequency to within the specified range.

2. A computer program shall be used to generate the pump structural natural frequencies based on a comprehensive procedure. This procedure shall be applicable for vertical pumps.

3. The frequency analysis shall include but not be limited to:

a. The combined rotational stiffness of the discharge head flange, discharge head flange bolting, base plate/sole plate, and anchor bolting of a vertical pump.

b. The rotational dynamics of the motor.

4. The analysis shall be performed and certified by a registered professional engineer and calculations shall be provided to the Engineer with submittal data. The registered professional engineer shall certify the pump when operating from 70% full speed to 110% full speed does not come within 20% of the first or second critical harmonic speed.

C. Additional Information

1. In the event that it is impossible to conform to certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

2. Upon receipt and review of submitted material, provide the required number of certified prints and one reproducible tracing of all Drawings as specified in Section 01340: Shop Drawings, Working Drawings and Samples.

1.04 OPERATIONS AND MAINTENANCE DATA

A. Operating Instructions

1. Operating and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cut sheets, drawings, equipment lists, descriptions, etc., that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Section 01730: Operating and Maintenance Data.

2. A factory representative of all major component manufacturers, 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. With the Owner's permission, this work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3 - EXECUTION. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.05 PRODUCT 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 units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged storage 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. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted thereto.

E. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

F. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

G. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.06 TOOLS AND SPARE PARTS

A. One (1) set of all special tools required for normal operation and maintenance shall be provided, including, at a minimum, one (1) spanner wrench. All such tools shall be furnished in a suitable steel tool chest complete with lock and duplicate keys.

B. The manufacturers of the equipment specified herein shall furnish a complete set of recommended spare parts necessary for the first five (5) years of operation of the pumping system. Additional spare parts to be furnished where required, are listed in the respective paragraphs of PART 2 PRODUCTS. The high-pressure pump manufacturer shall provide at a minimum the following spare parts:

1. Two (2) full sets of wear rings and bearings for the pump model.

2. Two (2) spare complete mechanical seal kits for the pump model.

3. Two (2) sets of gaskets and O-rings for the pump model.

4. One year supply of each type of lubricant required.

1.07 WARRANTY AND GUARANTEES

A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for one (1) year, commencing at the time of final acceptance by the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. The pumping units required under this section shall be complete including proper alignment and balancing of the individual units. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the service to be performed. Ample room for inspection, repairs and adjustment shall be provided.

B. The discharge head for the pump shall be rigidly and accurately anchored into position. All necessary anchor bolts, nuts and washers shall be furnished by the pump manufacturer for installation by the contractor. Anchor bolts, nuts and washers shall be Type 316 stainless steel.

C. Stainless steel nameplates giving the name of the manufacturer, the rated capacity, head, speed and all other pertinent data shall be attached to the pump and motor.

D. The pumping unit and its driving equipment shall be designed and constructed to withstand the maximum turbine run-away speed of the unit due to backflow through the pump with the maximum TDH specified available at the pump discharge flange.

2.02 MATERIALS AND EQUIPMENT

A. General

1. The pumps shall be of the water lubricated, open line shaft, vertical turbine type suitable to pump raw water to which a scale inhibitor and sulfuric acid have been added to produce a pH as low as 5.0. All high pressure pumps will be equipped with variable frequency drives.

2. The pumps shall be standard dimensions such that parts will be interchangeable between like units and all units shall be supplied by the same manufacturer. The entire pumping unit including the discharge head, column piping, bowl assembly and suction bell shall be pickled and passivated following fabrication.

B. Performance Requirements

1. When operating at the design output speed of its squirrel cage induction motor, the pump shall have a characteristic performance curve which meets all the minimum conditions listed in Table 11215-B. The pumps and drive motors shall be capable of operating satisfactorily under the full range of conditions as defined by Table 11215-B. The design pump capacity, head and efficiency defined in Table 11215-B shall be the "design point". Pump efficiency as defined herein takes into consideration all losses from the pump intake suction bell to the pump discharge flange. Pumps shall meet Hydraulic Institute acceptance level 1U (0% negative deviation) for capacity and the design head condition.

2. There shall be no significant change in vibration and noise level per the Hydraulic Institute standards over the entire listed range of flow for the pumping system.

3. The pump "design speeds" shall be the motor output speed when operating at the pump design capacity and head.

4. With the pumping units operating at full motor speed, the maximum brake horsepower required by the pumps shall not exceed the maximum horsepower listed in Table 11215-B. If the high pressure pumping units require more than the maximum horsepower listed in Table 11215-B at the motor output shaft at any full motor speed operation point between shut-off and primary discharge head, they will be rejected.

5. Certified Factory Tests

a. The pumps shall be given a complete third party witnessed performance test to include head/capacity, H.P., and efficiency to prove that the

pumps supplied conform to the requirements of this Specification. The test data shall be submitted on an 8-1/2-inch by 11-inch sheet at as large a scale as is practical. Four copies of the approved pump test curves laminated in plastic shall be provided to the Owner. The curves shall be plotted from no flow at shut off head to maximum flow at minimum head specified. No shipment of the pumps is to be made until after the Engineer's approval of the testing is obtained. The pump performance tests shall use a factory-calibrated motor. The pump motor supplied shall be short commercial tested at the motor manufacturer's facility and the test results provided prior to shipment.

b. Factory Acceptance Test Requirement: Before shipping of any equipment from the pump manufacturer's factory to the job site, the new high-pressure pump will be required to go through a minimum one (1) hour third party witnessed factory test in which the unit is to be tested at the pumps full operational speed to demonstrate proper performance at the design flow rate and total developed head (TDH) as specified herein.

c. In addition to the criteria above, the pump manufacturer shall have power-metering instruments in-place for continual monitoring of 480 volt, 3-phase, 60 Hertz power draw on the pumping unit. The manufacturer must demonstrate during the entire factory test that the hydraulic efficiency requirements are in complete compliance with this Section. Failure of the pumping equipment to meet the efficiency requirements will be grounds for failing the factory test. Monitoring of vibration shall be provided by the manufacturer during performance testing in accordance with Hydraulic Institute standards. Excessive vibration will be grounds for failing the factory test.

C. Pump Construction

1. Discharge Head

a. The discharge head shall be 316L SS construction, with a 300# ANSI raised face flange on the pump discharge connection and 150# raised face flange at the head to barrel connection, designed for above ground discharge. The head shall support the driver with a machine rabbet fit for alignment. Vibration limits will be per Hydraulic Institute standards. The head shall be fitted with a cartridge type mechanical seal, Type 8B-1, single, inside balanced with tungsten carbide on ceramic sealing face with a flushing connection. The seal shall be designed for maximum discharge pressure at shut off and adjustable externally from the pump. The gland and shaft sleeve shall be 316 SS. The headshaft shall be 316 SS, and coupled to the motor shaft with a spacer type, adjustable flanged coupling, to facilitate easy removal and replacement of the seal.

b. The discharge head for the pumps shall be furnished with an ANSI flat face base flange for mounting to the pump can flange. A suitable rubber "O" ring gasket shall be furnished to provide an airtight seal between the flanges. The O-ring shall fit in a groove in the pump can mounting flange. The discharge head shall also be provided with a vent connection to serve as a suction vent for pump can.

c. Pump discharge shall be piped with stainless steel fittings and tube pipe to direct pump pressurized water to pump seals for flushing.

d. Following fabrication and prior to pickling and passivation the discharge head shall be bead blasted to provide a smooth and uniform finish.

e. Design columns, bowls and discharge heads for 150% of the pump shutoff pressure. Hydrostatically test columns, bowls and discharge heads at 150% of the pump shutoff pressure.

2. Column Assembly

a. Column Pipe

The discharge column to be furnished under these specifications shall be as specified in Table 11251-A.

The discharge column shall be furnished in interchangeable sections not over ten (10) feet in length and shall be coupled with flanged couplings.

b. Line Shaft Bearings

The column assembly bearing guides shall be aligned by rabbet bits and clamped between the column flanges. Each bearing guide shall contain a ground carbon, self-lubricating bearing, integral with the column. Bearing spacing shall be selected to insure operation at a minimum of 15% minus the critical speed.

c. Line Shaft

The line shaft shall be as specified in Table 11215-B. Diameter will be sized to conform to AWWA E103, latest revision, specification for required horsepower. It shall be of ample size to operate the pump without distortion or vibration and shall be capable of carrying the maximum horsepower that may be generated by the motor. The butting ends shall be machined, faced and recessed square to the axis of the shaft. To ensure accurate alignment, the shaft shall be straight within 0.003 inches total indicator reading over the total shaft length. The length of the shaft shall be such as to match properly the length of the

discharge column. Circular keys to carry thrust load and longitudinal keys to transmit torque shall be provided.

3. Bowl Assembly

a. General

1) Pump bowls, suction and discharge cases shall be without imperfections, accurately machined and fitted to close dimensions and as specified in Table 11215-A.

2) Impeller shaft shall be of sufficient diameter to transmit the pump horsepower with a liberal safety factor and rigidly support the impellers between the bowl or case bearings. The impeller shaft material shall be as specified in Table 11215-A.

b. Vertical Turbine Pumps

1) The suction case and intermediate bowls shall be fitted with replaceable lateral wear rings. Wear rings shall have the minimum practical clearance to the mating cylindrical surface of the impeller to provide adequate sealing to restrict the leakage of flow at the impeller skirt independent of vertical positioning of the impellers. The impeller shaft shall be supported in the bowl by a graphitar bearing.

2) The suction bowl shall have a graphitar or Vesconite, self-lubricating, bearing positioned in a housing supported by four vanes. The discharge case shall have vanes to deliver the flow of water with minimum turbulence.

3) Impeller shall be of the enclosed type, machined, perfectly balanced mechanically and hydraulically, and filed for optimum performance and minimum vibration. The design shall be non-overloading for the capacity of the motor selected. The impeller shall be double keyed to the impeller shaft.

D. Motors

1. General:

a. The motors for the pumps shall be of the vertical solid shaft squirrel cage induction type. The motor shaft shall have a 0.001-inch total indicated run out.

b. Motors must be designed to accept all upthrust loads imposed by pump during starting and running.

c. All motors shall be built in accordance with latest NEMA, IEEE, ANSI and AFBMA standards where applicable.

d. Motors shall conform to all requirements stipulated in PART I GENERAL of this Section of the Specifications unless modified in this paragraph.

2. Performance Requirements

a. Motors shall be rated 460 volts, 3 phase, 60 Hertz.

b. Motors shall be inverter duty for use with variable frequency drives Motor nameplates shall read “Inverter Duty Rated”.

c. Motors shall have horsepower, full load output speed ratings and efficiencies as listed in Table 11215-B.

d. Motors shall be free of objectionable noise and vibration. Vibration level measured on the bearing housing shall be in accordance with values shown in NEMA and Hydraulic Institute Standards.

e. Speed: As shown in present specification.

f. Service factor: 1.15 for all motors.

3. Design Type:

a. Provide 3 phase, 480 volts, NEMA Design B, induction motors.

b. Acceleration NEMA time: If the calculated acceleration time of the combined motor and driven load exceeds 3 seconds at 90% of rated voltage, request review by the Engineer. Do not proceed with manufacturing without approval.

c. All induction motors shall have squirrel cage rotors.

4. Motor Insulation and Winding:

a. Class: Use a class F insulation with temperature rise of Class B or better, meeting the requirements of NEMA MG 1 and made of non-hygroscopic materials. The insulation shall be manufacturer’s premium grade, resistant to attack by moisture, acids, alkalies, and mechanical or thermal shock for 480-volt motors.

b. All insulated winding conductors shall be copper.

c. Motors shall be inverter duty rated for use with variable frequency drives. Insulation for inverter duty motor shall meet or exceed the Pulse Endurance Index for magnetic wire and shall not be damaged when exposed to repeated pulse type wave forms, repetitive high voltage transients, switching frequency and rate of rise the pulse. All bearings on the non-drive end shall be insulated and the drive end bearings shall be provided with shaft ground rings.

5. Enclosure:

   a. Use enclosure type as follows:

      i. WP-I design.

      ii. Motor frames and end shields shall be heavy fabricated steel on such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed. Openings for ventilation shall be uniformly spaced around the motor frame.

      iii. Motors shall have drain openings and plugs suitably located for the type assembly being provided.

6. Space Heaters:

   a. Provide space heaters in all motors

      i. Use heaters hermetically sealed in stainless steel or equivalent corrosion-resistant sheaths.

      ii. Heaters shall be rated for 240V, but will be operated at 120 volts.

      iii. Braze heat-resistant insulated leads to the heater or supply heater with brazed leads and extend to the conduit box.

7. Paint:

   a. Shall be severe duty and shall have an epoxy coating per IEEE 841.

8. Motor Efficiencies:

   a. Motors shall be of the NEMA premium efficiency type. Efficiency values shall be based on tests performed in accordance with IEEE Publication No. 112, Method B. Motors with horsepower or rpm's not listed shall conform to comparable standards of construction and materials as those for listed motors.

   b. Motor shall be severe duty rated for industrial application.

9. Noise and Vibration:

   a. Motors shall be free of objectionable noise and vibration. Vibration level measured on the bearing housing shall be in accordance with values shown in NEMA and Hydraulic Institute Standards.

10. Conduit Box:

   a. Provide motor with a conduit box amply dimensioned for the motor lead terminations, include a grounding lug. Supply a gasket suitable for the motor enclosure type and application.

   b. Provide an oversized box to facilitate wiring terminations. Oversized terminal box shall have a volume greater than or equal to the next standard NEMA size box.

11. Additional Requirements:

   a. 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.

   b. Stator cores shall be made of low loss, non-aging electrical sheet steel with insulated laminations.

   c. Stators shall be random wound and insulated with glass and mica applied directly to the coils. Motors shall have a Class F rise non-hygroscopic epoxy sealed or encapsulated insulation system limited to the temperature rise specified in 2.02.E.2.e. All connections shall be silver soldered with no crimp connections used except for terminals. A coil bracing system for stator end turns shall be utilized to minimize coil movement during starting and running conditions.

   d. Rotors shall be made from high grade steel laminations adequately fastened together, and to the shaft. Rotor squirrel cage may be of cast-aluminum or copper alloy bar-type construction with brazed end rings.

   e. Bearings shall be grease lubricated antifriction type with an AFBMA average bearing life of 20 years. Bearing design shall include over-grease protection. Bearings shall include isolators for protection against stray current that can be generated by inverters.

   f. The motor thrust bearing shall have ample capacity to carry the weight of all the rotating parts plus the hydraulic thrust of the pump impellers, and have an ample safety factor. This factor should be based on an average life expectancy of five years operation at 24 hours per day.

g. All motors shall have an interior coating of chemical resistant corrosion and fungus protective coating on all interior surfaces. Exterior prime coating shall be compatible with the field applied finish coating.

h. Nameplates shall be stainless steel.

i. Lifting lugs or "O" type bolts shall be supplied on all motors capable of supporting the weight of the motor. Enclosures shall have stainless steel screen and shall be protected against corrosion, fungus and insects.

j. All fittings, bolts, nuts and screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads.

m. The main terminal box shall be NEMA 12 and provide ample room for connections.

n. Motors shall be provided with a non-reverse ratchet coupling assembly.

o. Bearings shall be grease lubricated antifriction type with an with an AFBMA average bearing life of 20 years. Bearing design shall include over-grease protection and platinum RTDs (100 ohm) on the thrust bearing.

12. Tests

a. All motors shall be completely assembled at the factory and shall be given routine tests conducted in accordance with NEMA Standards LUG1-20.46 and MG1-20.47 which includes the following non-witnessed tests:

i. No load current.
ii. Winding resistance.
iii. High potential dielectric tests.
iv. Bearing inspection.

b. Copies of the test results for the motor shall be certified by a responsible test engineer. The test results shall be furnished to the Engineer for review before shipment of the motors as required by Paragraph 1.03.

E. Pump and Motor Coupling Guard

1. Provide a coupling guard on the pump base to prevent personal injury from the rotating pump and motor coupling. The guard shall be manufactured of stainless steel heavy wire fabric or expanded metal and shall comply with all applicable OSHA requirements. The guard shall be bolted, hinged or screwed to the pump base with stainless steel bolts and nuts or screws and shall be easily removable for access to the pump and motor coupling.

F. Suction Vessel

1. The pumps shall be installed in the existing suction vessel (can) as shown on the process mechanical Drawings.

2.03 ACCESSORIES

A. Gauges

1. The pump shall be equipped with a discharge pressure gauge. The pressure gauge shall be mounted on the pump discharge piping with the centerline of the gauge tap on the centerline of the pump discharge. High and low pressure switches shall be placed as shown on the process diagrams.

2. Gauges for the pumps shall be as specified in Section 13615: Process Instrumentation and Controls Products.

3. Gauges shall be equipped with a surge suppression snubber and diaphragm seals. Each gauge shall be equipped with a lever handle gauge cock and union.

4. Connection of the gauges to the pressure taps in the pump discharge shall be with screwed stainless steel pipe neatly installed with straight runs and right angle bends.

B. Stator Accessories:

1. Winding Thermal Protection:

a. Resistance Temperature Detectors:

(i) All motors shall be provided with replaceable 100 ohm platinum stator RTD's.

(ii) Six (two each phase) positioned to detect highest winding temperature and located between coil sides in stator slots.

(iii) RTD leads brought to conduit box separate from motor terminal box, together with bearing RTD leads.

2. Bearing Temperature Protection:

a. Replaceable 100 ohm platinum on the thrust bearing of motor.

(i) RTD leads brought to conduit box separate from motor terminal box, together with winding RTD leads."

C. Fasteners: All pumps and column fasteners shall be of Type 316 stainless steel.

PART 3 - EXECUTION

3.01 MONITORING AND QUALITY CONTROL:

A. The Contractor is responsible for coordinating with the supplier of equipment under this section and the I&C System Supplier to ensure that the equipment is compatible with and provides all necessary ancillary and accessory equipment to accept control signals provided by the SCADA system and provide monitoring and feedback signals to the SCADA system. This shall include all equipment control switches, flow detection switches, motor winding temperature switches and position switches that are mounted on or adjacent to the equipment for monitoring the performance of that piece of equipment. This shall also include all relays, transmitters, dry contacts and termination switches that are required on, adjacent to or in control panels supplied by the equipment vendor that are necessary to interface with the PLC/SCADA control system.

B. Functional Tests: Conduct on the pump.

1. Alignment: Test compete assemblies for correct rotation, proper alignment and connection, and quiet operation.

2. Flow Output: Measured by plant instrumentation and storage volumes.

C. Performance Test: In accordance with Hydraulic Institute Standards.

D. Perform Manufacturer and Supplier product quality control specifics as required for this project.

3.02 INSTALLATION

A. Installation shall be in strict accordance with the Manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the Manufacturer's recommendations. Anchor bolts shall be set in accordance with the Manufacturer's recommendations.

B. The Contractor shall submit a certificate from the equipment manufacturer stating that the installation of the 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 the unit.

C. All exposed portions of the pumps and motors shall be shop primed and painted in accordance with Division 9.

D. The Contractor shall make all electrical connections to equipment specified. Installation shall be made in compliance with manufacturer's recommendations and the Contract Drawings. If the Contract Drawings or drawings and recommendations from the

Manufacturer are not available then installation shall proceed according to the best electrical industry and trade practice.

E. Properly install and align motors in the locations shown, except motors which are factory mounted on the driven equipment. When the motor an equipment are installed, the nameplate must be in full view.

3.03 INSPECTION AND TESTING

A. General

1. The pump equipment manufacturer shall furnish the services of a competent and experienced representative who has complete knowledge of proper operation and maintenance of the equipment to inspect the installed equipment, supervise the initial test run, and to provide instructions to the plant personnel. The first visit will be for checking and inspecting the equipment after it is installed. The second visit will be to operate and supervise the initial field test. At least two (2) days shall be allocated solely to the instruction of plant personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten days in advance with the Owner and shall take place prior to plant start-up and acceptance by the Owner. The final copies of operation and maintenance manuals specified in Section 01730: Operation and Maintenance Data must have been delivered to the Engineer prior to scheduling the instruction period with the Owner. With the permission of the Engineer, these services may be combined with those provided under Paragraph 1.03.C.

2. Field tests shall not be conducted until such time that the entire installation is complete and ready for testing.

3. The Contractor shall provide the services of a qualified third party vibration consultant to measure critical frequencies of the installed equipment and measure total vibration of the units. The results shall be furnished to the Engineer in accordance with shop drawing requirements.

B. Pumps

1. After all pumps have been completely installed, and working under the direction of the Manufacturer, conduct in the presence of the Engineer, such tests as are necessary to indicate that the pumping system operates satisfactorily and generally meets the conditions of service specified. The factory witnessed tests are the basis of equipment efficiency demonstration, the field test shall demonstrate correct mechanical operation after pump start-up. Field tests shall include all pumps included under this section. Supply all labor, equipment and incidentals required to complete the field tests.

2. If the pump performance does not meet the Specifications, corrective measures shall be taken or pumps shall be removed and replaced with pumps which satisfy the conditions specified. A 24-hour operating period of the pumps will be required before acceptance.

3. Stainless steel pumping units shall show no signs of corrosion upon acceptance by the Owner.

C. Motors

1. General: Provide all necessary instruments, labor and personnel required to perform motor inspection and testing.

2. Inspection: Inspect all motors for damage, moisture, alignment, freedom of rotation, proper lubrication, oil leaks, phase identification and cleanliness, and report any abnormalities to Engineer before energizing.

3. Energizing: After installation has been thoroughly checked and found to be in proper condition, with thermal overloads in motor controllers properly rated and all controls in place, energize the equipment at system voltage for operational testing.

4. As a part of the testing procedure, the Contractor shall prepare a card for the motor, installed on this contract. After the motor has been run to operating temperature, the motor shall be shut down and an insulation resistance measurement shall be made, using a megohmmeter. Make the test immediately after shutdown. Record megohmmeter reading and winding temperature. Correct reading of insulation resistance to 40° C/104°F. Insulation resistance in megohms, corrected to 40° C, shall be at least equal to one (1) megohm for each 1000 volts applied.

5. The Contractor shall check all motors for correct clearances and alignment and for correct lubrication in accordance with Manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections if necessary.

3.05 START-UP AND INSTRUCTION

A. Manufacturer's Representative: Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. Two (2) person-days for installation assistance and inspection. No less than a total of two (2) person-days of installation assistance.

2. Two (2) person-days for functional and performance testing and completion of Manufacturer's Certificate or Proper Installation and pre-startup classroom or

site training. No less than a total of two (2) person-days of functional and performance testing.

B. See Section 01650 - Start-Up.

TABLE 11215-A

MATERIALS OF CONSTRUCTION

Component	Material
	RO Feed Pumps
Discharge Head	316 SST
Bowls/Adapters	316 SST
Impellers	316 SST
Pump (Line) Shaft	316 SST
Suction/Bowl Bearings	Graphalloy
Barrel (ASTM A790)	Existing
Column (ASTM A790)	316 SST
Coupling Guard	316 SST
O-Rings	Buna-N

TABLE 11215-B

PUMPING UNIT DESIGN REQUIREMENTS

Item/Design Conditions	RO Feed Pumps
Pump Tag Number	HPP-0603 HPP-0604
Pump Type	Multi-Stage Vertical Turbine
Pump Sizing	One (1) unit per RO skid
Maximum Motor Full Load Speed (rpm)	1,800
Pump Design Speed (rpm)	1,780
Maximum Motor to be Supplied (hp)	300
Motor Type	TEFC
Motor Drive	Variable Frequency
Maximum Stages	7
Pump Column Diameter (inches)	10
Discharge Size, (inches)	10
Discharge Connection Flange Type	ANSI 300 Class
Suction Pressure (psi)	15-20
Design Capacity per Pump (gpm)	1,750
Total Design Head (feet)	530
Shut-Off Head (feed), minimum	714
Minimum Pump Efficiency at Design (%)	81
Pressure Gauge Range (psi)	0-300

* Design requirements shall be coordinated with membrane OEM furnished design of Reverse Osmosis System. TDH may vary based on skid design configuration selected.

END OF SECTION

SECTION 11217

VERTICAL IN-LINE CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: Furnish all labor, materials, equipment and incidentals required to provide, install, test, complete and ready for operation two (2) vertical, in-line, centrifugal pumps as specified herein and shown on the Drawings.

B. **Bid Alternate: Furnish all labor, materials and equipment and incidentals required to provide, install, test, complete and ready for operation the pre-degasification carbon dioxide feed system, which includes an additional two (2) vertical, in-line, centrifugal pumps as specified herein and shown on the Drawings.**

B. Related Work Described Elsewhere:

1. Section 01340: Shop Drawings, Working Drawings and Samples

2. Section 01600: Material and Equipment

3. Section 01650: Start-Up and Demonstration

4. Section 01730: Operating and Maintenance Data

5. Section 01740: Warranties and Bonds

6. Section 03300: Cast-in-Place Concrete

7. Section 09961: High Performance Paints and Coatings (except as specified herein)

8. Division 15: Mechanical piping, valves, pipe hangers, and supports

9. Division 13: Instrumentation and Controls

10. Division 16: Electrical work and motors (except as hereinafter specified)

C. General Design:

1. Four (4) carbon dioxide booster pumping units are required for this contract. The pumps shall be located and arranged as shown on the Drawings.

2. General design information is provided in Table 11217-A.

3. All working parts of identical pumps and motors, such as bearings, wearing rings, shaft, sleeves, motors, etc., shall be of standard dimension built to limit gauges or formed to templates such that parts will be interchangeable between like units and such that the Owner may at any time in the future obtain replacement and repair parts for those furnished in original machines. All parts shall be properly stamped for identification and location in the machines as shown on the Operation and Maintenance manuals furnished.

4. All equipment, coatings, and materials that come in contact with drinking water shall comply with ANSI-NSF Standard 61, and the manufacturer shall provide documentation to demonstrate compliance.

1.02 QUALITY ASSURANCE

A. To assure unit of responsibility, the motors shall be furnished and coordinated by the pump manufacturer. The Contractor shall assume full responsibility for the satisfactory installation and operation of the entire pumping system including pumps and motors.

B. The pumps covered by these Specifications are intended to be standard pumping equipment of proven ability as manufactured by a reputable manufacturer having extensive experience in the production of such pumps. The pumps furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactory when installed. Pump shall be manufactured in accordance with the Hydraulic Institute Standards.

C. All equipment furnished under this Specification shall be new and unused and shall be the standard product of manufacturers having a successful record of manufacturing and serving the equipment and systems specified herein a minimum of five (5) years.

1.03 SUBMITTALS:

A. Materials and Shop Drawings

Copies of all material required to establish compliance with the Specifications shall be submitted in accordance with the provisions of the General Conditions and Section 01340: Shop Drawings, Working Drawings and Samples. Submittals shall include at least the following:

1. Certified dimensional shop and erection drawings of each item of equipment and auxiliary apparatus to be furnished, showing all important details of construction, dimensions, and anchor bolt locations, plans and details.

2. Certified sectional drawing of pumping unit with part numbers and material specifications.

2. Manufacturer's literature and illustrations, bulletins, and/or catalogs of the equipment.

3. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves, based on actual shop tests of similar units, which show that they meet the specified requirements for head, capacity, efficiency, NPSHR, 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 no flow at shut off head to pump capacity at minimum specified total head.

4. Data including principle dimensions materials of construction, space required, clearances, piping and electrical connections and requirements, controls, type of finish, installation instructions and other pertinent information.

5. A complete total bill of materials of all equipment including the weights of equipment furnished.

6. A list of manufacturer's recommended spare parts in addition to those specified in Paragraph 2.03, with the manufacturer's current price for each item. Include gaskets, packing, etc., on the list. List bearings by the bearing manufacturer's numbers only.

7. Complete motor data, including temperature switch information and wire termination diagrams. The following data shall be provided on the drive motors: rpm at full load, frequency, voltage, full load current, code and design, letter, efficiency, horsepower, number of phases, time rating, temperature rise, service factor, service duty, and bearing life rating. The submittal shall include motor manufacturer's recommended lubrication requirements.

8. Copies of all factory test results, as specified in PART 2 – PRODUCTS of this Section of the Specifications.

B. Additional Information

1. In the event that it is impossible to conform with certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

2. Upon receipt and review of submitted material, provide the required number of certified prints and on reproducible tracing of all Drawings as specified in Section 01340: Shop Drawings, Working Drawing and Samples.

C. Operating and Maintenance Instructions

1. Operating and maintenance manuals shall be furnished. 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 operation and maintenance personnel unfamiliar with such equipment. The number of copies and special requirements shall be as specified in Section 01730: Operating and Maintenance Data.

2. A factory representative of all major component manufacturers, 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 test run as provided under PART 3 – EXECUTION. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

D. Certifications: Furnish certifications as specified in Section 01650: Start-Up and Demonstration. Furnish the Engineer with a written certification signed by the manufacturers' representative that the installed equipment:

1. Has been properly installed per the manufacturer's requirements.
2. Has been lubricated per the manufacturer's instructions.
3. Has been accurately aligned and proper running clearances set.
4. Is free from undue stress imposed by piping or mounting bolts.
5. Is ready to be operated on a continuous basis, and is free from any known defects.

1.04 PRODUCT 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 complete and the units 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.

C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

D. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted thereto.

E. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

F. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage, and handling.

G. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.05 WARRANTY AND GUARANTEES:

A. Provide equipment warranty as specified in Section 01740: Warranties and Bonds.

PART 2 - PRODUCTS

2.01 EQUIPMENT GENERAL REQUIREMENTS

A. Pump curves shall be continuously rising and shall be free of dips and valleys from the design point to the shut-off head.-off head.

B. Material Service Requirements: Pumps and all related equipment shall be constructed of materials suitable for the intended applications.

C. All parts shall be so designed and proportioned as to have liberal strength and stiffness, and to be especially adapted from the work to be done. Ample room and facilities shall be provided for inspection, repairs, and adjustment.

D. Data Plates:

1. All data plates shall be of stainless steel suitably attached to the pump with stainless steel screws. Pump data plates shall contain the manufacturer's name, pump size and type, serial number, speed, impeller diameter, design capacity and head, and any other pertinent data.

2. Motor data plates shall contain the manufacturer's name and model number, serial number, horsepower, speed, frequency, voltage, phase, efficiency, service factor, and all other pertinent data attached to each motor.

E. Hardware: All machine bolts, nuts and cap screws shall be of the hex head type 316 stainless steel (18-8). Hardware requiring special tools or wrenches shall not be used.

F. Parts Numbering: Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Identical parts for separate units shall have the same number.

G. The nameplate ratings for the motors shall not be exceeded, nor shall the design service factor be reduced when its pump is operating at any point on its characteristic curve at maximum speed.

F All pumps shall be designed and built for 24-hour continuous service at any and all points within the specified range of operation, without overheating, without cavitation, and without excessive vibration or strain. All pumps shall be designed for outdoor service.

G. Miscellaneous Parts: The equipment shall be furnished with shims, stainless steel anchor bolts, couplings, motor flanges, and any other miscellaneous materials necessary to properly mount and install pump and motor.

H. Painting: All external parts of the pump, motor, drive unit, base, and accessories shall be primed and finish painted (1 coat) at the factory prior to shipping. Surface preparation, priming and finish coating shall be in accordance with Section 09961: High Performance Paints and Coatings. All coatings used for shop painting shall be the products of the same manufacturer as the coating to be used for field painting to assure coating compatibility. Color of finish coating shall be medium gray. All coatings that come into contact with pumped water shall be suitable for potable water services as approved by the National Sanitation Foundation (NSF) 61.

G. The pumps shall be standard dimensions such that parts will be interchangeable between like units and all units shall be supplied by the same manufacturer.

2.02 VERTICAL IN-LINE PUMP

A. General: Pumps shall be of the vertical, in-line, centrifugal, single stage design for outdoor installation. Design shall comply with ANSI B73.2M, except as modified herein. Pumps and motors shall be close coupled. Provide a design for which the motor support or stand is bolted onto the pump casing. Provide a bearing frame or housing to contain both the radial and thrust bearings. The pumps shall be of standard dimensions; built to limit gauges or formed to templates, such that parts will be interchangeable between like units.

B. Performance Requirements:

1. When operating at the output speed of the drive supplied, each pump shall have a characteristic performance curve which meets all the minimum conditions listed in Table 11217-A. The pumps and motors shall be capable of operating satisfactorily under the full range of conditions defined.

2. Maximum motor speeds shall not exceed those listed in Table 11217-A to satisfy the specified hydraulic duty requirements.

3. The maximum brake horsepower required by the pumps shall not exceed the maximum horsepower listed. If the pumping units require more than the maximum horsepower listed at the motor output shaft at any full speed operation point between shut-off and secondary discharge head, they will be rejected.

C. Pump Casing

1. The pump casings shall be volute type casing designed for the type of service herein specified and be constructed of materials shown in Table 11217-B.

2. The design pressure of the casing, including the stuffing box and gland, shall be at least as great as the pressure-temperature rating of ANSI B16.1, Class 125 flanges. Design casing and cover to withstand a hydrostatic test of one and one-half times the maximum design pressure for the pump, or twice the pump

shutoff head, whichever is greater. Casings shall be fitted with the appropriate size ANSI Class 125 flange connection.

3. The design shall permit removal of the rotating elements from the top of the casing without disturbing the suction and discharge connections or the pump driver a through back pullout assembly. Provide threaded (ANSI B1.20.1) drain connections in the bottom of the casing. Provide threaded (ANSI B120.1) tapped openings for lantern ring connections, stuffing box drain, and casing drain. Minimum connection or outlet size shall be ¼ inch. Support the pump by a cast iron casing support.

4. Casing and gland shall have a corrosion allowance of at least 1/8 inch.

D. Suction and Discharge Connections

Suction and discharge connections shall be flanged, ANSI B16.1, Class 125. Flanges shall be flat faced. The suction and discharge flanges shall be located on a common center line 180 degrees apart for mounting in-line. Bolt holes shall straddle the horizontal and vertical centerlines.

E. Pump Impellers

1. The pump impeller shall be of the open or closed type manufactured of material listed in Table 11217-B and shall be statically and dynamically balanced to prevent whipping and vibration throughout the operating range, from shutoff head to run out. The pump manufacturer shall be fully responsible for the vibration-free operation of the pumping unit throughout the entire operating range. No fillers of any type will be allowed.

2. The impeller shall be securely fastened to the shaft by means of a threaded connection or an impeller key and screw. Provide shaft and sleeve design such that the sleeves tighten with the rotation of the shaft. The shaft sleeve shall extend the length of the seal box.

F. Wear Rings (Casing and Impeller)

1. Each pump casing and impeller shall be fitted with removable wearing rings. The wear rings shall be constructed of material listed in Table 11217-B.

G. Pump Shaft

1. The pump shaft shall be constructed of material listed in Table 11217-B having an impeller extension and accurately machined.

2. The pump shaft shall be protected from wear by a corrosion and wear resisting hardened stainless steel shaft sleeve having a 400 minimum brinell hardness. Shaft deflection shall be no greater than 0.002-inch through stuffing box with pump running at design condition and 0.002-inch at shut off condition.

G. Bearing Frame

1. Provide two antifriction-bearing assemblies. One assembly shall be free to float within the bearing housing assembly to carry radial thrust only. The other assembly shall be designed to carry both radial and axial thrust. Bearings subject to radial thrust only shall be single row. Bearings subject to both radial and axial thrust shall be double row. All bearings shall be designed for a minimum 100,000 hours calculated minimum L10 rated bearing life at 25% BEP per ANSI/HI 1.3-2013.

2. All bearings shall be accessible while the pump is in operation. Bearings shall be easily removable without disturbing any part of the pump other than the bearing caps. The bearings shall be grease lubricated and a relief shall be provided so that excessive grease pressure will not damage the bearings.

3. For protection of bearings during shipment and installation, the bearings shall be properly protected with a high quality rust preventative grease. Each bearing frame shall be designed so that the complete rotating element can be removed from casing without disconnecting piping.

4. The bearing support frame shall be fabricated steel or cast iron construction and shall be designed to provide a self-centering and self-indexing fit with the wetted end of the pump to insure proper alignment of the bearings and stuffing box.

H. Mechanical Seal

1. The seal box shall be engineered specifically for double mechanical seals. The seal box shall be designed for the compressed seal length and shall not require any adjustments. The seal housing shall be extra long to provide excellent circulation of clear sealing liquid. The housing shall have one ½-inch tapped opening for the sealing water connection. Seal water piping shall be stainless steel connected to the pump discharge. The complete seal box shall be removable as an assembly.

2. The standard hardened stainless steel shaft sleeve design shall be provided with an o-ring.

3. The seal shall be of the end face, self cleaning type with non clogging springs, positive positioning and drive, precision lapped carbon primary ring and tungsten carbide mating rings, 316 stainless steel gland, Viton “O” rings and 316 stainless steel or Hastelloy C metal parts. Seal shall be Chesterton Model 886, John Crane or approved equal.

I. Pump Support

1. Each pump and motor shall be mounted on a fabricated steel casing support of sufficient size and strength to support all loads to which it may be subjected, as shown on the Drawings. The casing support shall be suitable to carry the entire weight of the supplied pump and motor unit.

2.03 PUMP MOTORS

A. The pump manufacturer shall be responsible for supplying the motor and shall ensure proper coordination for mounting of the motor on the pump. He shall properly select and size the drive unit for the pump inclusive of thrust bearing capacity for all conditions as start-up, runout, and shutoff. Motors shall meet the requirements of Section 16150: Motors unless otherwise specified herein.

B. The pump motor shall be a standard C face vertical motor. The motor shall be designed for continuous operation with a 460 volt; 3-phase, 60 Hertz power service; with a maximum speed shown in Table 11217-A.

C. The motors shall not be overloaded at any point on the driven pump's performance curve. The more shall be NEMA Design B, and shall be designed constructed and tested in accordance with applicable IEEE, NEMA, AFBMA and ANSI standards as manufactured by U.S. Electrical Motors, or an equal approved by the Engineer. Motors shall be given a short commercial test in accordance with IEEE standards and furnished with the following construction features before shipping to the pump manufacturer testing facility:

1. Construction: All cast iron construction for frame, end brackets, conduit box and fan shroud. Motors shall be supplied with lifting lugs or "O" type bolts on the top of the motor.

2. Enclosure: Total Enclosed Fan Cooled (TEFC) design with forced air circulation by integral fan.

3. Horsepower: Motor horsepower shall meet the requirements as specified in Table 11217-A.

4. Efficiency: Premium, 95 (minimum) percent at full load capacity.

5. Insulation: Class F

6. Temperature Rise: Class B based upon 40 degrees C ambient.

7. Service Factor: 1.15

8. Epoxy coated rotor and stator windings.

9. Motor windings for stator and rotor motor leads shall be manufactured using solid copper wire.

10. Shielded, regreasable, vacuum degassed steel ball bearings. Motor thrust bearings shall have ample capacity to carry the weight of all rotating parts plus the hydraulic thrust of the pump impellers with an ample safety factor. Minimum AFBMA B-10 bearing life of 100,000 hours.

11. Corrosion resistant hardware and grease plugs.

12. Gasket between motor frame and conduit box.

13. Gasketed cast iron conduit box.

14. Stainless steel nameplate fastened with stainless steel pins.

15. Accessories: Each motor shall be provided with a heat overload protection device to protect the motor from overheating during operation. Head overload protection shall be accomplished through temperature switches embedded in the motor windings that shall immediately stop the drive motor in the event of excessive heat buildup. Motor shall be provided with a 120-volt single phase strip heater to maintain a motor temperature of at least 40 degrees C, or 10 degrees C above ambient, whichever is greater.

16. Vibration and Sound limits: Vibration shall not exceed Hydraulic Institute Standards and sound pressure level shall not exceed 80 dbA at 5 feet under full load conditions in accordance with IEEE standard 85.

17. A grounding lug shall be provided in the conduit box.

2.04 ACCESSORIES

A. Lubricants: Pump and drive units shall be delivered with the equipment fully lubricated insofar as possible. If any point cannot be serviced, it shall be clearly marked to the effect that it is not lubricated and requires serving prior to operation. An adequate supply of proper lubricant, with instructions for its application, shall be supplied with the equipment for each point not lubricated prior to shipment.

B. Spare Parts: Furnish the recommended spare parts, properly boxed and labeled for each size and type of pump provided for the Project, as a minimum, the following:

1. One (1) set of gaskets for each pump.

2. One (1) set of mechanical seals for each pump.

3. One (1) shaft sleeve for each pump.

4. One (1) set of wear rings for each pump.

5. One (1) set of bearings for each pump.

6. One (1) set of pressure gauges.

7. Additional spare parts shall be provided in accordance with manufacturer's recommendation.

C. All special tools required for normal operation and maintenance shall be furnished with the equipment.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall be in strict accordance with the respective manufacturer's instructions and recommendations in the locations shown on the Drawings. Equipment shall be installed by experienced and mechanically skilled workmen with previous experience in similar installations. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

B. All necessary piping, fittings, valves, air relief valves, vents, concrete foundation, anchor bolts, grouting, etc. shall be provided to ensure a complete and satisfactory installation of the pumping equipment including pump, electric motor, electrical connections, and piping connections.

C. Hardware: All anchor bolts, nuts and washers shall be Type 316 stainless steel. All brackets and the hardware items shall be Type 316 stainless steel.

D. Install piping, fittings, valves and other appurtenances to the pump installation in accordance with the manufacturer's installation instructions, the requirements of referenced sections included with these specifications and as shown on the Drawings. Equipment shall be installed in a workmanlike manner so that individual equipment will function properly and freely and no individual parts shall be strained.

E. Pump bases shall be rigidly and accurately anchored into position, precisely leveled and aligned, so that the completed installation is free from stress or distortion. All necessary foundation bolts, plates, nuts, and washers shall be furnished and installed by the Contractor and shall conform to the recommendations and instructions of the equipment manufacturer. Anchor bolts shall be set by the Contractor in accordance with the manufacturer's recommendations. Grouting under bases after the equipment is set is included as work under this section. Pumps and pump bases shall have adequate provisions to collect drainage and conduct it away to the nearest drain.

F. Noise and Vibrations: all equipment containing moving parts shall be installed level and plumb, unless otherwise indicated in the Drawings or in the specifications; and shall be anchored securely in order that noise be suppressed to a minimum and that vibrations do not cause damage while in operation.

3.02 COATINGS

A. All exposed portions of the pumps and motors shall be shop primed, with primer compatible with field painting as specified in Division 9.

B. Gears, bearing 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 periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.

C. Field painting is specified under Painting: Section 09961: High Performance Paints and Coatings. The primer and paint used in the shop shall be products of the same manufacturer as the field paint to assure compatibility.

B. All nameplates shall be properly protected during painting.

3.03 FACTORY SERVICE REPRESENTATIVE

A. The equipment manufacturer shall furnish the services of a competent and experienced representative who has complete knowledge of proper operation and maintenance of the equipment for a period of not less than two 8-hour days in two separate visits to inspect the installed equipment, supervise the initial test run, and to provide instructions to the plant personnel. The first visit will be for checking and inspecting the equipment after it is installed. The second visit will be to operate and supervise the initial field test. At least four (4) hours of the second day shall be allocated solely to the instruction of plant personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten days in advance with the Owner and shall take place prior to acceptance by the Owner. The final copies of the Operation and Maintenance manuals specified in Section 01730: Operating and Maintenance Data must have been delivered to the Engineer prior to scheduling the instruction period with the Owner. See Section 01730 Operating and Maintenance Data for additional training requirements.

3.04 INSPECTION AND TESTING

A. After pump has been completely installed, the Contractor shall conduct, in the presence of the Engineer, testing of all mechanical equipment and piping as in operation to demonstrate capacity, correct alignment, smooth operation, proper adjustment, and freedom from noise, vibration, over-heating and leaking, and to ensure satisfactory compliance with the Specifications. All defects shall be corrected. The Contractor shall supply all oil, grease, electric power, water, and all other material necessary to complete the field tests.

B. If the pump performance does not meet the Specifications, corrective measures shall be taken by the Contractor, or pump shall be removed and replaced with a pump which satisfies the conditions specified.

C. Motor Field Testing: Motor shall be disconnected from the pump and run for four (4) hours. Following the run-in test, reconnect the motor to the pumping equipment and reinstall all coupling guards.

D. Pump Field Testing:

1. Upon completion of all the mechanical work, the Contractor shall conduct testing as specified herein to demonstrate that the equipment performs in accordance with all Specifications.

2. The Contractor shall perform initial testing of the equipment to ensure himself that the tests listed in the Demonstration Test paragraph below can be completed.

3. The Demonstration Test shall demonstrate that all items of these Specifications have been met by the equipment, as installed, and shall include the following tests:

   a. That the pump can deliver the specified pressure and discharge flow at rated efficiency.

   b. That the pump controls perform satisfactorily.

4. In the event that the equipment does not meet the Demonstration Test, the Contractor shall, at his own expense, make sure changes and adjustments in the equipment which he deems necessary and shall conduct further tests until written certification is received from the Engineer.

E. All piping, fittings and valves shall be hydrostatically tested in accordance with Section 15044: Pressure Testing of Piping.

F. All piping, fittings, and valves shall be disinfected and bacteriologically cleared for service in accordance with Section 15041: Disinfection of Potable Water Piping.

TABLE 11217-A

VERTICAL IN-LINE CENTRIFUGAL PUMP SCHEDULE

Items/Design Conditions	Value **(Bid Alternate)**	Value
Equipment Tags	**21-PMP-31, 21-PMP-32**	21-PMP-33, 21-PMP-34
Quantity	**2**	2
Service	**Carbon Dioxide Carrier Water Booster Pumps**	Carbon Dioxide Carrier Water Booster Pumps
Maximum Motor (hp)	**10**	10
Motor Type	**TEFC**	TEFC
Maximum Pump Design Speed (rpm)	**1,800**	1,800
Suction Size (in)	**2.5**	2.5
Discharge Size (in)	**2.5**	2.5
Primary Operating Flow (gpm)	**120**	120
Primary Operating Head (ft)	**165**	151
Minimum Efficiency @ Primary Flow & TDH (%)	**67.5%**	67.5%
Secondary Operating Flow (gpm)	**150**	150
Secondary Operating Head (ft)	**140**	140
Minimum Efficiency @ Secondary flow & TDH (%)	**70%**	70%
Minimum Shut-Off Head (ft)	**195**	195
Maximum Allowable NPSH Required (feet) [1]	**30**	30
Pump Manufacturers	A. Goulds B. Aurora C. Grundfos	

[1]At all points on the pump curve.

TABLE 11217-B

VERTICAL END SUCTION CENTRIFUGAL PUMP SCHEDULE

Designation	Material
Casing	Stainless Steel, AISI Type 316
Impeller	Stainless Steel, AISI Type 316
Bearing Frame	Cast Iron, ASTM A48, Cl. 30
Shaft	Stainless Steel, ASTM A276, Type 416 or Stainless Steel, AISI Type 316
Shaft Sleeve	Stainless Steel, ASTM A276, Type 420, ASTM A276, Type 416 or Stainless Steel, AISI Type 316
Wear Rings	Stainless Steel, AISI Type 316

END OF SECTION

SECTION 11220

CENTRIFUGAL SAMPLE PUMPS (**ADDITIVE BID ALTERNATE**)

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of Work: This section specifies the requirements for one (1) process water sample pump installed where shown in the Drawings and (1) uninstalled spare sample pump **as part of the Pre-Degasification Carbon Dioxide Feed System Additive Bid Alternate**.

B. The sample pumps will pump process water sample streams through the analyzer.

C. The Contractor shall furnish all labor, materials, equipment and incidentals necessary to furnish and install process sample pumps as shown on the Drawings and as specified herein.

1.02 REFERENCES

A. Related Sections

1. Section 01340: Shop Drawings, Working Drawings, and Samples.

2. Section 16150: Motors.

3. Section 15070: Schedule 80 Polyvinyl Chloride (PVC) Pipe and Fittings.

4. Section 15100: Valves and Appurtenances.

1.03 SUBMITTALS

A. Shop Drawings: Shop drawing submittals shall be made in accordance with the requirements of Section 01340, except as modified herein.

1. Provide manufacturers' catalog sheets with the selected model numbers and accessories clearly indicated.

2. Include a data sheet listing guaranteed operating points as well as performance curves over the required operating range showing compliance with the following: Curves shall be submitted on individual 8-1/2-in by 11-in sheets.

3. Manufacturer's recommended spare parts list, including current list prices for all components. List bearings and seals by the respective manufacturer's part number only.

4. Wiring diagrams.

5. Complete motor data.

6. Operating and installation instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer: The equipment specified under this section shall be a standard product of a Manufacturer who has been regularly engaged in the production of the equipment for a minimum of 5 years. The sample pump shall be of proven ability and shall be designed, constructed, and installed in accordance with best industry procedures and methods.

B. Warranty: The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Section 01740: Warranties and Bonds.

PART 2 – PRODUCTS

2.01 GENERAL DESCRIPTION

A. Operating Conditions: The Work of this Section shall be suitable for long term operation under the following conditions:

1. Duty: Continuous

2. Drive: Constant speed

3. Ambient environment: outdoor

4. Ambient temperature (°F): 32 to 105

5. Ambient relative humidity (%): 0 to 100

6. Fluid: Blended Reverse Osmosis Permeate

7. Fluid temperature (°F): 70 to 104

8. Fluid pH range: 5 to 10

9. Fluid specific gravity: 1.0

10. Fluid viscosity (absolute, cp at 60 °F): 1.12

11. Suction lift at pump (ft): 10.0

B. Performance Requirements:

1. Design flow capacity (gpm): 15.0

2. Design flow pump head (TDH ft): 45

3. Maximum pump speed (rpm): 3600

5. Maximum motor size (hp): 1

C. Pump Connections:

1. Suction fitting, min size (in): 1 (FNPT)

2. Discharge fitting, min size (in): 3/4 (MNPT)

2.02 PUMP REQUIREMENTS

A. Sample pumps shall be self-priming, centrifugal sample pumps. Each sample pump shall be capable of delivering 15 gpm at a minimum total dynamic head of 45 feet with a 10-foot suction lift. Each pump shall be furnished with up to a 1 horsepower electric motor. The pump shall not overload the supplied motor over the entire pump operating curve. Each pump body and seal plate shall be of 316 stainless steel or thermoplastic construction, resistant to chlorinated water with dissolved oxygen at or near saturation. Thermoplastic pump casings and components shall be UV resistant and rated for full exterior exposure. Units shall be furnished with fiberglass reinforced polycarbonate impellers. Motors shall be continuous duty, totally enclosed fan-cooled (TEFC) units with permanently grease-lubricated shielded ball bearings, thermal overload protection with automatic reset, and a threaded stainless-steel shaft. Motors shall be designed to operate on a 115 volt, 1-phase 60 Hertz power supply.

B. The sample pumps shall be Pentair Sta-Rite, Filter Pump Industries Penguin, or an Engineer approved equal.

PART 3 – EXECUTION

3.01 DESCRIPTION OF WORK

A. General: The Contractor shall be responsible for the fabrication and procurement, factory testing, delivery, proper storage and proper installation of the sample pumps at the facility site. The Contractor shall also be responsible for furnishing the services of a qualified manufacturer's field representative to:

1. Instruct the installers in the proper procedures and methods of installing the sample pump.

2. Observe the installation of the sample pump at the facility site to make sure the pump is installed in accordance with the manufacturer's methods, procedures and recommendations.

3. Inspect the installed pump prior to testing and startup, including calibration and adjustment of the equipment for proper operation.

4. Conduct the field testing of the sample pump and perform necessary field adjustments during the field testing until the installed equipment is operating properly and to the satisfaction of the Engineer.

5. Provide on-site assistance during the testing and startup.

3.02 SERVICES OF MANUFACTURER

A. Delivery, Installation and Field Adjustment: In addition to the fabrication of the pump, factory testing of the equipment, and the delivery of the pump to the Facility, the manufacturer shall furnish the services of a qualified field representative that shall be present during the installation of the pump.

B. Startup: A qualified field representative of the manufacturer shall be present at the facility site during the pre-operational testing and startup of the systems, including the pump field tests. Contractor shall include in its bid sufficient costs for a qualified manufacturer's field representative to be at the facility site for a minimum period of one (1) day.

C. Qualified Manufacturer's Field Representative: The qualified manufacturer's field representative(s) shall be direct employees of the manufacturer and shall be regularly employed as field representatives instructing installers, inspecting respective equipment installations, calibrating and adjusting pump, and troubleshooting and correcting equipment installation and operational problems. The qualified manufacturer's field representatives shall be duly trained by the company in the installation, operation and maintenance of the equipment being furnished under this specification. Sales representatives of the manufacturer do not qualify as qualified manufacturer's field representatives.

3.03 TRAINING

A. The Contractor shall provide training in accordance with Section 01650: Start-Up and Demonstration and Section 01730: Operating and Maintenance Data.

3.04 FIELD TESTS

A. After the pump has been completely installed, the Contractor shall conduct demonstration testing of pump to demonstrate that the pump has been properly installed and all necessary adjustments made.

B. The demonstration testing shall demonstrate that all items of these Specifications have been met by the pump, as installed.

C. If the pump performance during the demonstration testing does not meet the Specifications, corrective measures shall be taken by the Contractor to correct any observed deficiencies with the pump to the satisfaction of the Engineer and the Owner.

END OF SECTION

SECTION 11245

CHEMICAL METERING PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. This section covers the furnishing of all labor, materials, equipment, accessories, and incidentals required and installation, placing in operation, and field testing of the packaged chemical feed systems, chemical metering pumps, motors, controls, and accessories specified herein and as shown on the Drawings.

2. 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 specific equipment application. They are, however, intended to cover the furnishing, the shop testing, the delivery and complete installation of all materials, equipment and appurtenances for the complete pumping units, controls, and accessories as specified herein, whether specifically mentioned in these Specifications or not.

3. These specifications cover the replacement of existing chemical metering pump accessories such as calibration columns and pulsation dampeners where shown in the Drawings.

B. Related Work Described Elsewhere

1. Instruments and control systems are detailed in Division 13.

2. Mechanical piping, valves, pipe hangers, and supports are included in their respective Section of Division 15.

3. Electrical work, except as hereinafter specified, is included in Division 16.

C. General Design

1. All of the equipment specified herein shall be in complete conformity with the Drawings and Specifications. All of the equipment specified herein is intended to be new standard equipment for use in liquid chemical feed systems and shall include, but not be limited to, the following items of material and equipment:

a. Hydraulically Actuated Pumps
b. Calibration columns
c. Pressure relief valves

d. Pulsation dampeners
e. Pressure gauges/transmitters
f. Backpressure valves
g. Inlet Strainer
h. Pump drive and controls
i. Pressure Switces

2. All working parts of identical pumps and motors, such as bearings, check valves, shafts, sleeves, motors, etc., shall be of standard dimension built to limit gauges or formed to templates such that parts will be interchangeable between like units and such that the Owner may at any time in the future obtain replacement and repair parts for those furnished in the original machines. All parts shall be properly stamped for identification and location in the machines as shown on the Operation and Maintenance Manuals furnished.

1.02 QUALITY ASSURANCE

A. To assure unity of responsibility, the motors, controls, and accessories shall be furnished and coordinated by the pump manufacturer or supplier. The supplier shall assume complete responsibility for the satisfactory installation and proper operation of the entire pumping system including pumps, motors, controls, and accessories.

B. Manufacturers: The hydraulically actuated metering pumps shall be as manufacturd by Prominent, Milton Roy, Pulsafeeder, or Grundfos. No substitutions are permitted.

C. The pumps covered by these Specifications are intended to be standard pumping equipment of proven ability as manufactured by a reputable, qualified manufacturer having long experience in the production of such pumps. The pumps furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed. Pumps shall be manufactured in accordance with the Hydraulic Institute Standards.

D. All equipment furnished under this Specification shall be new and unused and shall be the standard product of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein a minimum of five (5) years.

1.03 SUBMITTALS

A. Materials and Shop Drawings

Copies of all materials required to establish compliance with the specifications shall be submitted in accordance with the provisions of the General Conditions, Section 01340: Shop Drawings, Working Drawings and Samples, and these Specifications. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.

2. Descriptive literature, bulletins, and/or catalogues of each individual piece of equipment.

3. Installation and arrangement drawings showing dimensions and locations of equipment. Show locations of pumps, piping, valves, pulsation dampeners, pressure gauges, calibration columns, electrical equipment, and pipe and valve supports.

4. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves, based on actual shop tests of similar units, which show that they meet the specified requirements for head, capacity, linearity, 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 no flow at zero stroke speed to pump capacity at specified total head.

5. Data including principle dimensions, materials and construction, space required, clearances, piping and electrical connections and requirements, controls, type of finish, installation instructions and other pertinent information.

6. A complete total bill of materials of all equipment including the weights of equipment furnished.

7. A list of the manufacturer's recommended spare parts. Include gaskets, packing, diaphragms, etc. on the list. List bearings by the bearing manufacturer's numbers only.

8. Complete motor data.

9. Copies of all factory test results, if specified in PART 2 - PRODUCTS of this Section of the Specifications.

10. The recommended grades of lubricants along with alternative references to equal products of other manufacturers.

11. Complete wiring diagrams and schematics of each control panel, controllers, and control devices furnished under this Section.

12. Complete wiring diagrams and schematics of all power and control systems showing wiring requirements between all system components, motors, sensors, control panels, etc., including connections to work of other Sections.

13. Quality Control Submittals:

    a. Manufacturer’s Certification of Compliance demonstrating that all materials of construction that come into direct or indirect contact with

the chemicals being pumped are fully compatible for the specified service.

b. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.

c. Special shipping, storage and protection, and handling instructions.

d. Manufacturer's printed installation instructions.

e. Manufacturer's Certificate of Proper Installation.

f. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

g. Field Performance Test Certificate.

B. Additional Information

1. In the event that it is impossible to conform with certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

2. Upon receipt and review of submitted material, provide the required number of certified prints and one reproducible tracing of all Drawings as specified in Section 01340: Shop Drawings, Working Drawings and Samples.

1.04 OPERATIONS AND MAINTENANCE DATA

A. Operating and Maintenance Instructions

1. Operating and maintenance manuals shall be furnished. 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 operation and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Section 01730: Operating and Maintenance Manuals.

2. A factory representative of all major component manufacturers, 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. With the Owner's permission, this work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3-EXECUTION. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.05 PRODUCT 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 units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged storage 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. Finished iron or steel surfaces not shop painted shall be properly protected to prevent rust and corrosion.

E. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

F. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.06 WARRANTY AND GUARANTEES

A. The manufacturer's written warranty shall be submitted for full equipment service and parts, as specified in Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for one (1) year, commencing at the time of final acceptance by the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. The pumping units required under this section shall be complete including proper alignment and balancing of the individual units. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the service to be performed. Ample room for inspection, repairs and adjustment shall be provided.

B. All equipment and piping shall be rigidly and accurately anchored into position and all necessary foundation bolts, plates, nuts, and washers shall be furnished and installed. All bolts, nuts, and washers shall be of 316 stainless steel.

C. All necessary accessory equipment and auxiliaries required for the proper functioning of the chemical feed system installation incorporating the highest degree of standards for

the specified type of service shall be furnished by the system supplier whether or not specifically mentioned in these Specifications or shown on the Drawings.

D. Stainless steel nameplates giving the name of the manufacturer, model number, rated capacity, speed, and any other pertinent data shall be attached to each item of equipment.

E. A separate stainless steel nameplate with the equipment identification number as specified herein and as shown on the Drawings shall be attached to each item of equipment in an easily visible location. The lettering shall be stamped on using 1/4 inch high or larger letters.

F. Stainless steel nameplates giving the name of the manufacturer, serial number, model number, horsepower, speed, voltage, amperes, and other pertinent data shall be attached to each motor.

G. All electrical materials and equipment shall be Underwriters Laboratories, Inc. listed and shall otherwise be equal to those specified under Division 16: Electrical.

2.02 MATERIALS AND EQUIPMENT

A. Metering Pumps – Hydraulically Actuated Metering Pump

1. The chemical metering pumps shall be of the single diaphragm design with the diaphragm actuated and balanced hydraulically. The pump, motor, gear reducer, and stroke controller, where required, shall be mounted on a common baseplate.

2. Hydraulically actuated pumps shall be provided with adjustable hydraulic relief valve which shall bypass the hydraulic fluid through an integral passage to provide full protection of the pump drive mechanism from excessive discharge pressure. The hydraulic reservoir and gear lubrication system shall be vented. The pump shall be designed to run safely to the relief valve setting. The pump mechanism shall have flooded lubrication using a common oil with the hydraulic system and shall be sealed from direct contact with the outside atmosphere and suitable for the specified operating conditions with or without the use of heating or cooling systems. The drive worm gear shall be supported on each end by tapered roller bearings. All drive components shall be completely immersed in oil.

3. Pump shall be provided with precise seating, suction, and discharge ball check valves. The check valves shall be removable from the liquid end for servicing or replacement. The suction and discharge check valve cartridges or seats and element shall be easily field replaceable. Check valves shall be single or double ball, in line (straight-through) type check valves. No spring-loaded check valves will be acceptable. All check valve components shall be compatible with the materials to be pumped as listed in Table 11245-A.

4. The diaphragm shall be supported on each side by contour plates. The diaphragm materials shall be compatible with the materials to be pumped as listed in Table 11245-A.

5. The pumps shall have a steady state flow accuracy of within ±1 percent over a turndown ratio of 10:1. Flow repeatability shall be within ±3 percent over the turndown ratio. Deviation from linearity shall not exceed ±3 percent over the turndown ratio. The pumps shall be capable of accepting manual or electric control, either factory mounted or by field conversion. Pumps shall be provided with manual 0-100 percent stroke adjustment via a unit mounted micrometer unless an automatic stroke adjustment mechanism is specified in Table 11245-A. The manual stroke adjustment shall be capable of being performed while the pump is operating or idle.

6. Materials of construction for the pumping units shall be compatible with the fluids to be pumped and as listed in Table 11245-A.

7. All pump components that come into contact with drinking water shall be NSF International Standard 61 certified.

B. Motor and Control

1. Each hydraulically actuated metering pump shall be driven by an integrally mounted AC motor. The The drive shall be operated off of 480 volt, 60 Hz, three phase AC power.

2. Motors shall be standard totally enclosed fan cooled (TEFC) AC units and of the frame size selected by the manufacturer to prevent overheating when continuously operated at 10 percent speed and constant torque loaded. Drives shall be suitable for continuous operation over a 20 to 1 speed range within plus or minus 2 percent of selected operating speed. Each pump and drive including coupling and guard shall be factory mounted on a common base and tested. Motor shall be invertor duty rated for variable frequency drive application.

3. A thermal switch shall be furnished in each drive motor and wired under Division 16: Electrical to stop motor on high winding temperature.

4. The metering pump motor speed shall be controlled by a variable frequency drive (VFD). Furnish VFD for metering pump and VFD shall conform with Specification Section 16151. Refer to Instrumentation and electrical drawings for the control requirements of the VFD's and the control panel.

5. The pump controller shall accept an analog signal such that stroke frequency is proportional to a 4-20 mA signal. The pump controller shall be capable of control through the remote signal or manually at the controller.

6. Electronic Stroke Control

a. Each chemical feed pump shall be equipped with an electronic stroke controller if scheduled herein under Table 11245-A. The electronic stroke controller shall automatically adjust the stroke length of the pump in response to a 4 to 20 mA analog signal as specified under Instrumentation (Division 13). The control system shall be constructed to completely isolate the control signal from the AC power supply.

b. The stroke controller including AC synchronous drive motor and control circuitry shall be enclosed in a NEMA 4 watertight enclosure suitable for mounting on the chemical feed pump. The drive motor shall operate off of 480 volt, 60 Hz, three phase AC power. The design shall allow the system to operate under continuous stall or without signal without damage to the drive motor or control circuitry. The response time for 0 to 100% change shall be 15 seconds or less. The system shall provide a 1 to 10% dead band adjustment. The actuator shall consist of a fully enclosed cog belt coupled to a high-quality, vernier-type adjustment with lock to permit manual mechanical override and readout in the event of signal equipment malfunction.

c. The stroke controller shall provide for over-signal protection and programmable signal loss protection. An integral dip switch shall allow the operator to program the controller to either freeze the stroke length at the last position or drive to zero in the event of a control signal loss.

d. The electronic stroke controller shall be provided with controls for panel mounting inside the operator control panel described under 2.02B.7. The operator controls shall allow the operator to manually adjust the stroke length of each pump from the local operator control panel using the electronic stroke controller. The panel mounted controls shall include an auto-manual selector switch and 0 to 100% ratio control switch for each chemical metering pump. All panel mounted control components to be NEMA 4X.

7. Metering Pump Local Control Panels

a. A wall mounted local control panel shall be provided for the proposed sodium hydroxide chemical feed system. The control panel shall accept external 120VAC, 1-phase power supply and shall have a main breaker with external handle for disconnect mean. The control panel shall be a stainless steel NEMA Type 4X enclosure and shall have UL label. Each local control panel shall be provided with indication lights, pushbuttons, displays, etc. as describes in this specification and as shown in the drawings for a complete and working system.

b. Control and status indications for metering pumps shall be resided in the local control panels and shall have a running indication LED light, fault indication LED light, in remote indication LED light, start/stop pushbutton, speed indication/display, speed control (potential meter), and stroke control, etc. for each pump. “Start/stop pushbutton” and speed control potential meter shall only be active when “Hand-Off-Auto” selector switch at the VFD is selected in “Hand” at each VFD. Coordinate with Electrical Contractor for conduits and cables required before bidding.

c. The electronic stroke length controller, when required, shall be provided with a local-remote switch. When “remote” is selected, the stroke length control shall be by the 4-20 mA input signal either from the local control panel or from the PLC control panel and when “local” is selected, stroke length control shall be adjusted manually.

d. Each control panel shall have two additional local displays for chlorine residual and process water flow, as shown on the instrumentation drawings. The display shall be LCD type digital display and shall accept 4-20 mA input.

8. The metering pumps shall be provided with all the additional signals as shown on the Instrumentation Drawings.

9. The supplier of equipment under this section is responsible for coordinating with the I&C System Supplier to ensure that its equipment is compatible with and provides all necessary ancillary and accessory equipment to accept control signals provided by the SCADA system and provide monitoring and feedback signals to the SCADA system that are on the Drawings and Division 13 for this equipment. This shall include all equipment control switches, flow detection switches, motor winding temperature switches and position switches that are mounted on or adjacent to the equipment for monitoring the performance of that piece of equipment. This shall also include all relays, transmitters, dry contacts and termination switches that are required on, adjacent to or in control panels supplied by the equipment vendor that are necessary to interface with the PLC/SCADA control system.

C. Nameplates:

1. Each pump shall be equipped with a stainless steel nameplate, indicating equipment characteristics, pump capacity, motor horsepower, speed, electrical characteristics, manufacturer, model number, and serial number.

2.03 ACCESSORIES

A. Pressure Relief Valves

1. Pressure relief valves shall be provided on the discharge header of each chemical feed system as shown on the Drawings. Pressure relief valves shall use a diaphragm design and be externally adjustable by means of a screwdriver. All materials of construction shall be compatible with, and fully resistant to corrosion by the liquids being pumped. The size shall match the associated metering pump capacity.

B. Backpressure Valves

1. Backpressure valves shall be provided on the discharge headers of the chemical feed systems as shown on the Drawings. Backpressure valves shall use a diaphragm design and be externally adjustable by means of a screwdriver. All materials of construction shall be compatible with, and fully resistant to corrosion by the liquids being pumped. The size shall match the associated metering pump capacity.

C. Pulsation Dampeners

1. Pulsation dampeners shall be provided for installation on the discharge piping of each metering pump as shown in the Drawings. Pulsation dampeners shall provide for a volumetric residual fluctuation of ±4 percent or less based upon a single feed pump in operation. The pulsation dampeners shall be equipped with a pressure gauge and charging valve mounted on top of the gas chamber. All materials of construction shall be compatible with and fully resistant to corrosion by the liquids being pumped. Pulsation dampeners shall be supplied by the pump manufacturer.

D. Calibration Columns

1. Provide transparent calibration chambers to be mounted on the suction piping of each chemical feed system as shown on the Drawings. The calibration columns shall be supplied with flanges on each end with NPT taps for connection of piping. The flanges shall be gray PVC for acrylic or clear PVC columns and stainless steel or fiberglass with Viton O-ring seals for glass columns. Glass columns shall be provided with stainless steel tie rods for structural stability. The calibration columns shall be as manufactured by Griffco, or approved equal. Calibration colmns replacing existing calibration columns shall be sized to match the existing columns. The calibration column shall be sized such that a measurable capacity of the chamber is at least 1 minute discharge of each pump at maximum pumping capacity.

E. Pressure Gauges:

1. Pressure gauges shall be provided on the discharge header of metering pumps as shown in the Contract Drawings. Each gauge shall have a range of 0 to 100 psi. Gauges shall have a PVC or stainless steel diaphragm seal (CPVC for Sulfuric Acid) and shutoff valve. Shutoff valves shall be of the same material as the piping with seals that are resistant to the chemical applications.

F. Pressure Switches.

1. Pressure switches shall be provided for installation on the discharge pipng of each metering pump as shown in the drawings and as specified in division 13.

2.04 SPARE PARTS

A. All special tools required for normal operation and maintenance of the equipment shall be furnished with the equipment by the manufacturer.

B. The following spare parts shall be furnished for the hydraulically actuated metering pumps:

1. Two (2) extra sets of all gaskets, seals, diaphragms, packing, etc. of each different type.

2. One (1) box of fuses of each size furnished.

3. One (1) container of each type of lubricating or hydraulic oil required.

4. Check valve assemblies.

C. The Manufacturer shall recommend and supply all spare parts in addition to the aforementioned necessary for the first five (5) years of operation. Spare parts shall be marked with parts numbers and packed in suitable containers also marked with the part numbers.

D. All tools and spare parts shall be furnished in containers clearly identified with indelible markings as to their contents. Each container shall be packed with its contents protected for storage. All tools shall be furnished in steel tool boxes.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation of the pumps, drivers, and accessories shall be in strict accordance with the manufacturer's instructions and recommendations in the location shown on the Drawings. Installation shall include furnishing the required lubricants for initial

operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

3.02 INSPECTION AND TESTING

A. Furnish the services of a factory representative who has complete knowledge of proper operation and maintenance to inspect the final installation and supervise test runs of the equipment.

B. Upon completion of installation, the manufacturer, in the presence of the Engineer, shall perform a preliminary test (no chemicals) over the full range of each system to insure the functioning of all component parts to the satisfaction of the Engineer. The test shall be over the full range of capacity. The manufacturer shall furnish all labor and equipment. Power shall be supplied by the Contractor. Approval of the preliminary test by the Engineer shall not constitute final acceptance of the equipment furnished.

C. After the plant is in operation, a full operating test shall be performed in the presence of the Engineer and a qualified manufacturer's representative on the system. The manufacturer shall furnish all labor, materials and equipment required for such tests and shall correct any deficiencies noted by repairing or replacing the defective component and retesting as required until the equipment meets the Specifications and the satisfaction of the Engineer. The manufacturer shall have 30 days to make the changes necessary to meet the Specifications. If after said 30 day period all deficiencies have not been satisfactorily corrected, the Owner may order the manufacturer to remove the equipment from the installation and refund to the Owner all payments made to him. Chemicals for the full operating test will be furnished by the Owner.

3.03 START-UP AND INSTRUCTION

A. Submit to the Engineer and Owner completed checkout forms and certification of completed demonstration and training forms per Section 01650: Start-up and Demonstration. Start-up and commissioning shall not begin until all required forms are complete and all manufacturer’s exceptions have been resolved by the Contractor.

B. Contractor shall furnish at his expense the services of a factory-trained service engineer for system start-up, calibration and instruction briefings for operating personnel. Service shall be furnished for a minimum of two (2) working days with additional time furnished if required to correct problems or deficiencies.

C. Manufacturer's Representative: Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

2. 1/2 person-day for prestartup classroom or site training and 1/2 person-day for facility startup.

TABLE 11245-A
FEED PUMP DESIGN REQUIREMENTS

Item	Stage 1 Odor Control Sodium Hydroxide Feed System	Finished Water pH Adjustment Sodium Hydroxide Feed System
Equipment Numbers	20-CFP-01	20-CFP-03 and 20-CFP-04
Type	Hydraulic Actuated Diaphragm	Hydraulic Actuated Diaphragm
Number of units	1	2
Pump Design capacity (each)	12 gph	15 gph
Minimum Feed Rate (each)	1.2 gph	1.5gph
Min. operating pressure	100 psi	100 psi
Power Requirements	½ hp	½ hp
Approved Pump Models	Pulsafeeder, Milton Roy, or Grundfos	Pulsafeeder, Milton Roy, or Grundfos
Enclosure	TEFC	TEFC
Stroke Length Control	Manual	Electronic
Stroke Speed Control	Flow Proportional 4-20 mA Signal	Flow Proportional 4-20 mA Signal
Stroke Adjustment	100%	100%
Stroke Length Adjustment	Manual	pH Dependent, 4-20 mA Signal
Solution Strength	50%	50%
Materials		
Liquid End Body	PVC	PVC
Diaphragm	Teflon	Teflon
Check Valve Balls	Ceramic	Ceramic
Seat & O-rings	Teflon	Teflon
Hardware	316 Stainless Steel	316 Stainless Steel
Ancillary Equipment Location		
Pressure Relief Valves	Discharge Piping	Discharge Piping
Pressure Switch	Disharge Piping	Discharge Piping
Back Pressure Valves	Discharge Piping	Discharge Piping

Item	Stage 1 Odor Control Sodium Hydroxide Feed System	Finished Water pH Adjustment Sodium Hydroxide Feed System
Pulsation Dampeners	Discharge Piping	Discharge Piping
Calibration Column	Suction Piping	Suction Piping
Ancillary Equipment Settings		
Pressure Relief Valve Setting	100 psi	100 psi
Back Pressure Valve Setting	50 psi	50 psi
Calibration Column Size	1000 mL with 10 mL gradiations	1000 mL with 10 mL gradiations

END OF SECTION

SECTION 11250

REVERSE OSMOSIS TREATMENT SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. The work covered in these specifications includes the design, furnishing and installation of two (2) new reverse osmosis membrane treatment units including instrumentation. The reverse osmosis (RO) membrane treatment units will treat pre-treated Floridan Aquifer water. The RO membrane system has an existing total blended water capacity of 4.0 MGD, with a design permeate flow of approximately 3.5 MGD and a blend capacity of approximately 0.5 MGD of filtered Floridan Aquifer water. The RO system improvements will increase the total blended water capacity to 8.0 MGD (6.0 MGD firm capacity). The permeate water quality specified herein shall be met at startup and through the end of the initial five (5) year operating period.

2. The RO membrane system will consist of two (2) new two-stage RO membrane trains.

3. Bid Alternative: The Contractor and membrane OEM shall provide the City an additive bid alternative for replacement of the existing membranes, brine seals and O-rings currently installed in RO Skid No.'s 1 and 2. The existing RO skids each contain 39 pressure vessels, each housing seven (7) spiral wound membrane elements for a total of 273 membrane elements per skid or 546 elements total. All requirements listed herein for the design, installation, startup, testing and warranty of the new membrane elements shall apply to the bid alternative if selected by the City.

4. It is the intent of the Engineer and Owner to have all items on the RO trains purchased, engineered, and supplied by the Contractor retained membrane OEM. Therefore, all process components within the limits of the RO trains shall be the product of the membrane OEM. Membrane OEM shall provide oversight and supervision during installation of the RO system components.

5. The membrane OEM shall be responsible for furnishing all field instruments associated with the RO trains. The membrane OEM shall be responsible for the installation, and testing of field devices that are furnished on the RO trains to include the following:

RO Skid Instruments (typical for 1 skid, X Denotes Skid # [3-4] as shown in the drawings)

- Stage 1 Feed Pressure Transmitter (PIT-7X1)
- Stage 1 Concentrate / Stage 2 Feed Pressure Transmitter (PIT-7X2)
- Stage 2 Concentrate Pressure Transmitter (PIT-7X3)
- Combined Permeate Pressure Transmitter (PIT-7X4)
- Stage 1 Permeate Flow Meter (FE/FIT-7X2)
- Stage 2 Permeate Flow Meter (FE/FIT-7X1)
- Concentrate Flow Meter (FE/FIT-7X3)
- Total Permeate Conductivity Sensor/Analyzer (AE/AIT-7X1)
- Concentrate Conductivity Sensor/Analyzer (AE/AIT-7X2)

The Contractor shall locate and install field instruments as shown in the drawings.

6. The Contractor shall be responsible for coordination between the membrane OEM and the Control System Integrator (CSI as defined in the Division 13 specifications), and shall assume ultimate responsibility in providing all items required to form complete and operable membrane treatment trains within the existing system, whether specified herein or not.

7. The membrane OEM shall be responsible for furnishing two (2) RO Skid Instrument and Sample Panels (one at each skid). These panels are defined herein and shall be provided in full accordance with the requirements set forth in Division 13, Instrumentation and Controls. Automatic membrane process control strategies developed by the CSI shall be submitted to the membrane OEM for review, approval, and written acceptance prior to their associated shop drawing submittal.

8. The reverse osmosis membrane treatment system shall be coordinated with all related systems to form a complete integrated operating system. The membrane OEM for this project shall coordinate the membrane systems with the following equipment and their suppliers:

   a. Chemical Pretreatment
   b. Micron (Cartridge) Filtration
   c. Reverse Osmosis High Pressure Feed Pumps
   d. Membrane CIP System
   e. Interconnecting Piping and Valves
   f. Instrumentation and Controls
   g. Skid Sample Panels for Sampling of Individual Vessels
   h. Electrical

9. The RO equipment shall be completely pre-assembled (except for below grating piping) including the frames, piping, valves, instruments, sample lines with carrier pipes, and sample panels, at the OEM's fabrication facility and tested prior to shipment to the project site. Each RO system treatment unit shall include the skid,

pressure vessels, support structures, membrane elements, valves, interconnecting piping and wiring, instrument and sample panels, conduit, tubing, fasteners, and instrumentation. The system shall be sized for orientation and function as indicated in the mechanical process construction drawings.

10. The membrane OEM shall provide operator training, calibration, testing and start-up, etc. as required for the delivery and certification of the complete units. The membrane OEM will perform hydrostatic testing for leakage on the piping components in accordance with Section 15044.

11. The pressure vessels, along with the associated feed and permeate piping, shall be disinfected in accordance with Section 15041 – Disinfection of Potable Water Piping prior to loading of the RO membranes.

12. The RO system described in this section will be the end product of one membrane OEM, and like items of equipment shall be the product of one manufacturer to facilitate standardization of performance, operation, spare parts, maintenance and manufacturer's service.

B. Related Work Described Elsewhere

1. Process Panels and Racks: Section 11257
2. Cartridge Filters: Section 11334
3. Vertical Turbine RO Feed Pumps: Section 11215
4. Instrumentation: Division 13
5. Interconnecting Piping and Valves: Division 15
6. Electrical: Division 16

C. Design Criteria

1. The OEM shall install (2) new RO skids, each with a total permeate capacity of 1.75 MGD, expandable to 2.0 MGD. The permeate water quality shall meet all design requirements. The RO membrane system shall be designed based upon the following raw water and permeate quality design criteria:

a. Design Water Quality:

Constituent	Design Raw Water Quality (mg/L)	Design Permeate Water Quality (mg/L)[1]
pH (before acid addition)	7.8	-
pH (acid addition)[2]	6.8	-
Total Alkalinity (as $CaCO_3$)	167	20-40
Total Dissolved Solids	1,803	<400
Total Hardness (as $CaCO_3$)	614	40-100
Total Iron (Fe)	0.03	<0.1
Barium (Ba)	0.11	$\leq$1.6
Strontium (Sr)	17	<4

Constituent	Design Raw Water Quality (mg/L)	Design Permeate Water Quality (mg/L)[1]
Calcium (Ca)	124	<24
Magnesium (Mg)	74	≤15
Sodium (Na)	389	<130
Potassium (K)	9	2.3
Chloride (Cl)	790	<170
Sulfate (SO_4)	198	<50
Fluoride (F)	0.47	≤0.8
Nitrate (as N)	BDL	<1
Silica (as SiO_2)	20	<6
Sulfide	2.6	

Notes:
(1) Permeate Design Water Quality based on 5-year warranty period, with maximum salt passage allowance of 15% per year.
(2) OEM to design for a feed pH of 7.8 (no acid addition) and 6.8 (acid pretreatment).

b. Total Installed Raw Water Feed Flow per Unit[1] — 2.19 MGD

c. Total Installed Permeate Flow per Unit[1] — 1.75 MGD

d. Total Concentrate Flow per Unit — 0.44 MGD

e. Design Product Recovery — 80%

f. Quantity of Skids — Two (2)

g. Membrane System Design Stages — Two (2)

h. Membrane Array Design (Per Train)[1]
Installed Vessels in 1st Stage — 26
Installed Vessels in 2nd Stage — 13

Notes:
(1) RO trains shall be expandable to accommodate up to 48 total pressure vessels situated in a 6-vessel wide by 8-vessel high array to produce 2.0 MGD with no blend water added to the permeate.

i. Design Feed Pressure — 200-230 psi

j. Maximum Permeate Backpressure — 25 psi

k. Minimum Concentrate Discharge Pressure
Minimum (one skid operating) — 6 psi
Maximum (all skids operating) — 55 psi

l. Average Membrane Skid Flux Rate — 15.0 gfd

m. Minimum Second Stage Permeate Flux Rate — 10.0 gfd

n. Raw Feedwater Turbidity — ≤1 NTU

o.	Minimum Feedwater Temperature, F	70°
p.	Maximum Feedwater Temperature, F	78°
q.	Support Material	FRP

2. The following specifications shall govern the pressure vessels:

a.	Type	Match Existing Skids and per Drawings
b.	Pressure Rating	300 psi
c.	Vessel Size	
	1) Length	25 feet
	2) Diameter	8 inches
	3) Number of Membrane Elements	Seven (7)
d.	Code Rated	Yes
e.	Material	FRP
f.	Manufacturers	Code Line Protec

3. The following specifications shall govern the reverse osmosis membranes:

a.	Minimum Chloride Rejection	97%
b.	Minimum THMFP Precursor Rejection	90%
c.	Maximum Feedwater SDI	≤3
d.	Membrane Element Area	400 sf
e.	Manufacturers	DuPont Hydranautics Toray

1.02 QUALITY ASSURANCE

A. The equipment furnished shall be the standard product of a manufacturer regularly engaged in the fabrication of reverse osmosis treatment equipment of the type specified herein.

A qualified OEM shall:

1. Be able to document available bonding capacity equal to 150% of the value of the membrane treatment system specified herein.

2. Have a full-time in-house engineer and CADD technician on staff for system design and submittal preparation.

3. Have been doing business continuously under the present name for a period of at least five (5) years during which time the company shall not have declared bankruptcy.

4. Have previous experience demonstrating OEM's ability to fabricate, install, startup and troubleshoot the membrane treatment system specified herein.

5. Have a minimum of four (4) reference spiral wound municipal membrane water treatment projects. Reference projects shall be either completed, or if in progress, be at least 80% complete to apply as experience. All projects shall have a minimum of 1 MGD installed membrane capacity and at least two (2) skids. At least one (1) of the reference projects shall have individual skids with a capacity of at least 1.5 MGD per skid and a total installed capacity of at least 3.0 MGD or greater. Experience of individuals shall not count toward the required experience.

6. The equipment furnished shall be the standard product of the following approved membrane OEMs (listed in alphabetical order). No exceptions to the listed manufacturers will be accepted.

    1. Biwater
    190 E. Arrow Highway, Unit F, San Dimas, CA 91773
    909/-599-4129

    2. Harn R/O Systems, Inc.
    310 Center Court, Venice, FL 34292
    941/488-9671

    3. H2O Innovations, Inc.
    1048 La Mirada Court, Vista, CA 92081
    760/598-2206

B. The approved membrane OEM shall supply all membrane elements under this contract from a single approved Membrane Element Manufacturer (MEM) having significant experience in the manufacture of such products. The approved MEMs are specified below. Refer to Section 2.02, A, 3. herein for additional membrane element requirements.

1. DuPont (formerly Dow)

2. Hydranautics, (Nitto Denko)

3. Toray Membrane USA

1.03 SUBMITTALS

A. Materials and Shop Drawings

1. Preliminary Submittal: Submit process flow diagrams, process and instrumentation diagrams, and general arrangement drawings for the RO skids within 60 days of the Notice to Proceed.

2. Detailed Submittal: Copies of all materials required to establish compliance with the specifications shall be submitted in accordance with the provisions of Section 01340: Shop Drawings, Working Drawings and Samples of these Specifications. All of the equipment to be provided by the membrane OEM shall be combined into a single submittal. Submittals shall include at least the following:

   a. Detailed shop and erection Drawings showing all important details of construction, dimensions, materials of construction and anchor bolt locations.

   b. Descriptive literature, bulletins, and/or catalogs of all equipment to be furnished.

   c. Data including principle dimensions, materials and construction, space required, clearances, piping and electrical connections and requirements, type of finish, installation instructions and other pertinent information for the membrane skids. Calculations to demonstrate compliance with the specified pipe velocity requirements, pipe classes and thicknesses and control valve sizing shall be included.

   d. A complete total bill of materials of all equipment including the weights of equipment furnished.

   e. Complete product literature, wiring diagrams and schematics of each RO Skid Instrument Panel, controllers, control devices and related components.

   f. Complete wiring diagrams and schematics of all power and control systems showing wiring requirements between all system components, motors, sensors, control panels, etc., including connections to work of other Sections.

   h. Performance data for all items of equipment.

   i. A list of the manufacturer's recommended spare parts including manufacturer's name, address, telephone number, part number and description.

   j. Detailed drawings of skid sample panels and all equipment associated therewith.

k. Complete structural design drawings for the membrane system support structure. The drawings shall bear the seal of a Professional Engineer licensed in the State of Florida.

l. Submittals related to the membrane process should be packaged as a combined submittal such that the overall system operation may be reviewed. The exception to this requirement shall be the field instruments which shall be submitted by the CSI under Division 13.

m. The membrane OEM shall state their basis for design, indicating the membrane, number of membrane elements and pressure vessels, flux rate, type of array, staging, recovery, salt passage, and design water quality parameters as listed in 11250, 1.01, C, 1, a herein. A copy of membrane performance projections performed using the membrane manufacturer's design software shall be submitted to support the design. All of the above information shall be furnished for a minimum of 0 year and 5 year designs.

3. Testing Data Submittal: Copies of all testing results required to establish compliance with the specifications.

a. Wet test data or an Engineer approved equivalent on all membrane elements. Membrane wet testing shall be performed by the membrane manufacturer and the test data shall be summarized in an organized fashion to include statistical analysis of the test results. Every effort shall be made to maintain consistent feed water quality throughout the wet testing activities. Feed water conductivity and alkalinity levels shall be maintained around the manufacturer's published test conditions +/- 5% of the standard value. Feed water pH shall be maintained around the manufacturer's published test conditions +/- 0.5 pH units. The membrane rejection characteristics shall be equal to or greater than design rejection utilized in performing the membrane projections furnished under 1.03, A, 2 above. The Engineer reserves the right to reject any membrane elements that are tested outside of the published test conditions and/or indicate a rejection or productivity value that is greater than +/-1 standard deviation from the total population of elements tested. At the Engineer's sole discretion a full custom load of the membrane skids may be considered as an equal to meeting the wet testing rejection/productivity requirements above, given the average rejection and productivity of the membrane elements as a whole are greater than or equal to the design criteria used in the approved membrane projections.

b. Certified pressure tests on all pressure vessels with proof of ASME certification for pressure vessel design.

B. Additional Information

1. In the event that it is impossible to conform to certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

2. Upon receipt and review of submitted material, provide the required number of certified prints and one reproducible tracing of all Drawings as specified in Section 01340: Shop Drawings, Working Drawings and Samples.

C. Operating Instructions

1. Operating and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, spare parts lists, data needed to order replacement parts, descriptions, etc., that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Section 01730: Operating and Maintenance Data.

2. Either a technician from the membrane OEM or a factory representative of all major component manufacturers, 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. With the Owner's permission, this work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3-EXECUTION. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery, storage and handling of products shall be as specified in Section 01600: Material and Equipment.

1.05 WARRANTY AND GUARANTEES

A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for 1 year after the time of completion and acceptance.

B. Membrane OEM shall provide the membrane element manufacturer’s standard warranty, with riders if necessary, to include at a minimum, one (1) year full membrane replacement from the Acceptance Date and a prorated membrane replacement cost clause for the second, third, fourth, and fifth year from the Acceptance Date.

C. Patents and Licenses

1. The membrane OEM shall be responsible for all patents or licenses that exist because of the equipment that may be provided.

2. The membrane OEM shall assume all costs of patent fees or licenses for the equipment or process, and shall safeguard and save harmless the Owner from all damages, judgment, claims and expenses arising from license fees, or claimed infringement of any letters, patent or patent rights, or fees for the use of any equipment or process structural feature or arrangement of any of the component parts of the installation, and the price bid shall be deemed to include payment of all such patent fees, licenses or other costs pertaining thereto.

D. The membrane OEM shall furnish a written guarantee for all work, materials, equipment, etc., against defects. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for one (1) year, commencing at the time of final acceptance by the Owner.

E. In addition to the one-year warranty period described above, the membrane OEM shall provide a "pass through" membrane performance guarantee from the membrane manufacturer for a period of five (5) years from the final acceptance date of beneficial use of the equipment.

1. The membrane shall be warranted by the membrane equipment supplier to meet the TDS and chloride permeate water quality criteria as specified herein and based on the water quality parameters specified herein for a period of five (5) years from the final system acceptance date by the Owner. The membrane shall also be warranted to meet the manufacturer’s published standard warranties relative to minimum permeate flow, and maximum log mean salt passage. The membrane OEM shall restore the system performance to the specified levels by repairing or replacing the membrane elements, at their option, should the system fail to meet the performance requirements.

2. Membrane replacements for claims made after the first twelve months shall be performed at the original purchase price less a prorated rebate on the unrealized life of the warranty.

1.06 CONTROL PROGRAMMING, DATA TRENDING, AND DATA NORMALIZATION

A. The Membrane OEM shall coordinate with the CSI to ensure that proposed control settings and strategies, including startup and shutdown sequencing, alarms, interlocks, set-points, and delay timers are appropriate for the new RO treatment trains. The Membrane OEM and CSI shall jointly facilitate a control narratives workshop to present proposed control strategies to the Engineer and the Owner and how they will integrate into the existing system, and incorporate feedback and comments prior the initial submittal of the control narratives shop drawing.

B. SCADA Based Data Normalization: The Membrane OEM shall coordinate with the CSI responsible for programming of the plant SCADA system, and shall provide basic

membrane data normalization functions within the plant historian that do not require the use of third party or proprietary software or hardware.

1. A SCADA tag shall be provided in the historian for the following data for each stage of each RO skid: differential pressure, normalized differential pressure, normalized permeate flow, salt rejection, normalized salt rejection, flux, and recovery rate.

2. The RO Membrane Element Manufacturer shall provide all required formulas and correction factors to facilitate such data trending. Historian programming shall be performed such that data points are not displayed when an RO skid is not operating.

PART 2 - PRODUCTS

2.01 MATERIAL AND EQUIPMENT

A. Reverse Osmosis Membrane Trains

1. Design Criteria:

a. System performance shall be based on the provision of permeate water quality as specified herein, and the finished product water shall meet all Florida Department of Environmental Protection drinking water standards for public water systems.

b. To ensure system capacity, the plant must be initially supplied with sufficient membrane capacity to compensate for normal flux decline over the life of the membranes.

c. The supplied RO system shall be capable of continuous operation at a recovery rate of 80-percent.

d. No single membrane element within the RO membrane system shall exceed a flux of 20 gfd or the manufacturer's maximum flux rate, whichever is lower.

2. Module Assembly: The RO membrane skids shall be assembled into two (2) identical separate 2.0 MGD skids. Each unit shall be provided with individual feed and discharge piping and controls. Each unit shall be independently mounted and capable of independent operation to permit individual RO membrane skid shutdown for membrane replacement, repairs, cleaning, etc. Each two-stage RO membrane skid will consist of three membrane "trees" or skid subsections, two in the first stage and one in the second stage. These "trees" or skid subsections shall be capable of complete isolation to facilitate cleaning events.

3. Membrane Elements:

a. The membrane elements shall be those manufactured by one of the approved MEMs listed in Section 1.02 above. Each RO membrane element shall be a non-cellulosic, polyamide derivative, spiral-wound, thin film composite membrane, 8 inches in diameter, and a maximum of 40 inches in length (nominal). Each RO membrane element shall contain a minimum of 400 (nominal) square feet of active membrane area.

b. The semi-permeable membrane shall have the rejection values as specified herein before and shall be capable of tolerating continuous exposure to temperatures of up to 40 degrees C and within a feed pH range of 4.0 to 9.0. The cleaning pH tolerance shall be within a range of 2.0 to 12.0. The membrane element housing shall be of FRP with PVC end caps. Membrane elements shall be individually tested and marked with a permanent factory serial number.

c. A test report shall be submitted to the Owner and Engineer with the following information for each element: membrane serial number, date of test, test conditions (temperature, pressure, feed water composition, recovery), and test results (salt rejection, membrane productivity).

4. Membrane Pressure Vessels:

a. Pressure vessels shall be made of filament-wound fiberglass reinforced plastic (FRP) using continuous glass roving, impregnated with an elevated temperature cure epoxy resin system. Each vessel shall have a diameter and length designed specifically to contain a quantity of seven (7) standard 8-inch diameter by 40-inch long spiral-wound membrane elements. Each pressure vessel shall be of the side ported, with 1-1/2, 2, or 2-1/2 inch diameter ports as required to meet the maximum design velocity criteria. Each feed/concentrate side port or mega side port shall be constructed of Type 316L stainless steel pipe and shall be designed to interface with a flexible grooved coupling. Each port shall be designed with an anti-rotation mechanism. The side port design velocity for process and cleaning flows shall not exceed 10 feet per second.

b. The pressure vessel design must meet all the requirements of ASME Section X, entitled Fiber Reinforced Boilers and Pressure Vessels. The vessels shall be Code stamped, and proof of Code compliance shall be demonstrated by submission of an ASME Data Design Report for the vessel design and fabrication procedure proposed.

c. Vessels shall have a maximum working pressure of not less than 300 psi at a temperature up to 120 degrees F with a minimum operating temperature of not less than 20 degrees F. The vessels shall be capable of withstanding stress of four times the normal operating pressure before failure occurs.

d. The pressure vessel prototype must not burst at less than six times (6x) its rated pressure after being pressure cycled 100,000 times.

e. The pressure vessels shall be supported in at least three places along their length; vessels shall be supported on plastic, contoured saddles or cradles, and secured in place with 316 stainless steel retaining clamps. U- bolts are not acceptable.

f. The shell of each pressure vessel shall have a smooth exterior surface that has been coated with a two-part urethane enamel for superior gloss retention, abrasion resistance, and to block all light that may promote biological growth. The vessel coating color shall be White. The shell bore of each pressure vessel shall be fabricated from a resin-rich epoxy barrier that has been cured to allow for superior corrosion. resistance

g. Pressure vessel side port shall be constructed of 316L stainless steel or a material of equal or higher corrosion resistance. Dished head retaining rings shall be constructed of 316 stainless steel.

h. Each pressure vessel head shall be designed for removal by hand under normal operating conditions. Each head seal gland shall be designed to eliminate dead space and to allow the seal surface to be exposed for flushing of the seal. Each permeate port shall be designed with an anti-rotation mechanism. Each head shall be retained by a single retaining mechanism that provides ASME required redundancy and is constructed of stainless steel. Each mechanism shall be able to be removed by hand. Each head shall contain an integral secondary interlock that shall require a simple, yet specific sequence of events to remove the end closure and shall not require the use of separate components that may become separated from the vessel.

i. Pressure vessels shall be as manufactured by Pentair/Codeline or Protec. No other vessel manufacturers will be considered.

5. Membrane Support Structures:

a. The membrane support structures shall be fabricated of painted FRP, or electropolished 316L stainless steel structural shapes.

b. The membrane OEM shall submit structural design drawings signed and sealed by a professional engineer in the State of Florida for the membrane system support structure in conformance with 1.03.A.2.j.of this specification.

c. The membrane OEM shall be responsible for furnishing the pressure vessel support structure. Each pressure vessel shall be supported at least in three places by the support structure.

d. The membrane system support structures shall be designed and constructed to meet the published support span requirements from the pressure vessel manufacturer.

e. Each pressure vessel assembly shall be adequately supported on the frame by plastic, contoured saddles or cradles and stainless-steel retaining clamps. All mounting hardware and bolting shall be passivated 316L stainless steel.

f. For the stainless-steel structure, all 316L stainless steel shall be electropolished to a bright and uniform finish. Electropolished piping shall be free of pebbly, orange peel, or pitted appearance as in Electropolish Finish Standards (EFS) 3.

g. Support structures shall be anchored to the building floor with 316 SS anchor bolts.

h. For the FRP structure, the structural members shall comply with ASTM- D570 for water absorption. All cut sections shall be properly sealed to prevent the absorption of water. Structural shapes shall be “Extren” 500 or engineer approved equal. All joints shall be bonded and riveted for maximum strength, with corners supported by double gussets. The structure and joints shall be glued and bolted.

i. The FRP membrane system support structure shall be coated with a 2- part system high gloss polyurethane coating system. Surface preparation shall be in accordance with Section 09961 of the specifications. The coating system shall be Imron HG, as manufactured by Dupont or an approved equal. The FRP coating system color shall be white.

2.02 MEMBRANE SKID PROCESS PIPING AND VALVES

A. Membrane Process Piping:

1. Each piping manifold shall be designed to distribute and/or collect flow while minimizing headloss on the process fluid and flow imbalances. Stainless steel piping connections shall be welded, except as required for connection to valves and equipment or to avoid pipe spools longer than 20 feet, in which case, the joints shall have flanged joints, or split couplings.

2. Feed, interstage, and concentrate manifolds and piping shall be fabricated from 316L stainless steel. Concentrate piping shall be constructed of 316 L stainless steel up until 5 feet beyond the back-pressure control valve after which shall be constructed of Schedule 80 PVC in accordance with Section 15070 – Schedule 80 Polyvinyl Chloride (PVC) Pipe and Fittings. PVC piping shall be designed for 100 psig working pressure. Manifolds shall be fabricated in accordance with Section 15066 – Stainless Steel Pipe and Fittings, and as modified herein. Stainless steel piping shall be designed maximum projected working pressure (based on membrane projections) and shall include additional operating pressure for fouled/scaled membrane elements and losses in the RO skid manifold piping. Piping wall thickness shall be designed for the hydrostatic test pressure as required in Section 15044 – Pressure Testing of Piping. Calculations of wall thickness shall be based on the minimum wall thickness due to manufacturing tolerances, a joint efficiency of 70%, and a safety factor of 5 to 1. Pipe wall thickness shall be Schedule 40S minimum. Coupling grooves in Schedule 40S pipe shall be cut, not rolled. No field welding of skid piping will be permitted. The membrane OEM shall provide flanges or grooved couplings where required for field assembly. Flanges shall be manufactured to ANSI B16.5, slip-on or weld neck.

a. 316L stainless steel skid manifold piping shall be welded seam, annealed after welding, and electropolished inside and out in conformance with ASME B912.

b. 316L stainless steel skid manifold piping shall be designed for a velocity of five (5) to eleven (11) feet per second for process and cleaning flows unless otherwise approved by the Engineer.

c. The high points of the vertical manifold risers shall each be provided with a ¼-inch stainless steel connection and tubing for use as a manual air release line. The tubing shall be directed down the header vertically with the ¼-inch stainless plug valve located at 42-inches above the finished floor. The low points of manifolds shall be provided with ¾ inch NPT connections for drains. The high points of the permeate piping shall be provided with minimum 1-inch NPT connections for air relief valves and minimum 2-inch NPT connections for vacuum breaker valves as shown in the Drawings. Discharge of water from the manual air release line and manifold drains shall be routed to the sample panel via flexible nylon tubing. Operators shall be able to control

the air release valves and manifold drains directly from the sample panel.

d. The feed, interstage, and concentrate manifolds shall be connected to the pressure vessel ports with 1-1/2, 2, or 2-1/2-inch flexible grooved connectors. Lateral alignment between the manifold and vessel side ports shall be within 0.0030 inches and angular alignment shall be within 1.5 degrees unless more stringent alignment is specified by the vessel or coupling manufacturers, in which case, the closer tolerance shall apply.

e. Manifolds and piping shall be securely supported from the membrane system support structure or the floor. Manifold support stanchions that are welded to the manifold shall be the same material and finish as the manifold. For side ported vessels, provisions must be made in either the feed or concentrate manifold of each stage to allow for movement of the manifold with vessel side ports as the vessel length expands under pressure. Manifolds shall not rely upon mechanical-type coupling joints to support the coupled sections of manifolds.

f. Each manifold shall be provided with 3/8-inch NPT connections for sample points and 1/2-inch NPT connections for pressure instruments as indicated on the Drawings.

g. All finish hardware for the skid piping shall be bright finish Type 316 stainless steel.

h. Flexible Grooved joint connectors for the reverse osmosis skid piping shall be 316L stainless steel, conforming to ASTM A351. Fastening hardware shall be Type 316L stainless steel and the gasket material shall be EPDM. Grooved connectors shall be Schedule 40S minimum, and suitable for the working pressure of the piping system. Joint connectors shall be manufactured by Piedmont Pacific Corp., Victaulic Company of America or approved equal.

3. Permeate manifolds and piping, cleaning manifolds and piping, and concentrate piping downstream from the concentrate control valve on each skid up until the manifolds shall be fabricated from Schedule 80 PVC in accordance with Section 15070 – Schedule 80 Polyvinyl Chloride (PVC) Pipe and Fittings. PVC piping shall be designed for 100 psig working pressure. Coupling grooves in Schedule 80 pipe shall be compatible with flexible type couplings.

a. PVC manifolds and piping shall be finished in accordance with Section 09961 – High Performance Paints and Coating.

b. PVC manifolds and piping shall be designed for a maximum velocity of 7 feet per second (fps) for process and cleaning flows unless otherwise approved by the Engineer.

c. PVC manifolds and piping shall be securely supported from the membrane system support structure or the floor in accordance with Section 15126 – Pipe Hangers and Supports.

d. Grooved joint connectors may be used for final assembly of fabricated PVC piping or at transitions from PVC to stainless steel piping. Grooves cut in Schedule 80 PVC piping shall maintain a pressure rating that is greater than the test pressure per Section 15044, or the working pressure multiplied by a safety factor of 1.5, whichever is higher. Grooved joint connectors shall be as specified in 2.02, A, 4, h above.

B. Membrane Process Valves:

1. Feed, interstage, concentrate control valves, cleaning isolation valves, and tune up valves shall be made of 316 stainless steel unless noted otherwise herein. Isolation and check valves on the total permeate piping shall be made of type 316 stainless steel. Valves shall be provided in accordance with Section 15100 - Valves and Appurtenances and Section 15105 – Process Control Valves.

a. Isolation Valves: Stainless steel isolation valves shall be furnished as shown in the drawings to allow isolation of the feed, interstage, and concentrate piping during cleaning. Valves for isolation of stainless-steel piping 4-inches in diameter and greater shall be type BFV4 butterfly valves as specified in Section 15100.

b. Feed Control Valves: Modulating feed control valves shall be provided on the proposed skids. The valves shall be high performance butterfly valves. The valves shall meet the performance criteria as listed in Section 15100.

c. Concentrate Control Valves: Modulating concentrate control valves shall be provided on the proposed skids. The valves shall be rotary ball control valves with electric motor operators. The valves shall meet the performance criteria as listed in Section 15105.

d. Total Permeate Isolation Valves: Total Permeate Isolation Valves shall be provided on each of the individual skid's total permeate piping. The valves shall be as specified in Section 15100.

e. All valves installed on each RO membrane skid shall be mounted in such a position that the valve position indicators are plainly visible when standing on the floor. All valves installed on each RO membrane skid of the same type shall be from one manufacturer. All valves installed on each RO membrane skid shall be convenient for manual operation by hand from the floor by operators, using a valve chain wheel where required.

2. Small diameter valves on the permeate piping and concentrate check valves shall be thermoplastic construction in accordance with Section 15100 - Valves and Appurtenances, and as specified herein.

a. Combined Permeate and Permeate to Waste Isolation Valves: Isolation valves shall be furnished as shown in the drawings to allow isolation of the cleaning permeate piping. Valves shall be as specified in Section 15100.

b. Permeate and Concentrate Check Valves: Wafer body thermoplastic check valves shall be furnished as shown in the drawings to prevent backflow in the RO concentrate piping. Check valves shall be type CV8 as specified in Section 15100 – Valves and Appurtenances.

c. Vessel Profiling Valves: Each pressure vessel shall be equipped with a full port 3/8-inch PVC ball valve for sampling and for insertion of tubing to enable profiling of the membrane pressure vessel. Vessel profiling ball valves shall be as manufactured by Asahi/America, Plastomatic or Engineer approved equal.

d. Air Release Valves: Provide one air release valve on the permeate piping loop each skid. The valves shall be type ARV as specified in 15100.

e. Permeate Backpressure Valve: Provide one permeate backpressure valve to be type DV3 as listed in Section 15100.

f. Vacuum Breaker Valves: Provide one vacuum breaker valve on the permeate piping loop each skid. The valves shall be type VRV1 as specified in Section 15100.

g. Permeate Pressure Relief: Provide one rupture disk for pressure relief on the total permeate piping of each skid (existing and proposed) and 1 spare for each installed unit. Rupture disk shall be the Zook Mono Type with Burst Sensor or engineer approved equal.

2.03 ACCESSORIES

A. Cleaning Connections:

1. Cleaning connections shall be provided on the feed, interstage and concentrate piping, as indicated on the design drawings.

2. The skids shall be constructed with isolation valves to enable each of the two trees of the first stage, and the one tree of the second stage to be isolated and cleaned independently without the dismantling of the interconnecting feed piping.

B. Instrument and Sample Panels:

1. The membrane OEM shall provide instrument and sample panels for each of the RO treatment skids. Each skid panel shall be fabricated from white FRP or white PVC. Panels shall be fitted with sample valves. There shall be one permeate sample valve for each pressure vessel on the skid, plus 1st stage feed and permeate, 2nd stage feed and permeate, combined permeate, and concentrate. The skid sample panel shall also be equipped with a minimum 6-inch wide by 6-inch deep trough, of the same material as the panel, which will be drained through a 1.5-inch PVC pipe. Sample valves shall be arranged in horizontal rows, with the rows staggered so that the upper valves discharge between the lower valves. Each valve will be fitted with PVC discharge spout, to prevent splashing. Sample tubing and valves shall be polypropylene and PVC, respectively for permeate samples and Alloy 400 (Monel) for all RO feed, interstage, and concentrate samples. All spouts shall be cut so that all discharges are horizontally aligned. The RO instrument and sample panel is detailed in the design drawings and specified in more detail under Section 11257: Reverse Osmosis Process Panels and Racks.

C. Sample Tubing and Valves:

1. High Pressure Samples: Tubing, fittings, and connectors shall be 1/4-inch 316 stainless steel, Swagelok or engineer approved equal. Valves shall be as listed under Section 15100 for BV7.

2. Low Pressure Samples: Tubing connectors to be Parker black polypropylene design. Valves shall be as listed under Section 15100 for BV7.

3. All sample tubing shall be neatly bundled and enclosed in Schedule 40 PVC piping from the areas near the sampling points to the sample panel. The bundled sample lines shall enter and exit the Schedule 40 PVC through machined openings and all pipe ends shall be capped.

2.04 SPECIAL TOOLS AND SPARE PARTS

A. General: Special tools and spare parts shall be furnished by the manufacturer of the respective equipment item. Spare parts shall be suitable packages labeled with respect to their contents and delivered to the Owner. Indicated quantities below do not include installed items or items consumed by the Membrane OEM during installation and start-up.

B. Spare Parts:

1. Spare components for the membrane elements, including:

a. Twenty (20) brine seals for use with the membrane elements.

b. Two (2) lots (25 minimum per lot) of O-rings or other types of seals for element permeate tube interconnectors.

2. Spare components for pressure vessels, including:

a. Ten (10) product water tube (PWT) adaptor seals.

b. Ten (10) PWT adaptors with seals.

c. Ten (10) head seals.

d. Ten (10) sets of head retaining rings (with fasteners).

e. Fifty (50) PWT shims.

f. Three (3) complete head assemblies.

g. Six (6) permeate rupture discs.

C. Special Tools:

1. One (1) set of head retainer ring pliers or other tools required for vessel head removal.

2. One (1) battery operated, hand-held, digital conductivity meter capable of measuring and indicating sample conductivities from 0 to 20 mS/cm, adjustable over 4 ranges. The meter shall have an integral sample cup and be automatically temperature compensated.

3. One (1) manual SDI test apparatus including a pressure regulator, micron filter pad holder, 500 mL graduated cylinder, hoses with connectors, and two hundred 0.45-micron filter pads, as defined in 2.04C.1.

D. Two (2) probing apparatus utilizing 1/4-inch nylon tubing shall be provided.

PART 3 - EXECUTION

3.01 PREPARATION

A. Painting and Finishing

1. All surfaces shall be factory finished and/or coated in a manner suitable for their particular uses in the plant. Such finishes and/or coatings shall be clearly indicated and specified on the shop Drawings and shall require the Engineer's approval. Alkyd coating systems will not be acceptable and epoxy, vinyl and epoxy ester coating systems will generally be acceptable depending upon the application. On completion of the installation, all surfaces shall be touched up where necessary with a coating similar to that applied at the factory.

2. All exposed metal surfaces not specified for a special coating system, and with the exception of stainless steel, shall have one of the applicable coating systems as specified in Section 09961: High Performance Paints and Coatings.

3.02 INSTALLATION

A. All equipment shall be installed in accordance with the manufacturer's recommendations and the approved shop drawings, and all work shall be performed by experienced personnel in accordance with recommended practices. The membrane OEM shall provide oversight and supervision during installation and integration of the RO trains.

B. All equipment and material shall be installed plumb and/or horizontal within one-quarter inch in ten feet and conform to the reviewed shop drawings.

C. Support structures or skids shall be anchored to the building floor, and grouted in place with non-shrink grout after final alignment.

D. The RO skid process piping and pressure vessels shall be flushed, pressure tested, cleaned/swabbed, and disinfected prior to loading of membrane elements.

E. The membrane OEM shall supervise and assist the Contractor’s personnel with loading the membrane elements into the pressure vessels. The membrane OEM shall provide a minimum of two individuals, of which one individual must be a full-time employee of the membrane OEM for at least one year.

F. A competent and experienced representative or project manager of the selected membrane OEM shall be on site during the entire installation, testing and start-up process for the RO and CIP systems. The membrane OEM representative shall also be on-site for final connection of electrical and instrumentation and control wiring to the membrane OEM supplied RO Skid Instrument Panels.

G. Control system testing and acceptance, final documentation and training shall be required per Basic Instrumentation Requirements Section 13410.

3.03 INSPECTION AND TESTING

A. Factory Performance Testing of specific OEM components shall be performed before delivery to the site to the extent possible:

1. Any software shall be platform tested.

2. Any communication protocol between PLCs shall be platform tested.

B. Functional Testing: Functional testing of the membrane system shall be accomplished utilizing each membrane skid with test orifices installed in the permeate ports of each vessel to simulate pressure drops. Skid and pretreatment system shall be operated at representative

flows with automatic instrument control as required to confirm responsiveness over design operating range.

3. Testing shall continue until the skid can run for 4 consecutive hours without interruption. Two successful start-up and shutdown sequences shall be demonstrated prior to the start of the 4-hour test.

4. Demonstration of correct control loop operation in conjunction with instrument loop testing is also required.

5. Functional testing will not be considered complete until all associated instrument loops have been successfully tested.

6. Each skid shall be tested independently and together for a total of four (4) tests.

7. Data Collection During Functional Test: Continuous water quality and mechanical data shall be collected hourly to verify the proper operation of the instruments unless otherwise indicated during the performance testing.

8. Conclusion of Function Testing: At the conclusion of the functional testing, the vessels shall be disinfected, cleaned with the manufacturer's recommended cleaning agent, and flushed to ensure vessel cleanliness. Vessel interior surfaces shall be thoroughly wiped prior to the loading of the membranes.

9. During membrane loading, the brine seals, O-rings, connectors, anti-telescope device, and physical condition of the module wrap shall be inspected. Serial numbers and pressure vessel location of each membrane element shall be documented, tabulated, and furnished to the Engineer for review. Sanitary conditions shall be maintained throughout the membrane loading activities. Loading shall only be performed by personnel wearing gloves and utilizing a membrane manufacturer approved disinfecting solution to sanitize gloves at regular intervals.

C. Start-Up Testing: Each membrane skid shall be started-up and operated for a total of twelve (12) hours over a 2-day period at design conditions, during which time two (2) consecutive day bacteriological samples shall be taken and tested for bacteriological clearance in accordance with AWWA C653 – Disinfection of Water Treatment Plants. Following the twelve (12) hours of start-up operations, the skid pressure vessels shall be surveyed for mechanical integrity of the membrane elements and permeate tube seals by measuring the permeate conductivity at each vessel. Pressure vessels that yield a permeate conductivity that is outside of one (1) standard deviation from the average for each stage shall be profiled to determine the suspected area of failure. The membrane OEM shall make any changes required to bring the permeate quality of the outlier pressure vessel(s) within the specified range. Final conductivity measurements from the mechanical integrity testing shall be submitted to the Engineer for approval prior to beginning the Performance Testing. Acceptance of these results does not waive the requirements for the membrane

OEM to provide the system performance as specified in 1.01, C, 1, a, above and as verified under 3.03, C, herein.

D. Performance Testing: At the completion of installation and functional testing, all systems related to the RO treatment process shall be cleaned, checked and tested. Each RO treatment unit skid shall then be started up and normal adjustments for operation made. The Contractor shall give, in writing, to the Owner and Engineer seven (7) days' notice that the plant is ready to undergo the performance test.

1. Time of performance testing for the membrane systems shall occur per the plant's startup procedure in Section 01650. Final acceptance of the RO membrane system will be contingent upon successful performance testing.

2. The unit shall be operated at full capacity for a minimum continuous period of 48 hours. During this period, readings shall be taken each 1/2 hour to demonstrate that the permeate water quality specified herein can be met, and to establish baseline operational data for the skids. The CSI shall also take samples and have them analyzed by an HRS approved laboratory for the parameters listed under 1.01,C to demonstrate compliance with the permeate water quality. Two (2) sets of samples shall be taken, one after the first 24 hours of operation and one at the end of the 48 hour test. Feed water quality shall be monitored during the performance testing to establish a level of rejection that is provided by the membrane system. If the feed water quality differs from the values used in the membrane projections, the normalized rejection shall be used to determine the permeate water quality that is required to demonstrate system performance. If the equipment fails to operate continuously due to equipment failure, then the test shall be restarted. In the event any of the guarantees cannot be met, the membrane OEM shall be responsible for making any changes required in order to meet the guarantees. Following the completion of any required changes, the test shall be repeated.

E. Following start-up and initial operation of the RO treatment system, the membrane OEM shall submit a report to the Engineer and Owner with the following information: data showing compliance with the specified performance and water quality parameters, recommendations for proper chemical feed rates, and recommended valve settings for flow control.

3.04 OPERATOR TRAINING

A. The membrane OEM shall be responsible for training the Owner's operating personnel in the operation, trouble-shooting, and maintenance of the RO membrane treatment system and ancillary facilities. Classroom sessions and hands-on training will be required. Classroom instruction shall be given in the following:

1. Basic Water Chemistry.

2. Pretreatment requirements, Scaling and Fouling of Membranes.

3. Basic Theory of Membrane Separation.

4. Description and function of control system components.

5. Routine Plant Operations.

6. Record keeping and normalization.

7. Routine Maintenance Procedures.

8. Emergency Situations.

9. Cleaning Operations (including when to initiate cleaning).

10. Membrane warranty provisions.

B. The operator training program, hands-on portion, shall be provided by the membrane OEM and the instrumentation CSI, and will include the following:

1. Start-up and shut-down procedures.

2. Operations of chemical systems.

3. SDI measurement and vessel profiling.

4. Emergency procedures.

5. Use of control system interface hardware.

6. Instrumentation calibration.

7. Membrane system cleaning.

C. The membrane OEM shall provide to the Engineer, a proposed outline of the operator training program for review, comment, and approval.

D. The operator training program for the RO membrane treatment system and ancillary facilities will be for at least five (5) one-day sessions. Two (2) additional one-day training sessions will be scheduled and approved by the Owner to coincide with the first required cleaning event following start-up. If a cleaning event is not required within the first 18 months of operation, the Owner may use the two (2) additional one-day training sessions for additional classroom or hands-on training.

3.05 QUARTERLY SITE VISITS

A. The Membrane OEM shall provide a service contract during the 1-year warranty period to provide two (2) 8-hour days of on-site technical assistance on a quarterly basis (at a minimum frequency of every 90 days). While on-site the Membrane OEM shall provide a fully qualified field representative. The Owner may request assistance with tasks related to the RO membrane system operations, including, but not limited to: additional training, data collection, data normalization troubleshooting, membrane cleaning, equipment calibration, SOP development.

END OF SECTION

SECTION 11257

PROCESS PANELS AND RACKS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes fabrication and installation of sample panels.

B. Furnish all labor, materials, equipment and incidentals required and install complete, ready for operation, and field test the RO treatment process and related panels and instrumentation as shown on the Drawings and specified herein.

C. It is the intent of these specifications to provide for the design, furnishing and installation of the Process Panels and Racks by the membrane original equipment manufacturer (membrane OEM). The approved membrane OEMs are listed in Section 11250: Reverse Osmosis Treatment System. The only exception to this requirement is for panels/racks that are not connected to the membrane skids, which may be furnished by the I&C System Supplier (Controls System Integrator) at the Contractor's option.

D. Related Work Described Elsewhere:

1. Section 01650: Start-Up and Demonstration.

2. Section 01700: Contract Closeout.

3. Section 06610: FRP Fabrications.

4. Section 09905: Piping, Valve and Equipment Identification System.

5. Division 13: Instrumentation and Controls.

6. Section 15000: Mechanical – General Requirements.

7. Section 15044: Pressure Testing of Piping.

8. Section 15066: Type 316 Stainless Steel Pipe and Fittings.

9. Section 15070: Schedule 80 Polyvinyl Chloride (PVC) Pipe and Fittings.

10. Division 16: Electrical.

1.02 SUBMITTALS

A. Materials and Shop Drawings:

1. Copies of all materials required to establish compliance with the specifications shall be submitted in accordance with the provisions of Section 01340: Shop Drawings, Working Drawings and Samples of these Specification. Submittals shall include at least the following:

a. Detailed shop and erection Drawings showing all important details of construction, dimensions, materials of construction and anchor bolt locations.

b. Descriptive literature, bulletins, and/or catalogs of all equipment to be furnished.

c. Data including principle dimensions, materials and construction, space required, clearances, piping and electrical connections and requirements, type of finish, installation instructions and other pertinentinformation.

d. A complete total bill of materials of all equipment including the weights of equipment furnished.

e. Complete product literature, wiring diagrams and schematics of the controllers, control devices and related components.

f. Complete wiring diagrams and schematics of all power and control systems showing wiring requirements between all system components, motors, sensors, terminal panels, etc., including connections to work of other Sections.

g. Performance data for all items of equipment.

h. A list of the manufacturer's recommended spare parts including manufacturer's name, address, telephone number, part number and description.

i. Detailed drawings of process sample panels and all equipment associated therewith.

j. Schedule of sample stream flow rates required by each proposed analyzer device, and the associated selection of sample pumps (where applicable) and sizing of sample piping and valves.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Sample panels shall be shop assembled to the extent possible and where required by other Sections. Parts and assemblies that are shipped unassembled shall be suitably packaged for protection against damage.

1.04 WARRANTY AND GUARANTEES

A. Provide equipment warranty as specified in Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for two (2) years, commencing at the time of final acceptance by the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555.320(3) Florida Administrative Code.

2.02 RO PROCESS PANELS

A. RO Skid Instrument and Sample Panels (Typical of 2) (ISP-07X1)

1. The Membrane OEM shall provide one (1) instrument panel and one (1) sample panel each for the two (2) new individual RO treatment trains. All instrumentation associated with an individual RO process skid following the RO Feed pump shall be provided on each RO Skid Instrument panel, for a total of two (2) instrument panels and two (2) sample panels.

   The instrument panel shall be free-standing and include a wet area for process sample valves and pressure devices, and NEMA 4X rated instrumentation and electrical termination enclosures. Instrumentation shall be provided as shown on the design drawings and listed herein (X indicates number of skid, e.g., 3 or 4):

   a. Stage 1 Feed Pressure (PIT-7X1)

   b. Stage 1 Concentrate / Stage 2 Pressure (PIT-7X2)

   c. Stage 2 Concentrate Pressure (PIT-7X3)

   d. Total Permeate Pressure (PIT-7X4)

e. Stage 1 Permeate Flow (FIT-7X1)

f. Stage 2 Permeate Flow (FIT-7X2)

g. Total Concentrate Flow (FIT-7X3)

h. Total Concentrate Conductivity (AIT-7X2)

i. Total Permeate Conductivity (AIT-7X1)

j. Three-Way Pressure Indicator with Manual Selector Dial (Feed Pressure, Stage 1 Concentrate Pressure, Stage 2 Concentrate Pressure)

k. Three-way Pressure Indicator with Manual Selector Dial (Stage 1 Permeate Pressure, Total Premeate Pressure, Total Concentrate Pressure.

2. The sample panel shall consist of a wet panel for pressure devices with labeled sample valves and a drain trough. Sample tubing/valves shall be provided as shown on the design drawings and listed herein:

a. Permeate Sample from Each Pressure Vessel (39) with space for nine (9) additional future samples for a total of (48).

b. Combined Permeate Sample from Each Pressure Vessel Array (3)

c. Feed, Interstage and Concentrate Samples

2.03 MATERIALS AND EQUIPMENT

A. General

1. Materials:

a. Construct sample panels of FRP flat sheets and parts in accordance with Section 06610.

b. Structural components shall be FRP structural shapes complying with ASTM D-570 for water adsorption.

c. Fasteners shall be FRP rivets or, where required by the structural engineer, FRP bolts and nuts.

2. Structural Criteria:

a. The panels shall be suitable for all loads imposed.

b. Comply with the 2017 Florida Building Code.

3. Access Requirements:

   a. All process panels shall be configured so that the panel face can be easily removed and swung open on hinges for access to sample tubing and wiring. Hinges and hardware shall be constructed of 316/316L stainless steel, and the hinges shall not be visible when panel is in its normal position. The membrane OEM shall submit the design of the sample tubing access system for review and approval.

4. Coatings:

   a. Coating on FRP shall be as specified in Section 09961.

   b. The color shall match the RO Membrane System support frame and pressure vessels.

5. Sample and Impulse Tubing

   a. Sample and impulse tubing shall be provided from RO process piping to the RO panels specified herein, with sample return lines to process piping or sample waste to floor drains as shown in the design drawings. Low pressure (150 psi working pressure or lower) sample tubing shall be black polypropylene flexible tubing rated for a minimum of 250 psi, as manufactured by Parker or approved equal. Process tubing operating with higher working pressures shall be 316 stainless steel with compression fittings and appurtenances with plastic tube inserts, Swagelok or engineer approved equal as specified in Section 15066: 316 Type Stainless Steel Pipe and Fittings.

   b. Sample tubing shall range from 1/4-inch diameter through 3/4-inch diameter in size, with tubing sizing based on submitted instrumentation sample flows and sample tap flows, as confirmed by the panel supplier.

   c. Impulse tubing for pressure devices (gauges, transmitters, and switches) shall be 3/8-inch diameter in size.

6. Drainage:

   a. Sample ports on process panels shall be equipped with a minimum 6-inch wide by 6-inch deep trough, of the same material as the panel.

   b. Panel drain troughs shall be drained through a 1.5-inch Schedule 40 PVC pipe, field routed to the closest trench floor drain.

7. Sample Taps:

   a. Sample taps (valves) shall be mounted to the panel front and arranged in horizontal rows, with the rows staggered so that the upper valves discharge between the lower valves. Each valve shall be fitted with a 1/4- inch tubing discharge spout, to prevent splashing. All spouts shall be cut so that all discharges are horizontally aligned. The sample panels are detailed in the design drawings.

   b. Sample tap valves on systems with working pressure below 100 psi shall be ¼-inch PVC, 1/4 turn labcock valves by Asahi. Sample tap valves for working pressures above 100 psi shall be stainless steel 1/4 turn plug valves, 1/4-inch size, as manufactured by Swagelok, NUPRO or Ham-Let, or approved equal.

   c. Low pressure tubing shall be 1/4-inch black flexible polypropylene tubing rated for a minimum of 250 psi. High pressure tubing and tubing connectors shall be stainless steel, 1/4-inch steel design, with plastic tube inserts, Swagelok, or Engineer-approved equal.

   d. Tubing shall be routed from sample points to the sample panel using Schedule 40 PVC tube chases as specified in Sections 11250.

   e. Where visible, tubing shall be neatly arranged and bundled where possible. Bundles shall be retained with nylon “Tywraps”, or approved equal.

8. Multi-Port Valve (MPV):

   a. Multi-Port valves (MPV) shall be provided where required as shown on the design drawings. MPVs shall have a working pressure up to 500 psi and shall sustain temperatures of up to 200^{O}F (93^{O}C). Sizes shall range from 1/4-inch to 1/2-inch and shall have 6, 8 or 12-mm end connections. Multi-Port valves shall be manufactured by Swagelok, or Engineer-approved equal.

9. Labels:

   a. All instruments and panels shall be labeled in accordance with Sections 09905. Each instrument indicator shall have a label identifying the tag number and service (e.g. AIT-732 – Concentrate Conductivity). Identification plates shall be as specified in Section 9905.

10. Field Instrumentation:

    a. Field instrumentation shall be as specified in Division 13.

11. Cables and Sample Tubing:

a. All cables and sample tubing runs shall be on the backside of the panel and shall only penetrate the face of the panel adjacent to the instrument that they serve, if applicable. Location of all cable and sample panel penetrations shall be reviewed and approved prior to construction.

12. Electrical Terminations

a. Provide NEMA 4X rated electrical termination panels fabricated of Type
316 stainless steel for termination of instrumentation signals and electrical power to instrument transmitters. A main circuit breaker along with distribution circuit breakers and terminal block shall be provided. Electrical and Instrumentation work shall be in accordance with Division 13 and Division 16.

2.04 ANCHORAGE AND SUPPORT

B. Panels shall be supported from the floor or adjacent wall (where applicable). Anchors, bolts, nuts, and washers shall be Type 316 stainless steel. Use anti-seize lubricant to prevent galling of stainless steel fasteners.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions and as specified.

3.02 FIELD QUALITY CONTROL

A. Pipeline and Tubing:

1. Testing shall be in accordance with Section 15044: Pressure Testing of Piping.

END OF SECTION

SECTION 11300

CARBON DIOXIDE STORAGE AND PRESSURIZED SOLUTION FEED SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Scope of Work:

1. Furnish all labor, materials, equipment, and incidentals required and install, make ready for operation, and field test a carbon dioxide storage and feed system as specified herein and as shown in the Drawings.

2. The work covered in these specifications includes the design, furnishing, installation, and testing of a complete carbon dioxide storage and feed system, including one (1) liquid carbon dioxide storage tank system complete with refrigeration system, vaporizer, and vapor heater, regulators, one (1) automatic pressurized solution feed panel system, two (2) solution feed diffusers, pH analyzer and transmitter, controls, instrumentation and all piping, valves, and other appurtenances necessary for a complete system. **A Bid Alternate is also described for the addition of a second Pre-Degasification liquid carbon dioxide pressurized solution feed panel system and associated appurtenances, which will be implemented in the project at the discretion of the Owner. Refer to bold sections throughout this specification for Bid Alternate information.**

3. It is the intent of the specifications to provide a complete, operable carbon dioxide feed system, which shall function as specified herein. The Contractor shall furnish all items required to provide a complete system regardless of whether or not such items are specifically mentioned in these specifications or shown on the Drawings.

B. Related Work Described Elsewhere:

1. Section 01340: Shop Drawings, Working Drawings and Samples

2. Section 01600: Material and Equipment

3. Section 01650: Start-Up and Demonstration

4. Section 01730: Operating and Maintenance Data

5. Section 01740: Warranties and Bonds

6. Section 09961: High Performance Paints and Coatings

7. Section 11217: Vertical In-Line Centrifugal Pumps

8. Section 15000: Mechanical – General Requirements

9. Section 15044: Pressure Testing of Piping

10. Section 15064: Polyvinyl Chloride (PVC) Pipe and Fittings

11. Section 15066: Type 316 Stainless Steel Pipe and Fittings

12. Section 15070: Schedule 80 Polyvinyl Chloride (PVC) Pipe and Fittings

13. Section 15126: Pipe Hangers and Supports for Process Piping

14. Division 13: Instrumentation and Control

15. Division 16: Electrical

1.02 DESCRIPTION OF SYSTEM

A. General: All of the equipment specified herein shall be furnished by a single manufacturer and shall be in complete conformity with these Specifications. The Manufacturer and Contractor are responsible for furnishing and installing all equipment necessary for a fully operational system as specified herein and shown on the Drawings. All of the equipment specified herein is intended to be standard equipment for use in a carbon dioxide storage and feed system.

B. System Operation:

1. General: The carbon dioxide storage and feed system specified shall be furnished for the generation and feed of carbonic acid solution at two (2) injection applications points within the South Regional Water Treatment Plant, including (a) pH adjustment of the RO blended water prior to degasification and (b) pH adjustment and stabilization of the RO Blended water after degasification.

a. The application of generated carbonic acid solution to the RO blended water prior to degasification **(Bid Alternate 1)** will reduce the pH for hydrogen sulfide removal by the downstream degasification system.

b. The application of generated carbonic acid solution to the degasified water will increase the buffering capacity, aid in pH control, and allow the alkalinity to be increased by subsequent sodium hydroxide addition within the chlorine contact and blending basin.

c. The pH adjustment of the degasified water will be accomplished by using carbonic acid solution from one (1) respective carbon dioxide pressurized solution feed panel system. The carbon dioxide pressurized solution feed panel system shall mix carbon dioxide gas, which will be drawn under low pressure from one (1) shared carbon dioxide storage tank, with carrier water to produce a carbonic acid solution. The carrier water source shall

be supplied from the 24-inch reverse osmosis blended water (ROBW) as shown in the Drawings.

d. **Bid Alternate (Pre-Degasification CO_2 Feed System): The pH adjustment of the RO blended water will be accomplished by using carbonic acid solution from one (1) respective carbon dioxide pressurized solution feed panel system. The carbon dioxide pressurized solution feed panel systems shall mix carbon dioxide gas, which will be drawn under low pressure from one (1) shared carbon dioxide storage tank, with carrier water to produce a carbonic acid solution. The carrier water source shall be supplied from the 24-inch reverse osmosis blended water (ROBW) as shown in the Drawings.**

2. Carbon dioxide gas will be fed on a continuous basis to the solution feed panel system(s). Liquid carbon dioxide will be vaporized and maintained at 300 psig and 0 degrees Fahrenheit in the area above the liquid in the storage tank. From the vapor outlet of the tank, the carbon dioxide gas shall be piped to a vapor heater where it shall be heated to near room temperature. After the vapor heater, the carbon dioxide gas will pass through two regulators for pressure reduction. The first stage regulator will reduce the pressure from approximately 300 psig to 120 psig. After the pressure reduction, the carbon dioxide gas will be piped to the carbon dioxide pressurized solution feed panel system where the second regulator (on each panel system) will reduce the pressure from 120 psig to the required operating pressure. Downstream of the second pressure regulator on the solution feed panel, carbon dioxide vapor will be diffused with an injector into a carrier water line taken from the 24-inch ROBW line via booster pumps.

3. Two (2) in-line static mixers (on each panel system) will continuously mix the carbon dioxide vapor and carrier water in a side stream to form a high pressure carbonic acid solution.

4. For the CO_2 application to the RO blended water prior to degasification Bid Alternate, the rate of carbon dioxide mass feed to the carrier water and water injection point will be automatically adjusted based on a pH set-point and pH feedback transmitter. The pH set-point for the RO blended water will be based on the target pH for degasification after carbon dioxide addition. Carbon dioxide flow to the panel will be controlled by a carbon dioxide control valve, with a 10:1 turndown, that opens when there is flow to the degasification system and closes when water is not being supplied. Control of the system will be provided within a master control panel through the use of a programable logic controller (PLC).

5. For the CO_2 application to the degasified water, the rate of carbon dioxide mass feed to the carrier water and water injection point will be automatically adjusted based on a carbon dioxide dose set-point and the plant supply water flow. The carbon dioxide feed rate will be automatically trimmed according to a water pH set-point. The pH set-point for the degasified water will be based on the finished

water pH after sodium hydroxide addition. Carbon dioxide flow to the panel will be controlled by a dual gas fed train with high and low flow carbon dioxide control valves, each with a 10:1 turndown, that open when there is flow to the degasification system and closes when water is not being supplied. Control of the system will be provided within a master control panel through the use of a programmable logic controller (PLC).

6. The carbon dioxide pressurized solution feed system shall be provided with a CO_2 Master control panel with a PLC to control the pre degasification Bid Alternate and post degasification feed panels.

   a. For the pre-degasification CO_2 application Bid Alternate, the Master Control Panel shall receive a pH set point and pH transmitter signal on which the carbon dioxide feed rate is controlled. The pH transmitter signal will be from the pH analyzer after CO_2 addition for pre-degasification pH adjustment. A carbon dioxide mass flow meter, and transmitter will monitor the carbon dioxide mass flow rate for the pressurized solution feed panel and send an analog signal to the PLC. The PLC will evaluate the carbon dioxide dosage based on a pH set-point and pH transmitter signal and will transmit a proportional signal to the electro-pneumatic transducer to control the carbon dioxide control valve. The electro-pneumatic I/P transducer in the pressurized solution feed panel will utilize pressurized carbon dioxide gas for pneumatic control.

   b. For the post degasification CO_2 application, the Master Control Panel shall receive a carbon dioxide dose (mg/L) set-point, pH trim set-point, and plant water flow signal on which the carbon dioxide feed rate is calculated. A carbon dioxide mass flow meter, and transmitter will monitor the carbon dioxide mass flow rate for the pressurized solution feed panel and send an analog signal to the PLC. The PLC will evaluate the carbon dioxide dosage along with the plant flow, and then transmit an electronic signal from an electro-pneumatic I/P transducer to control the carbon dioxide control valves. Additionally, in the event that the pH set-point after carbon dioxide and sodium hydroxide addition is exceeded at the pH monitoring point, a pH signal will be sent to the PLC to override the plant flow and carbon dioxide flow signals, and then adjust the respective carbon dioxide dosage. The electro-pneumatic I/P transducer in the pressurized solution feed panel will utilize pressurized carbon dioxide gas for pneumatic control.

7. The plant design flow that the carbon dioxide system will be treating will range from 2.0 to 6.0 MGD for this expansion phase. Upon further expansion in the future, the plant design flow rate will range up to 10.0 MGD.

8. Flow Conditions Summary – Bid Alternate - Pre-Degasification Carbon Dioxide Pressurized Solution Feed System (PSF No. 1):

Plant water flow:	2.0 – 6.0 MGD (10 MGD ultimate maximum)
Carbon dioxide dosage:	12 – 120 pounds per hour
Carrier water flow:	120 gpm
Carrier water pressure:	60 – 100 psig

9. Flow Conditions Summary – Post-Degasification Carbon Dioxide Pressurized Solution Feed System (PSF No. 2):

Plant water flow:	2.0 – 6.0 MGD (10 MGD ultimate maximum)
Carbon dioxide dosage:	5 – 120 pounds per hour
Carrier water flow:	120 gpm
Carrier water pressure:	60 – 100 psig

1.03 QUALITY ASSURANCE

A. The equipment furnished shall be products of a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the equipment to be furnished. The system components shall be designed, constructed, delivered, and installed in accordance with the best practices and methods.

B. In order to provide unit responsibility, all equipment specified under this section shall be furnished by a single supplier. The supplier shall be responsible for all coordination of system design, fabrication, manufacture and shipping. The manufacturer, supplier, and the Contractor shall together assume complete responsibility for the proper installation and operation of the entire carbon dioxide storage and feed system. The Manufacturer shall have a minimum of five (5) years of experience in the production of carbon dioxide storage and feed equipment.

C. The Manufacturer shall have evidence that the Manufacturer's feed panel of equivalent or larger capacity and carbon dioxide storage tank of equivalent or larger capacity in a municipal drinking water application has been in successful operation for at least five (5) years.

D. Acceptable manufacturers: TOMCO$_2$ Equipment Company or Engineer Approved Equal. Any design or construction changes required to the layout, piping layout, pipe sizes, equipment configuration, electrical, and the like as shown on the Drawings and/or installation including all support appurtenances due to the furnishing of system provided by an alternate manufacturer shall be the responsibility of and at the expense of the Contractor.

1.04 SUBMITTALS

A. Submittals of all materials and equipment required to establish compliance with these Specifications shall be submitted in accordance with the provisions of Section 01340: Shop Drawings, Working Drawings and Samples. Submittals shall include at least the following:

1. Descriptive literature, bulletins, catalogs, and catalog cut sheets of each item of equipment.

2. ASME Code for Unfired Pressure Vessels certifications.

3. The empty weight and the maximum operating weight of each major item of equipment.

4. Certified shop and erection drawings showing all important details of construction, dimensions, and anchor bolt locations. Shop drawings shall also show complete information regarding location, size, type, and length of all welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society. Special conditions shall be fully explained by notes or details.

5. Complete piping and valving layouts and schematics for the carbon dioxide feed system equipment supplied.

6. A complete, total bill of materials and parts list for all equipment.

7. A list of the manufacturer's recommended spare parts and special tools. Include gaskets, packing, and other parts on the list.

8. List of local facilities and service organizations to obtain parts and service labor.

9. Complete installation, handling, and storage instructions.

10. Complete electrical and control schematics and interconnecting wiring diagrams and schematics showing extent of factory prewiring and required field wiring. Diagrams and schematics shall indicate all power and control systems including wiring requirements between all system components, motors, sensors, control panel and related systems, including connections to the work of other trades and Specification Sections.

B. Prepare the above information as a single package shop drawing submittal.

1.05 OPERATING INSTRUCTIONS

A. Operating and maintenance manuals shall be furnished to the Owner and Engineer in accordance with Section 01730: Operating and Maintenance Data. The manual shall be prepared specifically for this installation and shall include all required bulletins, catalog cut sheets, drawings, equipment lists, descriptions, and necessary information that are required to instruct operating and maintenance personnel unfamiliar with all of the equipment specified herein. A complete, corrected, and approved copy of the shop drawing submittal shall be included with each manual provided.

B. The operation and maintenance manuals shall be provided at a time in advance of the instruction and training period that is approved by the Owner.

1.06 TOOLS AND SPARE PARTS

A. Special tools required for normal operation and maintenance shall be supplied for each piece of equipment furnished.

B. Each piece of equipment shall be furnished with the manufacturer's recommended spare parts and shall include, as a minimum but not be limited to, the following:

1. One (1) complete maintenance package for the carbon storage tank's refrigeration, evaporation, and heater units as recommended by the manufacturer.

2. One (1) complete rebuilding kit for the carbon dioxide control valves.

C. All tools and spare parts shall be furnished in containers clearly identified with indelible markings as to their contents. Each container shall be packed with its contents protected for long-term storage.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The manufacturer of the equipment shall deliver a complete system ready for installation by the Contractor.

B. All equipment shall be crated, delivered, and uncrated so as to protect against any damage.

C. All equipment and material shall be stored in a clean, dry, weathertight building. All equipment and material 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 and the equipment is ready for operation.

D. Handle all equipment and materials during delivery, storage, and installation in a manner to prevent damage of any nature and in accordance with manufacturer's approved instructions.

E. The finished surfaces of all exposed flanges shall be protected by wooden blank flanges, strongly built and securely bolted thereto.

F. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

G. Any dismantled parts delivered with permission from the Engineer shall be properly labeled and/or tagged to provide for ease of re-assembly.

1.08 WARRANTY AND GUARANTEES

A. Provide equipment warranty as specified in Section 01740: Warranties and Bonds. The Manufacturer's warranty period shall be concurrent with the Contractor's for at least two (2) years, commencing at the time of final acceptance by the Owner. Guarantee shall cover all necessary labor, equipment, materials, and replacement parts resulting from faulty or inadequate equipment design, improper assembly, defective workmanship and materials, leakage, breakage or other failure of all equipment and components furnished.

B. Furnish to Engineer a written certification signed by the manufacturer's representative that the installed equipment:

1. Has been installed per manufacturer's requirements.

2. Is ready to be operated on a continuous basis, and is free from any known defects.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT - GENERAL

A. These Specifications are intended to give a general description of what is required but do not cover details of construction which may vary in accordance with the exact requirements of the equipment as offered. They are, however, intended to include the furnishing, shop testing, delivery, installation, supervision, and field testing of all materials, equipment and appurtenances for the carbon dioxide storage and feed system as herein specified, whether specifically mentioned in these Specifications or not. Also included in these Specifications is the instruction of the regular operating personnel in the care, operation and maintenance of all equipment.

B. All necessary accessory equipment and auxiliaries required for the proper functioning of the carbon dioxide feed system installation, incorporating the highest degree of standards for the specified type of service, shall be furnished by the system supplier whether or not specifically mentioned in these Specifications or shown on the Drawings.

C. All hardware shall be 316 stainless steel.

D. All water treatment chemicals and materials that will come into contact with drinking water shall comply with the requirements of NSF/ANSI 60 and NSF/ANSI 61.

2.02 LIQUID CARBON DIOXIDE STORAGE TANK

A. One (1) liquid carbon dioxide storage tank shall be provided. The storage tank shall be horizontal with I-beam frame and capable of holding 100,000 lbs. (50 tons) of liquid carbon dioxide at 300 psi and 0 degrees Fahrenheit. The storage unit shall consist of a welded carbon steel pressure vessel designed and constructed in accordance with Section VIII, Division 1 of the ASME Code for Unfired Pressure Vessels with a maximum allowable working pressure of 350 psi. The tank shall be furnished complete with a liquid level

gauge with a 6-inch dial and a transmitter calibrated to read in pounds, a 0 to 600 psig pressure gauge with a 6-inch dial and a transmitter, and all necessary schedule 80 pipe connections for filling and withdrawal of carbon dioxide from the storage tank. The level transmitter and the pressure transmitter shall each send a 4-20 mA signal to the plant SCADA system for indication of tank liquid level in pounds and pressure (psi), respectively. The tank shall have approximate dimensions of 56'-6" long x 7'-8" wide x 9'-0" high. Tank shall be TomCO2 Model 5075CA C-series, or Approved Equal.

B. The tank shall be insulated with a urethane foam type insulation. The vessel shall be applied with a primer prior to insulation. Prior to prime coating, all metal surfaces of the equipment within the system shall be thoroughly clean, dry, and free from all mill scale, rust, grease, dirt, paint, and other foreign substances. The insulation shall be a minimum of 4-inches thick and shall be covered with a 0.063-inch factory painted white aluminum shell. The ends shall be covered with aluminum pre-formed flanged and dished heads. The thermal conductivity (U-factor) for the insulated tank wall shall be a maximum of 0.04 Btu/hr • ft^2 • degrees F.

C. The proposed storage tank shall be furnished with an enclosure at one end to provide weather protection for the refrigeration unit, vaporizer, vapor heater, electrical and control equipment, piping, and valves. The enclosure shall consist of an aluminum structural frame covered with aluminum sheeting. The aluminum sheeting shall have a minimum thickness of 0.04 inches. The enclosure shall be furnished with a lockable hinged door for access. Enclosure shall provide adequate ventilation for the enclosed equipment. Enclosures shall be self-supporting without requiring additional or external structural support.

D. The storage tank, enclosure, frame, and other exposed metal surfaces shall be painted in accordance with the Manufacturer's standards for carbon dioxide service. Final finish coatings shall be polyurethane or equal coating system to provide UV resistance without chalking or fading.

E. The tank shall be protected from being subjected to pressures greater than the maximum allowable working pressure (350 psig) by means of two (2) ASME approved safety relief valves operating in conjunction with a three-way switching valve and two (2) bleeder type relief valves.

F. The tank shall be provided with a pressure switch and transmitter to transmit an alarm signal automatically to the Plant SCADA in the event of excessive high or low pressure in the storage tank. The alarm horn and indicating lights shall be mounted on the refrigerator control panel located on the storage tank. The panel shall be complete with an alarm silence circuit to shut off the audible alarm. Contacts shall be provided for remote indication of high and low tank pressure alarm.

G. All piping and fittings furnished as part of the storage vessel shall be grade B, seamless, Schedule 80 304 stainless steel with 2,000 psi rated threaded joint fittings. Stainless steel ball valves shall be provided at tank connections for the liquid fill, vapor return and vapor

process lines and where needed to remove and service the vaporizer, vapor heater and other equipment and connections without emptying the tank.

H. Storage tank shall include a factory installed grounding lug and elliptical manway.

I. The tank anchorage shall be designed in accordance with the applicable wind loading design standards as referenced herein. Design calculations shall be provided for the tank anchorage and shall be signed and sealed by a Professional Engineer registered in the State of Florida.

Wind Loads:	ASCE 7-10 2017 Florida Building Code
Risk Category:	III
Ultimate Design Wind Speed (mph):	V_{ult}=150
Wind Exposure Category:	C

2.03 REFRIGERATION SYSTEM

A. The tank shall be provided with a complete environmentally safe refrigeration system utilizing R-404A refrigerant. The evaporator coil of the refrigeration unit shall be located inside the top portion of the storage tank, with the compressor and air-cooled condensing coil mounted on the front head at the end of the tank. The system shall automatically maintain the carbon dioxide in the storage tank at 0 degrees F and 300 psi. The refrigeration unit shall be equipped with a condensing unit driven by a 6-hp, 480-volt, 60 Hz cycle, 3-phase compressor and provided with a circuit breaker disconnect switch, motor starter, and a 120-volt control voltage transformer mounted in a NEMA 4X Type 304 stainless steel enclosure. The condensing unit shall include a sight glass, refrigerant line, solenoid valve, expansion valve, and refrigeration coil mounted internally in the storage tank. Automatic controls shall be provided to start and stop the compressor, thereby controlling the temperature of the carbon dioxide in order to maintain the proper operating pressure (295 psig – 305 psig).

2.04 VAPORIZER

A. The storage tank shall be provided with one (1) complete electric pressure building vaporizer capable of vaporizing at least 240 lbs. per hour of liquid carbon dioxide at 300 psig and 0 degrees F in the storage tank. Automatic controls shall be provided to control the vaporizer to maintain the tank pressure above 245 psig. An adjustable differential pressure switch shall activate the vaporizer at 245 psig and shall deactivate the unit at 255 psig. Liquid carbon dioxide shall be drawn off of the tank near the bottom, with the vapor line returning to the tank near the top. A purging valve for easy removal of accumulated impurities and safety controls including a safety relief valve, a thermostat for over heat protection and a fused control circuit for coil protection shall be provided. Electric power to the unit shall be 12 kW at 480 volt, 3-phase, 60-Hz. Wiring shall be in accordance with the National Electrical Code. The electrical controls shall be housed in a NEMA 4X type 304 stainless steel enclosure with a circuit breaker disconnect switch. The electric vaporizer shall be supplied as an integral part of the storage tank, prepiped,

prewired, preinsulated and located and in the aluminum equipment enclosure. The vaporizer shall be model No. M-259CI as manufactured by TomCO_2 Equipment Company, or Engineer-approved equal.

2.05 VAPOR HEATERS

A. The tank shall be provided with one (1) 4 kW carbon dioxide vapor heater to heat the 0 degrees F carbon dioxide gas to near room temperature (70 ^oF). The vapor heater shall be supplied complete with a temperature controller utilizing a copper capillary sensing element adjustable from 30 to 110 degrees F. The vapor heaters shall include solid high conductivity aluminum pressure castings containing the electrical resistance heaters and aluminum castings containing the stainless-steel tubing for the carbon dioxide vapor. An overheat device shall be supplied to shut off the heating element should the temperature reach 200 degrees F. A manual reset button shall be supplied for restarting the heater after the overheat temperature controller has been tripped out. Electric power to the unit shall be 480-volt, single-phase, 60-Hz. The electrical components shall be housed in a stainless-steel enclosure with a thru-the-door disconnect switch. The vapor heaters shall be model No. CVH-4SS as manufactured by TomCO_2 Equipment Company or Engineer approved equal. The vapor heaters shall be shipped, installed, prepiped, and prewired inside the storage tank equipment enclosure.

B. A pressure relief valve shall be provided with the tank downstream of the vapor heater to protect the components from over pressurization due to thermal expansion. Relief pressure shall be pre-set at 450 psig and the relief valve shall be constructed of brass with stainless steel spring. The relief valves shall be rated for carbon dioxide service.

2.06 FIRST AND SECOND STAGE CARBON DIOXIDE PRESSURE REGULATORS

A. The storage tank shall be provided with one (1) first stage pressure regulator, Fisher Series 627 or equal, complete with pressure gauge downstream of the vapor heater and prepiped inside the equipment enclosure. The regulator shall reduce the pressure from the vapor heater from 300 psig to 120 psig. The regulator shall have a malleable iron body, aluminum spring case and lower case, nitrite and aluminum valve disc and holder, nylon fabric coated with nitrite diaphragm, stainless steel valve stem and valve stem guide. The outlet pressure of the regulator shall be easily adjusted through the use of an adjustant screw. A pressure gauge, 2½ -inch dial, 0-300 psi range, complete with isolation valve, shall be provided for indication of the carbon dioxide pressure downstream of each regulator.

B. Each carbon dioxide pressurized solution feed panel shall be furnished with one (1) second stage pressure reducing valve with isolation valve for reducing the carbon dioxide vapor from 120 psig to the operating set-point prior to entering the flow indicator as required by the Manufacturer. The pressure regulator shall be a Fisher Series 627, or equal with a malleable iron body, aluminum spring case and lower case, nitrile and aluminum valve disc and holder, nylon fabric coated with nitrile diaphragm stainless steel valve stem and valve stem guide, and 70-150 psi spring range. The outlet pressure of the regulator shall be easily adjusted through the use of an adjustment screw.

2.07 CARBON DIOXIDE PRESSURIZED SOLUTION FEED PANEL SYSTEM

A. Furnish and install one (1) carbon dioxide pressurized solution feed panel capable of feeding 120 lbs. of carbon dioxide per hour (2,880 lbs. carbon dioxide/day), at 60 psig minimum and 100 psi maximum.

A second carbon dioxide pressurized solution feed panel capable of feeding 120 lbs. of carbon dioxide per hour (2,880 lbs. carbon dioxide/day), at 60 psig minimum and 100 psi maximum will be provided under Bid Alternate 1, if selected for inclusion in the project by the Owner.

B. The carrier water supply shall be capable of providing a minimum of 120 gpm to each carbon dioxide solution feed system panel at 60 to 100 psig at approximately 60 to 95 °F. The carrier water shall be supplied via vertical in-line centrifugal booster pumps as specified in Section 11217 from the 24-inch ROBW as shown in the Drawings. The Contractor shall coordinate with the supplier the connection of the carrier water line to the solution feed systems.

C. Bid Alternate (Pre-Degasification CO_2 Feed System): Contractor shall provide an additive Bid Alternate to supply and install a solution feed panel and associated piping, pumps, valves and appurtenances for the addition of carbon dioxide solution into the pre-degasification injection point as shown on the Drawings. The solution feed panel for this bid alternate includes one (1) factory assembled, enclosed free-standing, type 304 stainless steel carbonic acid pressure solution feed panel shall be provided and installed for the pre-degasification application (No. 1) as shown in the Drawings. All materials within the pressurized solution feed panel in contact with drinking water shall be compliant with ANSI/NSF Standard 61. Carbon dioxide gas piping and fittings within the assembly shall be 3/4-inch, Type 304 stainless steel, Schedule 80. The water and carbonic acid solution piping and fittings shall be 3-inch, Type 304 stainless steel, schedule 10. The electrical supply to the panel shall be 120 volts, 60 Hertz. The panel shall have approximate dimensions of 68 inches long by 32 inches wide by 60 inches tall. The panel shall have the following components mounted on or within the enclosed panel:

1. One (1) stainless steel wye type strainer on the carbon dioxide vapor line on the inlet side of the panel.

2. One (1) second stage pressure reducing valve as specified previously in Section 2.06.B.

3. Two (2) pressure gauge shall be provided for indication of the carbon dioxide pressure upstream and downstream of the second stage carbon dioxide pressure regulator. The pressure gauges shall be stainless steel with a 2½-inch dial, 0-200 psi range, installed complete with a stainless steel ball valve for isolation.

4. **One (1) electric actuated carbon dioxide solenoid valve, with manual bypass, shall be provided for starting and stopping the carbon dioxide flow to the panel based on the starting and stopping of the plant flow. The valve body shall be stainless steel construction. The valve shall have a 120-volt solenoid. A manual by-pass isolation ball valve shall be provided to by-pass flow around the solenoid valve for manual operation. The valve body shall be constructed of Type 316 stainless steel and be suitable for carbon dioxide.**

5. **One (1) electronic coriolis carbon dioxide flow meter and transmitting indicator with local readout shall be provided. The meter shall be designed for mass flow and shall transmit an analog signal to the programmable controller. The body and wetted parts shall be Type 304 stainless steel. The accuracy of the meter shall be within +/- one percent. The sensor housing shall be Type 304L stainless steel and the meter housing shall be NEMA 4X. The flow meter shall be Micro-Motion Elite-Series, or Engineered approved equal.**

6. **One (1) gas actuated (ATO) carbon dioxide flow control valve shall be furnished and installed. The control valve shall have a 10:1 turndown. The valve shall have Type 316 stainless steel body, stainless steel trim with all elastomeric components compatible with a corrosive environment and carbon dioxide service. The valve shall be pneumatically operated with a spring opposed diaphragm actuator controlled by an electronic signal from the electro-pneumatic I/P transducer. The transducer converts a DC current input signal to a directly proportional pneumatic output. The transducer is designed to accept a 4-20 mA DC proportional control signal from the programmable controller. The valve actuator shall be supplied complete with a carbon dioxide gas regulator for utilizing the carbon dioxide gas at the panel as the pneumatic source.**

7. **One (1) manually operated carbon dioxide flow control valve for use as a bypass valve shall be provided for manual, fine flow-control of the carbon dioxide gas in the event of automatic control valve failure. The valves shall have Type 316 stainless steel body, stainless steel trim for use in a corrosive environmental carbon dioxide service.**

8. **Two (2) inline static mixers of PVC construction shall be furnished to continuously mix the carbon dioxide with the carrier water. The carbon dioxide vapor shall be injected upstream of the mixer through a stainless steel gas injector/diffuser to provide fine bubbles. Two (2) pressure gauges shall be provided, one on each side of the mixers to indicate excessive pressure drop through the mixers. Pressure gauges shall have stainless steel internals, a 2-1/2-inch dial, 0-160 psig range, and a 316 stainless steel isolation valve.**

9. **Eight (8) carbon dioxide isolation ball valves shall be provided on the panel, including one for the panel inlet, two for the control valve, one for the solenoid valve bypass, three for the flow meter isolation and bypass, and one for the**

manual drain line from the static mixes. The ball valves shall be constructed of Type 316 stainless steel and be suitable for carbon dioxide.

10. Two (2) carbon dioxide pressure relief valves shall be supplied in the carbon dioxide gas line for component protection. The valves shall have a brass body and stainless steel spring. Pressure relief valves shall be set to relieve at 150 psig and 50 psig, respectively.

11. One (1) stainless steel ball check valve shall be provided in the carbon dioxide injection line.

12. One (1) carbon dioxide injector/diffuser shall be provided to inject carbon dioxide gas into the carrier water line.

13. The carrier water feed line shall feature a low-pressure switch wired to the PLC to signal an alarm in the event of low pressure.

14. One (1) local termination panel housed in a NEMA 4X Type 304 stainless steel enclosure shall be provided as an integral component of the free-standing solution feed skid assembly. The local termination panel shall provide the housing and hard-wire connections to receive all control signals related to the pressurized solution feed system and transmit control signals to the CO_2 Master Control Panel PLC. The termination panel shall be complete with all necessary hardware to make a complete system.

a. The termination panel will include connections from each of the following to transmit command signals to the CO_2 Master Control Panel:

Electronic Coriolis carbon dioxide flow meter;
Electro-pneumatic transducer for flow control valve;
Carbon dioxide solenoid valve; and
Carrier water low pressure switch.

D. One (1) factory assembled, enclosed free-standing, type 304 stainless steel carbonic acid pressure solution feed panel shall be provided and installed for the post-degasification application (No. 2) shown in the Drawings. All materials within the pressurized solution feed panel shall be compliant with ANSI/NSF Standard 61. Carbon dioxide gas piping and fittings within the assembly shall be 3/4-inch, Type 304 stainless steel, Schedule 80. The water and carbonic acid solution piping and fittings shall be 3-inch, Type 304 stainless steel, schedule 10. The electrical supply to the panel shall be 120 volts, 60 Hertz. The panel shall have approximate dimensions of 68 inches long by 32 inches wide by 60 inches tall. The panel shall have the following components mounted on or within the enclosed panel:

1. One (1) stainless steel wye type strainer on the carbon dioxide vapor line on the inlet side of the panel.

2. One (1) second stage pressure reducing valve as specified previously in Section 2.06.B.

3. Two (2) pressure gauge shall be provided for indication of the carbon dioxide pressure upstream and downstream of the second stage carbon dioxide pressure regulator. The pressure gauges shall be stainless steel with a 2½-inch dial, 0-200 psi range, installed complete with a stainless-steel ball valve for isolation.

4. One (1) electric actuated carbon dioxide solenoid valve, with manual bypass, shall be provided for starting and stopping the carbon dioxide flow to the panel based on the starting and stopping of the plant flow. The valve body shall be stainless steel construction. The valve shall have a 120-volt solenoid. A manual by-pass isolation ball valve shall be provided to by-pass flow around the solenoid valve for manual operation. The ball valve shall be constructed of Type 316 stainless steel and be suitable for carbon dioxide.

5. One (1) electronic coriolis carbon dioxide flow meter and transmitting indicator with local readout shall be provided. The meter shall be designed for mass flow and shall transmit an analog signal to the programmable controller. The body and wetted parts shall be Type 304 stainless steel. The accuracy of the meter shall be within +/- one percent. The sensor housing shall be Type 304L stainless steel and the meter housing shall be NEMA 4X. The flow meter shall be Micro-Motion Elite-Series, or Engineered approved equal.

6. Two (2) gas actuated (ATO) carbon dioxide flow control valves (high and low flow) shall be furnished and installed. Each high and low flow control valve shall have a 10:1 turndown. The valves shall have Type 316 stainless steel body, stainless steel trim with all elastomeric components compatible with a corrosive environment and carbon dioxide service. The valves shall be pneumatically operated with a spring opposed diaphragm actuator controlled by an electronic signal from the electro-pneumatic I/P transducer. The transducer converts a DC current input signal to a directly proportional pneumatic output. The transducer is designed to accept a 4-20 mA DC proportional control signal from the programmable controller. The valve actuator shall be supplied complete with a carbon dioxide gas regulator for utilizing the carbon dioxide gas at the panel as the pneumatic source.

7. Two (2) needle valves shall be provided, one for each high and low gas actuated flow control valve for manual bypass and fine flow-control of the carbon dioxide gas in the event of automatic control valve failure. The valves shall have Type 316 stainless steel body, stainless steel trim for use in a corrosive environmental carbon dioxide service.

8. Two (2) inline static mixers of PVC construction shall be furnished to continuously mix the carbon dioxide with the carrier water. The carbon dioxide vapor shall be injected upstream of the mixer through a stainless-steel gas injector/diffuser to provide fine bubbles. Two (2) pressure gauges shall be provided, one on each

side of the mixers to indicate excessive pressure drop through the mixers. Pressure gauges shall have stainless steel internals, a 2-1/2-inch dial, 0-160 psig range, and a 316 stainless steel isolation valve.

9. Ten (10) carbon dioxide isolation ball valves shall be provided on the panel, including one for the panel inlet, two for each control valve, one for the solenoid valve bypass, three for the flow meter isolation and bypass, and one for the manual drain line from the static mixes. The ball valves shall be constructed of Type 316 stainless steel and be suitable for carbon dioxide.

10. Two (2) carbon dioxide pressure relief valves shall be supplied in the carbon dioxide gas line for component protection. The valves shall have a brass body and stainless-steel spring. Pressure relief valves shall be set to relieve at 150 psig, 100 psig, and 50 psig, respectively.

11. Two (2) stainless steel ball check valves shall be provided in the carbon dioxide injection line.

12. Two (2) carbon dioxide injector/diffusers shall be provided to inject carbon dioxide gas into the carrier water line.

13. The carrier water feed line shall feature a low-pressure switch wired to the PLC to signal an alarm in the event of low pressure.

14. One (1) PLC Master Control panel housed in a NEMA 4X Type 304 stainless steel enclosure shall be provided as an integral component of the free-standing solution feed skid assembly. The panel shall provide the housing and hard-wire connections to receive all control signals related to both pressurized solution feed systems and transmit control signals to the PSF Panels and SCADA System. The Master Control Panel shall be complete with all necessary hardware to make a complete system.

E. The above shall be factory assembled and all field connections clearly marked, and shall include all valves, gauges, pipe, pipe fittings, wiring, etc. required for a fully functioning panel. All welded stainless steel shall be pickled and passivated in accordance to ASTM A380. The entire assembly shall be shop tested and calibrated.

2.08 SOLUTION DIFFUSER

A. **Bid Alternate (Pre-Degasification CO_2 Feed System): One (1) carbon acid solution diffuser assembly shall be provided for the pre-degasification application (No. 1) to completely disperse the carbonic acid solution into the 24-inch RO blended water pressurized pipe where shown in the Drawings. The injection diffuser assembly shall be designed and sized by the Manufacturer for 120 gpm of carbonic acid solution flow. The diffuser shall be complete with 150# flanged connections. The diffuser and flanged connections shall be constructed of Type 316 stainless steel. One (1) pressure gauge shall be provided for indication of the carbonic acid solution pressure at the discharge**

location as shown in the Drawings. The pressure gauge shall be complete with a stainless-steel isolation valve, equipped with stainless steel internals, a 2-1/2-inch dial, and 0-160 psig range.

B. One (1) carbon acid solution diffuser assemblies shall be provided for the post-degasification application (No. 2) to completely disperse the carbonic acid solution into the chlorine contact basin splitter box (not-pressurized) where shown in the Drawings. The injection diffuser assembly shall be designed and sized by the Manufacturer for 120 gpm of carbonic acid solution flow. The diffuser shall be complete with 150# flanged connections. The diffuser and flanged connections shall be constructed of Type 316 stainless steel. One (1) pressure gauge shall be provided for indication of the carbonic acid solution pressure at the discharge location as shown in the Drawings. The pressure gauge shall be complete with a stainless-steel isolation valve, equipped with stainless steel internals, a 2-1/2-inch dial, and 0-160 psig range.

2.09 pH Analyzer and Transmitter

A. Bid Alternate (Pre-Degasification CO_2 Feed System): One (1) hot-retractable insertion type pH electrode assemblies shall be provided for field installation on the ROBW line after CO_2 addition but prior to degasification as shown on the Drawings. The electrode assembly shall include a pH glass electrode, a reference electrode, a thermo-compensator, and a pre-amplifier, all enclosed in a corrosion resistant polyether ether ketone (PEEK) body. Each electrode assembly shall be complete with 10 meters of cable and insertion hardware for mounting in the pipeline. The pH electrodes shall be Hach DPD1P1, or approved equal.

B. One (1) pH indicating analyzer/transmitters shall be provided with NEMA 4X enclosures to transmit the pH signal to the CO_2 Master Control Panel PLC. The pH analyzer shall be complete with output indication, remote pH transmission, and high/low pH alarms. The analyzer shall transmit a 4-20 mA signal. The pH analyzer shall be Hach SC-200 or approved equal.

2.10 CARBON DIOXIDE MASTER CONTROL PANEL

A. One (1) CO_2 Master Control Panel shall be provided that transmits and receives all control signals to and from each of the carbon dioxide pressurized solution feed systems. The CO_2 Master Control Panel shall control the functions of each pressurized solution feed system, including the pre-degasification pressurized solution feed panel (No.1) Bid Alternate, the post-degasification pressurized solution feed panel (No. 2), and the pH transmitters. The control panel shall be housed in a NEMA 4X Type 304 stainless steel enclosure mounted within the pressurized solution feed panel No. 2 as depicted in the Drawings.

1. The CO_2 Master Control Panel shall allow the operator to select either “manual” or “automatic” control modes for the pre-degasification (No. 1) and post-degasification (No. 2) systems. The “manual” mode shall allow the operator to select the injection rate of carbon dioxide gas flow in “lbs/hr”. For the pre-

degasification system (No. 1), the "automatic" mode shall provide automatic control based on an operator selected pH set point and pH feedback from the pH transmitter after CO2 addition but before degasification. For the post-degasification system (No. 2), the "automatic" mode shall provide automatic control based on a 4-20 mA signal from the plant water flow rate signal and an operator selected carbon dioxide dose in mg/L. Additionally, a final pH trim option shall be provided that automatically adjust the carbon dioxide feed rate based on an operator selected pH set-point and pH feedback from the pH transmitter after CO_2 and sodium hydroxide addition. In the "automatic" mode, the operator will select "on" within the plant SCADA controls, which will in turn relay the command to the CO_2 Control Panel to start each system.

2. If the CO_2 control panel loses communication with the plant SCADA, the control panel shall maintain operation at the last carbon dioxide set-point and plant flow rate feedback.

B. The control panel shall include the following components:

1. Hard-wired connections to receive all control signals related to the pressurized solution feed systems (No. 1 and No. 2) and transmit control signals to and from the CO_2 Master control panel PLC.

- Electronic Coriolis Carbon dioxide flow meter;
- Electro-pneumatic transducer for flow control valve(s);
- Carbon dioxide solenoid valve; and
- Carrier water low pressure switch.

2. One (1) PLC, which shall communicate with the plant control system over a fiber optic cable connection to transmit a PID analog control signal to the carbon dioxide control valves I/P transducers on each solution feed system. For the pre-degasification feed system (No. 1), the processor shall provide pH control based on an operator set point for pH and pH transmitter feedback. For the post-degasification feed system (No. 2), the processor shall provide flow-paced control with pH trim based on an operator set point for carbon dioxide dose and pH set point or an operator carbon dioxide mass flow rate set point. The processor shall be complete with all necessary I/O modules, switches, media converter, software, and operating interface to make a complete control system. The PLC shall be furnished with a fiber optic cable connection to the plant SCADA.

3. One (1) Hand/Auto/Off switch and power light shall be provided on the control panel door. The switch will provide 120 Volt AC power to the panel. Switch and light module shall be NEMA 4X rated.

4. One (1) touch-screen operator interface mounted on the face of the control panel for local control and monitoring of the carbonic acid feed equipment and tank.

5. One (1) 24-volt power supply shall be provided for supplying the loop power required to transmit the analog signals from the control panel to the plant control system.

6. One (1) electric panel heater shall be provided for minimizing moisture condensation on the PSF panel components. The heater shall be Hoffman Series, 400 Watts, 115 volts.

7. Two (2) Fiber Optic Cables.

8. Loop isolators for all incoming and outgoing 4-20 mA analog signals.

C. The following I/O signals shall be exchanged between the CO_2 control panel, solution feed system, storage tank and plant control system:

1. From the carbon dioxide storage tank to the plant control system (hard-wire):

- Carbon dioxide tank level signal (4-20 mA)
- Carbon dioxide tank pressure signal (4-20 mA)
- Carbon dioxide tank low pressure alarm (discrete)
- Carbon dioxide tank high pressure alarm (discrete)

2. From the plant control system to the CO_2 Master Control panel via network connection:

- Pressurized solution feed system selected (on/off)
- Plant water flow rate (MGD) (PSF No. 2)
- pH set-point after CO_2 addition to ROBW pre-degasification (PSF No. 1)
- pH set-point after CO_2 and sodium hydroxide addition (PSF No. 2)
- Carbon dioxide dose in mg/L (PSF No. 2)
- Finished Water pH after sodium hydroxide addition (4-20 mA)

3. From the CO_2 control panel to the plant control system via network connection:

- Carbon dioxide mass flow rate (pound per hour, pph) (PSF No. 1 and No. 2)
- Carrier water low pressure alarm (PSF No. 1 and No. 2)
- Pressurized solution feed system run status (on/off) (PSF No. 1 and No. 2)
- Pressurized solution feed system Auto/Remote status (PSF No. 1 and No. 2)
- Pressurized solution feed system Fault status (PSF No. 1 and No. 2)
- pH signal from the ROBW pre-degasification

4. From each solution feed system to the master control panel:

- Carbon dioxide mass flow rate (pph)
- Carrier water low pressure alarm

5. From the master control panel to the solution feed systems:

- CO_2 solenoid valve open command
- Control modulating valve position signals

6. From the pH transmitter to the master control panel:

- pH signal (4-20 mA) from the ROBW pre-degasification

PART 3 - EXECUTION

3.01 GENERAL

A. Installation of the equipment specified herein shall be performed by the Contractor in accordance with the Manufacturer's instructions and accurately aligned with related equipment.

B. The Contractor shall furnish the services of a competent factory representative familiar with the installation, operation, and maintenance of the equipment for a minimum of two (2) full 8-hour working days in two (2) separate visits to inspect the installed equipment, supervise initial test runs, and provide operating instructions to the Owner and Engineer. The first visit will be for checking and inspecting the equipment after its installed. The second visit will be to operate and supervise the initial field test for start-up and instruct the Owner's and Engineer's personnel. The Manufacturer's representative(s) shall revisit the job site as often as necessary after installation until all problems are corrected and the equipment has passed the acceptance test and is operating satisfactorily to the Owner and Engineer.

C. Refer to Table 11300-A at the end of this section for a breakdown of the on-site service hours required for installation, inspection, testing, and training.

3.02 INSTALLATION

A. The unit shall be installed in accordance with the manufacturer's instructions and accurately aligned with related equipment.

B. The Contractor shall supply all necessary anchor bolts, temporary lifting equipment, power, water, labor and all other requirements for satisfactory installation.

C. The Contractor shall submit for approval of the Engineer and the Owner a schedule of activities regarding the installation of the Carbon Dioxide Storage and Feed System.

3.03 PAINTING

A. Prior to prime coating, all metal surfaces of the equipment within the system shall be thoroughly clean, dry and free from all mill scale, rust, grease, dirt, paint and other foreign substances to the satisfaction of the Engineer.

B. All metal and PVC surfaces except factory finished equipment surfaces and those obviously not to be painted such as aluminum and stainless steel shall be shop primed as specified in Section 09961: High Performance Paints and Coatings.

C. Finish coating except on factory finished manufacturer's equipment shall be compatible with the prime coating used and shall be as specified in Section 09961.

3.04 TESTING, INSPECTION, AND START-UP

A. During the course of the project, the Contractor shall prepare system test procedures for each phase of the work, approved by the Owner and the Engineer, which shall demonstrate conformance of the system to the Specifications and project requirements.

B. Acceptance Test of Control Panel shall be provided.

C. The Contractor shall furnish the services of an experienced, factory-trained, authorized service representative to inspect and perform "check-out" tests to assure and certify proper installation and operation of all of the equipment.

D. The Contractor shall furnish the services of an experienced, factory-trained, authorized service representative to perform the "start-up" and "demonstration" tests to assure and certify proper installation and operation of all of the equipment. The manufacturer's representative shall revisit the job site as often as necessary after installation until all problems are corrected and the equipment has passed the acceptance test and is operating satisfactorily to the Owner and Engineer.

E. The Contractor shall furnish the services of a factory representative who has a complete knowledge of proper operation and maintenance requirements for the equipment to instruct representatives of the Owner on proper operation and maintenance of the equipment. This work is in addition to, but may be conducted in conjunction with, start-up and demonstration described above. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional services required to make approved modifications, repairs or corrections to the equipment shall be provided at no additional cost to the Owner.

Table 11300-A Manufacturer Field Services

Specification Reference	Services to be Provided by Factory Representative	Minimum Number of Trips[(a)]	Minimum Time on Site per Trip (hours)
3.02.C	Check and inspect installed equipment.	1	8
3.02.D&E	Operate and supervise the initial field tests for start-up and demonstration. Instruct representatives of the Owner and Engineer on proper operation and maintenance of the equipment.	1	8

(a) Representative(s) shall be present at frequent enough intervals to ensure proper installation, testing, start-up, and initial operation of the equipment. Representative(s) shall revisit the job site for 8-hours per day as often as necessary after installation until all problems are corrected and the equipment has passed the acceptance test and is operating satisfactorily to the Owner and Engineer.

END OF SECTION

SECTION 11305

DEGASIFIER AND AIR QUALITY CONTROL SYSTEM MODIFICATIONS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. The Contractor shall furnish all labor, materials, equipment, and incidentals required to install and test the upgrades and modifications to the forced draft aerator (FDA) degasifiers and air quality control (AQC) system as specified herein and shown in the Drawings. System upgrades and modifications shall be supplied by a single system supplier and shall meet the performance criteria specified herein. The upgrades and modifications shall include, but not be limited to the following:

a. One (1) blower complete with ductwork, damper, motor and controls.
b. Clean-in-place system complete with piping, pump, motor and controls.
c. One (1) hydrogen sulfide monitoring system.
d. Access ladders with cage and platform for each FDA degasifier and AQC vessel.
e. Vessel modifications as required for the addition of the clean-in-place system and access ladders. Includes the design and installation of vessel connections.

B. Related Work Described Elsewhere

1. Painting: Section 09961.
2. Instrumentation and Controls: Section 13410.
3. Division 15 Mechanical as applicable.
4. Division 16 Electrical as applicable.

C. General Design

1. All components within the degasifier that come into contact with potable water shall be fabricated of NSF approved materials in accordance with Standard 61.

2. Design Requirements

a. <u>Blower Item/Design Conditions</u>

Number of Blowers:	1
Blower Manufacturers:	KCH Engineered Systems New York Blower or Approved Equal
Airflow (scfm) per blower	15,000

Static Pressure (inch of H_2O) 10

3. Structural Design Criteria:

a. Wind Loads

Wind Loads:	ASCE 7-10, 2017 Florida Building Code
Risk Category:	III
Basic Wind Speed V (mph):	V_{ult} = 150
Wind Exposure:	C
Directionality Factor, Kd:	0.85
Topography Factor:	1.0

1.02 QUALITY ASSURANCE

A. Inspections and Testing Requirements: The Engineer reserves the right to reject acceptance of delivery of any or all pieces of equipment found, upon inspection, to have any or all of the following: blisters, chips, crazing, exposed glass, cracks, burned areas, dry spots, foreign matter, surface porosity, sharp discontinuity or entrapped air at the surface of the laminate.

B. The Engineer reserves the right to be present at the fabricator's facility for visual inspection of equipment to be supplied.

C. The manufacturer and/or local representative shall have more than ten (10) years of experience with dual laminate construction and have at least fifteen (15) similar installations on water treatment plants of which five (5) installations are in the State of Florida which were installed no more than five (5) years ago.

D. Reference Specifications, Codes, and Standards

1. Codes: All codes, as referenced herein, are specified in Section 01091, "Reference Specifications."

2. Commercial Standards:

ASTM C 581 Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures intended for Liquid Service

ASTM D4097 Specification for Contract Molded Glass Fiber Reinforced Thermoset Resin Chemical Resistant Tanks.

ASTM D 3299-81 – Specification for Filament Wound Glass Reinforced Thermoset Resin Chemical Resistant Tanks.

American National Standards Institute (ANSI).

E. All materials that come in contact with water shall be NSF Standard 61 approved and certified for use with potable water.

F. Unit Responsibility

1. The entire FDA and AQC system modifications as specified herein shall be provided by a single system supplier to ensure coordination and compatibility.

2. The Contractor shall be responsible for all the on-site installation for the FDA and AQC system as specified herein. The system supplier shall be responsible for providing the required technical services to the Contractor during the installation of the FDA and AQC system.

G. Approved System Suppliers

1. TSC-Jacobs, or approved equal.

1.03 SUBMITTALS

A. Materials and Shop Drawings

1. Submit to the Engineer for approval, as provided in the Section 01340: Shop Drawings, Working Drawings and Samples, operating and maintenance manuals, systems piping and wiring diagrams, and other descriptive material for all equipment to be furnished under this Section. All structural drawings, structural calculations and process calculations shall be signed and sealed by a Professional Engineer registered in the State of Florida.

In addition to the information above, the submittals shall include at least the following items to demonstrate conformance of materials:

a. Letter of Certification from the National Sanitation Foundation International (NSF) stating compliance with Standard 61.

B. Additional information

The Contractor shall supply certificates for the following from the FRP ductwork supplier:

1. The resin used shall be in accordance with ASTM C 581 and that the resin is compatible with an environment consisting of air, caustic, hydrogen sulfide gas, methane, various aromatic hydrocarbon vapors, droplets of saltwater, and droplets of water containing sodium hydrochlorite, sodium hydroxide, sulfuric acid, and hydrochloric acid.

2. The ductwork supplied meets the deflection requirements under the vacuum pressure and hoop (point) loading specified herein.

1.04 OPERATIONS AND MAINTENANCE DATA

A. Operating and Maintenance Manual: Submit six (6) sets of Operation and Maintenance Manuals in accordance with Section 01730. The operation and maintenance manuals shall have been prepared specifically for the model and type of equipment furnished and shall not refer to other models and types of similar equipment. Operating and Maintenance Data. The operation and maintenance manuals shall include but not be limited to the following:

1. Equipment function.

2. Description.

3. Normal and limiting operating characteristics.

4. Installation instructions (assembly, alignment and adjustment procedures).

5. Operation instructions (normal start-up and shutdown procedures, normal operating conditions and emergency situations).

6. Lubrication and maintenance instructions.

7. Troubleshooting guide.

8. Parts list with catalog numbers and predicted life of parts subject to wear.

9. Drawings - cross sectional view, assembly and wiring diagrams.

10. Performance data.

11. List of manufacturer's recommended spare parts for each equipment item.

1.05 PRODUCT 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 complete.

B. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer. Pumps shall be prepared for shipment in accordance with API Standard 610.

C. Finished surfaces of all exposed openings shall be protected by wooden blanks or Engineer approved equal.

D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

E. Each box or package shall be properly marked to show its net weight in addition to its contents.

F. Equipment shall be shipped and handled in such manner as to prevent damage. At the job site, equipment shall be stored in clean, dry, and protected locations.

1.06 WARRANTY AND GUARANTEES

A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Section 01740: Warranties and Bonds.

B. The equipment shall be under warranty 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 at no expense to the Owner.

C. The replacement or repair (including cost of parts and labor) of those items normally consumed in service, such as pump packing, oil, grease, and the like, shall be considered as part of routine preventive maintenance by the Owner.

D. Certifications: Furnish the Engineer with a written certification signed by the manufacturer's representative, that the installed equipment:

1. Has been installed per manufacturer's requirements.

2. Has been lubricated per manufacturer's instructions.

3. Is ready to be operated and is free from any known defects.

PART 2 - PRODUCTS

2.01 BLOWERS

A. One (1) blower, 08-BL-02, shall be provided at the location shown on the Drawings.

B. The blowers shall be 40 HP minimum, capable of moving 15,000 cfm at 10 inches W.C.

C. The fan wheel shall be the backwardly inclined design stainless steel hub and 316 stainless steel shaft. The shaft shall be encapsulated through the fan shaft seal. The fan shall be fabricated of Type II PVC, and the shaft Type 316 stainless steel.

D. The fan housing shall be constructed of Type II PVC. The housing shall be additionally braced as needed with 316 stainless steel inlet side and drive side plates, fastened to the PVC housing with Type 316 stainless steel hardware.

E. The fan will be furnished with a flanged inlet and outlet, and a PVC pipe coupling type drain. The fan shall include a backdraft damper on the discharge as shown on the drawings.

F. Access door will be gasketed and bolted to the fan housing with Type 316 stainless steel hardware.

G. Bearings shall be grease lubricated ball or roller bearings in housings that allow easy bearing replacement and provided with autogreasers.

H. Shaft seal shall be neoprene gasketed PVC plate attached to the fan housing with Type 316 stainless steel hardware.

I. The blower motor shall be 40 HP, TEFC construction with service factor of 1.15, voltage 460 volts, 60 Hz, 3 phase, with Class B insulation with Class F temperature rise.

J. Provide easy access belt guards on all fans.

K. The blower shall be equipped with the manufacturer's recommended filtration on the influent air to the blower.

L. Manufacturers, or Engineer Approved Equal:

1. KCH Engineered Systems.

2. New York Blower

2.02 DUCTWORK

A. All duct and fittings shall be manufactured by Midwestern Fabricators or Engineer approved equal.

B. Filament-wound ductwork with minimum design working pressure as specified herein shall conform to ASTM D 2310, Type 1, Grade 2, Class E.

C. Fabricator shall be responsible for the design of FRP duct, based on these Specifications and the Drawings.

D. Mechanical properties of contact molded reinforced laminate shall meet or exceed all requirements of PS 15-69 and ASTM C 582.

E. Squares of ends, fittings, elbows, and butt joints shall meet or exceed requirements of PS 15-69.

F. Duct and fittings shall be shop spooled as much as possible. Use of flanges shall be kept to a minimum, with field welded bell and spigot joints where required for installation. Use butt joints for shop and field welded joints is also acceptable.

G. Butt joints in duct over 20 inches in diameter shall have an internal overlay.

H. Flanges and fittings shall have a thickness based on PS 15-69, rated for specified pressure and vacuum.

I. For flanged fittings, bolt circle number and diameter shall be per Product Standard PS 15-69 for air service. Coordinate flange provisions with interconnecting equipment and fittings.

J. Fabricator shall provide all information details and requirements for installation and support of duct and torque valves for flange bolting.

K. Contractor shall provide all FRP duct supports as recommended by Fabricator and as shown on the Drawings.

L. Back face of all flanges shall be spot-faced, flat and parallel to the flange face, and be of sufficient diameter to accept an SEA metal washer under the bolt head or nut.

M. Design Conditions:

1. Ductwork fabricated to these Specifications, in general, shall operate at ambient temperatures.

2. Sulfide stripper ductwork will be subjected to, and shall be designed to withstand the following conditions:

a. Design Temperature: 40 to 100 degrees F.

b. Design Vacuum Rating: 7-inch water gauge.

c. Location: Indoors.

d. Chemical Composition of the Process Vapors: 0 to 150 pm H_2S.

N. Laminate shall consist of an inner surface (corrosion barrier), on an interior layer, and a structural layer.

O. Laminate Quality: Meet the requirements of the visual acceptance criteria in ASTM D2563, Level III for the interior and Level III for the exterior.

P. Reinforce inner surface with a resin-rich surfacing veil of 20 mils thick.

Q. Construct inner layer with resin reinforced with at least two plies of chopped strand mat. Thickness of interior layers shall be at least 100 mils.

R. Glass content of combined inner surface and interior layer shall be 27 percent plus or minus 5 percent.

S. The structural layer may be either filament wound or contact molded as follows:

1. Filament winding shall be with continuous strand roving to provide a glass content of 50 to 80 percent.

2. Contact molding shall consist of alternate layers of chopped strand mat and woven roving, providing a glass content of 25 to 40 percent.

T. The structural layer shall be filament wound with an exterior resin-rich gel coat layer.

U. Exterior Gel Coat Color: Provide pigmented gel coat color on all exterior ductwork. Coordinate gel coat color with work in previous paragraphs.

V. Resin System: Premium grade and corrosion resistant vinyl ester such as Dow Derakane 411, or equivalent.

1. Exterior Exposed Ducting: Add ultraviolet absorbers to exterior gel coat layer to improve weather resistance. Absorber shall be American Cyanamid Company, CYASBORB UV-9, or Engineer approved equal.

2. Interior Ducting: Construct with fire-rated resin.

3. Color: No dyes, pigments, or colorants shall be used except in the exterior gel coat.

The resin shall not contain fillers or thixotropic agents unless specified. Use manufacturer's currently recommended cure system unless otherwise agreed upon by the fabricator and Engineer.

W. Reinforcement:

1. Inner Surface: Chemical surfacing mat, Type C (chemical) glass, 20 mils thick, with finish and binder compatible and layup resin.

2. Corrosion Barrier: Resin-rich interior surface of nominal 100 to 120 mils thick, using chopped strand mat backing the veil. Use no additive in the corrosion barrier.

3. Chopped Strand Mat: Type E glass, minimum 1-1/2 ounces per square foot, with silane finish and styrene soluble binder.

4. Continuous roving used in chopper gun for spray-up shall be Type E glass.

5. Woven Roving: Type E glass, nominal 24 ounces per square yard, 4 by 5 weave, with silane type finish.

6. Continuous roving used for filament winding shall be Type E glass with a silane type finish.

X. Duct fittings shall conform to National Bureau of Standards PS 15-69, except as specified herein, formed over a removable mold. Mitered bends will be allowed for pipes greater than 24 inches in diameter. Filament wound fittings shall be of the same thickness specified for adjoining pipe or duct. Hand lay-up fittings shall be of the minimum pipe or duct wall thickness specified in PS 15-69 for the applicable pressure class.

Y. Duct flanges shall be fiberglass reinforced plastic of thickness specified in Commercial Standard PS 15-69 faced.

Z. Gaskets shall be full-faced, 1/8 inch thick, fabricated from EPDM. When mating flange has raised face, use flat ring gasket and provide filler gasket between OD of raised face and flange OD to protect FRP flange from bolting moment.

AA. Dampers

1. The dampers on the blower discharge shall be of the backdraft type.

2. The shaft end opposite the handle must be sealed and capped.

3. 316 Stainless steel locknuts or similar corrosion-resistant attachments shall be provided to fix damper position after balancing and adjustment of the system.

2.03 CLEANING PUMP

A. One (1) degasifier cleaning pump (08-PMP-01) shall be provided to pump cleaning solution (commercial grade sodium hypochlorite solution) from the degasifier sump to a connection above the distribution weir trough. The degasifier cleaning pump shall be piped and valved such that a pump can recirculate cleaning solution through one or two degasifiers at a time. Provide vessel modifications as required for the pipe connections and pipe supports.

1. All connections 2 inches and larger shall be flanged and shall have ANSI standard dimensions and bolting patterns.

2. All bolts, fasteners, supports, hinges, lifting lugs, etc., shall be Type 316 stainless steel. Gaskets shall be neoprene

3. Nozzles - Support: All nozzles 3-inch and larger shall be gusseted.

4. Nozzles - Angle to Vessel: Unless otherwise specified, nozzles on top or bottom shall have flanged faces perpendicular to the centerline of the vessel, and nozzles and side walls shall have flanged faces perpendicular to radial centerlines. Tolerance on angle flange face with respect to vessel centerline shall be 1/2 degree.

5. Nozzles - Attachment to Wall: Unless otherwise specified, nozzles on top and sides of all type of vessels shall be attached to the vessel wall according to Figure 3, ASTM D 3299. Nozzles on bottom of vessel shall be attached according

to Figure 4, ASTM D 3299. Flanges for pipe connections shall be flat faced with drillings conforming to ANSI B16.5.

B. Degasifier cleaning pump shall be of the horizontal, end suction, single stage, one piece molded recessed impeller type. Pumps and motors shall be flexible coupled with C-face adapter. Casing shall be molded single unitized structure including suction and discharge flanges. Degasifier cleaning pumps shall be capable of pumping bulky, fibrous solids up to 2 inches in diameter.

C. Degasifier cleaning pumps shall be Goulds Model CV3196, 4x6-13 LTX in Hastelloy C construction, rated for 750 gpm against the total dynamic head required or Engineer Approved Equal. The pumps shall be centrifugal design complete with corrosion resistant bases and a maximum 25 HP, TEFC motor.

D. Pump shall have a double mechanical seal. Seal flush water shall not be required. Suction and discharge connections shall be flanged, ANSI B16.5, Class 150. Provide Goulds ChemBase Plus chemical resistant, non-metallic polymer baseplate or Engineer Approved Equal.

E. Provide flexible couplings between the motor and the pump shafts. Couplings shall be of the spacer type with flexible disk elements. Coupling hubs shall be steel. Disks shall be Type 304 or 316 stainless steel. The spacer shall permit the removal of the coupling, bearings, seal, and rotor without disturbing the driver or the suction and discharge piping. Couplings shall be keyed in place.

F. Factory coat pump and baseplate with the manufacturer's recommended coatings.

G. The materials of construction shall be as follows:

Casing	Hastelloy C
Casing Gasket	Aramid Fiber with EPDM Rubber
Stuffing Box Cover	Hastelloy C
Impeller	Hastelloy C
Impeller O-Ring	Teflon
Shaft	316SS
Shaft Sleeve	None
Gland	Hastelloy C Flush
Bearings	SKF 6311 (Inboard Bearings) SKF 7310 BECBM (Outboard Bearing)
Coupling	T.B. Wood's-SC-9
Coupling Guard	Carbon Steel
Baseplate	Corrosion resistant polymer baseplate

H. All of the above pump motors are to be TEFC, severe duty, 460-volt, 3 phase, 60 Hz, and 1.15 service factor.

I. Manual operation shall be provided for the degasifier cleaning pump via local disconnect and local start/stop switch.

2.04 ACCESS STRUCTURES

A. Furnish each existing degasifer and air quality control vessel with an access ladder with cage and platform to provide access to the hatches as shown to allow for gravity loading and unloading of the packing, and for maintenance of the distribution laterals and nozzles and packing support system. Fabricate ladder, cage, platform, and handrail from aluminum in accordance with Section 05521, Pipe and Tube Railings. Support ladders and platforms from the side of the towers. Provide vessel modifications as required for the access ladder and platform supports. Fabricate all fasteners from Type 316 stainless steel. Design ladders and platforms to be in conformance with the most current edition of OSHA standards and for the criteria specified in Section 05521. General orientation of ladders and platforms shall be as shown on the drawings. Ladders and platforms shall be as designed by the system supplier to meet applicable standards. Drawings and calculations shall illustrate the ladders, platforms, and anchor bolts' ability to withstand the required wind loads. Wind loads shall be in accordance with ASCE 7-10, 2018 Florida Building Code using a basic wind speed of 152 mph (3 second gust), exposure C. All structural drawings and calculations shall be signed and sealed by a Professional Engineer registered in the State of Florida.

2.05 HYDROGREN SULFIDE MONITORING SYSTEM

A. The system supplier shall provide a Hydrogen Sulfide Monitoring System. The monitoring system shall provide monitoring and controls for automatic adjustment of the chemical composition of the scrubbing solution to minimize the possibility of odor breakthrough because of gas flow fluctuation. The Hydrogen Sulfide control system shall include at a minimum.

1. Hydrogen sulfide monitoring on the Stage 2 outlet stream. Provide ductwork modifications as required for device installation.

B. The Hydrogen Sulfide system shall be controllable through the SCADA system or at a local operator terminal. One (1) operator terminal with touchscreen capabilities shall be provided.

C. The Hydrogen Sulfide analyzer shall have a digital display programmable range and 4-20mA output. The controller shall have a dual alarm relay.

D. The system supplier shall coordinate with the hydrogen sulfide control system supplier so that the system can adjust the caustic feed rate based on the hydrogen sulfide in the scrubber outlet, or the measurements of the AQC pH probes.

E. Hydrogen Sulfide monitor shall be ATI model Q45S, or approved equal.

2.06 MONITORING AND CONTROL

A. The supplier of equipment under this section is responsible for coordinating with the I&C System Supplier to ensure that its equipment is compatible with and provides all necessary ancillary and accessory equipment to accept control signals provided by the SCADA system and provide monitoring and feedback signals to the SCADA system.

2.07 SPARE PARTS

A. The following spare parts shall be provided:

1. One (1) fan bearing set and belts for each blower.

2. One (1) set of mechanical seals, radial bearings, shaft sleeves, gaskets, O-rings, and seals for the cleaning pump.

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. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the Manufacturer's recommendations. Anchor bolts shall be set in accordance with the Manufacturer's recommendations.

B. The Contractor shall submit a certificate from the equipment manufacturer stating that the installation of the 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.

3.02 INSPECTION AND TESTING

A. General

1. The equipment manufacturer shall furnish the services of a competent and experienced representative who has complete knowledge of proper operation and maintenance of the equipment to inspect the installed equipment, supervise the initial test run, and to provide instructions to the plant personnel for the blower system, cleaning pump system, and hydrogen sulfide monitoring system. The first visit will be for checking and inspecting the equipment after it is installed. The second visit will be to operate and supervise the initial field test. At least one (1) day shall be allocated solely to the instruction of plant personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten days in advance with the Owner and shall take place prior to plant start-up and acceptance by the Owner. The final copies of operation and maintenance manuals specified in Section 01730: Operation and Maintenance Data must have been delivered to the Engineer prior to

scheduling the instruction period with the Owner. With the permission of the Engineer, these services may be combined with those provided under Paragraph 1.03C.

2. Field tests shall not be conducted until such time that the entire installation is complete and ready for testing.

B. Pumps

1. After all pumps have been completely installed, and working under the direction of the Manufacturer, conduct in the presence of the Engineer, such tests as are necessary to indicate that the pumping system operates satisfactorily and generally meets the conditions of service specified. Supply all labor, equipment and incidentals required to complete the field tests.

2. If the pump performance does not meet the Specifications, corrective measures shall be taken or pumps shall be removed and replaced with pumps which satisfy the conditions specified. A 24-hour operating period of the pumps will be required before acceptance.

C. Motors

1. 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.

3. The Contractor shall check all motors for correct clearances and alignment and for correct lubrication in accordance with Manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections if necessary.

D. Blowers

1. After all blowers have been completely installed and working under the direction of the manufacturer, conduct in the presence of the Engineer tests necessary to indicate that blower operation, efficiency, blower rpm and discharge pressure and capacity. Supply all labor, equipment and incidentals required to complete the field tests.

2. If the blower performance does not meet these Specifications, corrective measures shall be taken or blowers shall be removed and replaced with blowers which satisfy the conditions specified. A 24 hour operating period of the blowers will be required before acceptance.

3.03 START-UP AND INSTRUCTION

A. Manufacturer's Representative: Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. Two (2) person-days for installation assistance, inspection, and testing.

2. One (1) person-day for pre-startup classroom or site training.

B. See Section 01650 - Start-Up.

C. The Contractor shall disinfect the pump and all suction piping and discharge piping in accordance with FDEP regulations.

3.04 MISCELLANEOUS

A. If the equipment the Contractor proposed to furnish differs from that indicated on the plans or herein specified, or requires a different arrangement, the Contractor shall prepare and submit for review detailed structural, mechanical and electrical drawings and equipment lists showing all such changes. If accepted by the Engineer, any additional costs involved including those for project drawing changes and changes in interfacing work, shall be the responsibility of the Contractor and there shall be no additional cost to the Owner.

END OF SECTION

SECTION 11334

CARTRIDGE FILTERS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. This section covers the furnishing and installation of a cartridge filter unit for the reverse osmosis membrane pretreatment system.

2. Filters furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the fabricator unless exceptions are noted by the Engineer.

3. The Contractor shall coordinate the work between the suppliers of equipment to be used with or connected to the cartridge filters to ensure that all required provisions for mounting the accessories are included.

B. Related Work Described Elsewhere:

1. Reverse Osmosis Treatment Units: Section 11250.

2. Process Piping: Division 15.

3. Valves and Appurtenances: Section 15100.

C. General Design

1. Two (2) horizontal micron filter units shall be supplied for the filtration of pretreated reverse osmosis feed water prior to high pressure pumping and introduction into the membrane skids. The filter units will operate in parallel and will be connected to a common inlet and outlet piping manifold. Normal operation will consist of three (3) units in operation, however, two (2) units shall be capable of filtering the design flow rate without exceeding the maximum design loading rate of 4.5 gpm per 10 inch element. The filter units will be used to filter raw well water which has received pretreatment in the form of sulfuric acid addition and antiscalant addition and has a pH ranging between 5.0 and 6.5. Existing Cartridge Filters: Parker Model MP103H-4-10FK1. All working parts, such as covers, seals, eyebolts, hinges, etc., shall be of standard dimension such that the Owner may at any time in the future obtain replacement and repair parts for those furnished with the original equipment.

2. All components of the cleaning system will be constructed of a material that will be non-corrosive when exposed to the cleaning solution and surrounding environments.

1.02 QUALITY ASSURANCE

A. Governing Standards: Except as modified or supplemented herein, all materials and construction methods shall comply with the applicable provisions of the following standards:

1. ASME Boiler and Pressure Vessel Code, Section VIII, Division I.

2. ANSI B16.5 Pipe Flanges and Flanged Fittings.

3. Stainless Steel: ANSI 316L.

4. Polypropylene: FDA 21CFR Section 177.1520.

B. Cartridge Filter Units: The filter unit covered by these specifications are intended to be standard filtration equipment of proven ability as manufactured by a reputable manufacturer having experience in the production of such filters. All equipment furnished under this specification shall be new and unused and shall be the standard product of manufacturers having a successful record of manufacturing and supplying cartridge filtration equipment for a minimum of five (5) years. The filter unit shall be as manufactured by Parker Vessels Company Hannifin Corporation (Wessels), 3M (Cuno), or Engineer approved equal.

1.03 SUBMITTALS

A. Materials and Shop Drawings

1. Complete drawings, details, and specifications covering the filter unit and cartridges shall be submitted in accordance with Section 01340: Shop Drawings, Working Drawings and Samples.

2. The data shall include full information on materials of construction and data confirming their chemical resistance to the liquids being filtered.

3. The data shall indicate the sizes of all major cartridge filter components, weights, nozzle locations, anchor bolt locations and details, and full information and details concerning field assembly and installation.

B. Additional Information

1. In the event that it is impossible to conform to certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

C. Operating Instructions

1. Operating and maintenance manuals shall be furnished. 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 operation and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Section 01730: Operating and Maintenance Data.

2. A factory representative of all major component manufacturers, 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. With the Owner's permission, this work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3 EXECUTION. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The filter and components shall be adequately protected during transportation, in storage at the job site, and during subsequent installation and construction activities. Damaged units will be rejected and shall be replaced with undamaged units.

1.05 WARRANTY AND GUARANTEES

A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for one (1) year, commencing at the time of final acceptance by the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. A stainless steel data plate shall be attached to the filter unit showing the manufacturer's name, filter unit model number, number of filter elements, and size of filter elements.

2.02 MATERIALS AND EQUIPMENT

A. Filter Vessels

1. Filter vessels shall be horizontal or vertical design as depicted in Table 11334-1, and shall be fabricated from 316L stainless steel with all 316L stainless steel internals. Vessels shall be suitable for potable water use and the conditions of service stated herein. The vessels shall be constructed in accordance with OSHA code and ASME Boiler and Pressure Vessel Code Section VIII, Division II and be stamped certified with a national board number. The vessels shall be rated at a

minimum 120 psig design, temperature design per Table 11334-1, hydrostatic test pressure per ASME, with no corrosion allowance.

2. The vessel shall be fabricated with standard ANSI flanged inlet and outlet connections oriented as shown on the drawings. Heavy duty lifting lugs shall be provided on the top side of the housing to allow moving and positioning without causing damage. All welds shall be purged with inert gas and ground smooth. Pressure retaining welds shall be crevice-free. Vessels shall be cleaned, pickled, and passivated to remove scale and free iron and electropolished to prevent superficial corrosion. Electropolished finished surfaces shall be free of imperfections such as pitting, etches, burn marks or stains. If required to meet finish standards as specified herein, mechanical polishing shall be performed prior to electropolishing.

3. For horizontal vessels, a removable internal cartridge support and alignment plate fabricated of 316 stainless steel with a minimum ¼" thickness for stability shall be provided and must be bolted to four welded brackets to allow removal for maintenance. The alignment plate will have a hole pattern matching that of the seat cups in the separator plate. For horizontal vessels, the sealing face of the vessel shall have a single dove-tail O-ring groove to prevent the O-ring from falling out of the groove when the vessel cover is open.

4. Dual seal cups shall be provided to accept either single open end (SOE) 222 type O-ring connectors or standard double open end (DOE) type connectors. Dual seal cups shall be provided for future compatibility with DOE type connectors, however, only hardware for SOE type connectors is required to be provided. The inlet diffuser plate shall be a minimum of 1.5 times the open area of the inlet.

5. Door handles shall be ½" diameter bar stock. At least two (2) handles shall be provided on horizontal vessels.

6. The filter vessel dished head shall be equipped with a flushing entrance to provide adequate cleaning and draining of the head. The vessel compression plate shall be provided with a 1" flushing port. The drainage area shall be supported as to allow complete draining without causing interference to the cartridge support mechanisms.

7. In addition to the connections listed in 2.02, C., the filter vessels shall be provided with the following connections:

    a. Two (2) 1/2-inch 3,000 lb. NPT coupling for venting, one (1) on top of the dirty water chamber and one (1) on the top of the clean water chamber. (One (1) vent for the vertical vessel).

    b. One (1) 2-inch 3,000 lb. NPT drain coupling on the bottom of the dirty water chamber of the RO feed water vessels.

c. One (1) 2-inch 3000 lb. NPT drain coupling on the bottom of the clean water chamber for all vessels.

d. Two (2) 1/2-inch 3,000 lb. NPT couplings for pressure gauges. One (1) on the side of the dirty water chamber and one (1) on the side of the clean water chamber.

8. The coverlift, and eyebolts shall be constructed of 316 stainless steel. Hex nuts shall be 304 stainless steel with a Xylan coating. The coverlift mechanism shall be adequately designed and balanced so that the cover can be easily swung clear of the filter vessel top with minimal effort. 54" diameter and larger vessels shall be equipped with lubricated ball bearings on the coverlift mechanism. No bronze or brass components for the swingbolt assembly will be accepted.

B. Filter Cartridges

1. One (1) complete set of filter cartridges shall be supplied with each filter vessel for initial installation. All materials in the cartridge shall be grade FDA polypropylene, NSF certified (Standard 61, Drinking Water System Components – Health Effects). Filter cartridges shall be supplied by the filter vessel manufacturer and shall be fully dimensionally compatible with the vessels supplied. Filters shall be single open end (SOE) wound, 2 7/16" O.D. (+ 1/16" tolerance) with a 1" polypropyene core. The media shall be 100% napped polypropylene, continuously wound and shall provide a 90% removal efficiency at its micron rating as specified hereinafter. NSF certification shall be furnished to the Engineer prior to acceptance of the filter cartridge. SOE cartridges shall have two (2) 222 Buna N o-rings on the open end and a flexible polypropylene spring or fins on the closed end. Spare replacement filter cartridges shall be provided in accordance with 2.04, B herein.

C. Performance and Design Requirements

1. The cartridge filters shall conform to the requirements listed in Table 11334-1.

2.03 ACCESSORIES

A. Provide all hardware, including seat sups, springs, center posts, as required for the use of double open end (DOE) filter cartridges, plus 10% additional as spares of each component.

2.04 SPARE PARTS

A. A list of manufacturer's recommended spare parts shall be provided.

B. Filter Cartridges: In addition to filter cartridges that are supplied for startup and testing, three (3) full sets of replacement filter cartridges shall be provided for each cartridge filter unit installed.

C. Filter Cover O-Rings: Each filter vessel shall be supplied with one (1) spare O-ring.

2.05 QUALITY CONTROL

A. Perform Manufacturer's and Supplier's product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION

A. When installation has been completed and all connections have been made, all filter surfaces, interior and exterior, shall be thoroughly cleaned as recommended by the fabricator and to the satisfaction of the Engineer. Abrasive cleaning agents shall not be used. Following testing, disinfection, and surface cleaning, the units shall be thoroughly flushed with clean water using the drain connections to remove any sediment from the filter compartments prior to being placed into operation.

3.02 INSTALLATION

A. The filter shall be installed at locations as indicated on the Drawings. The filter shall be installed in accordance with the manufacturer's recommendations, the requirements of the applicable governing standard, and to the satisfaction of the Engineer, and made ready for the installation of piping and other appurtenances as indicated on the Drawings and specified under other sections.

3.03 INSPECTION AND TESTING

A. After completion of installation, the filter shall be filled with water and pressurized to the design pressure. During testing, flanged connections may be plugged by the installation of temporary blind flanges on the outside of the tank but shall not be blocked or plugged on the inside. All leaks or indications of leaks shall be repaired by the fabricator and made completely watertight. A leaking tank, upon repair, shall be retested to the satisfaction of the Engineer.

B. The vessels shall show no visible signs of corrosion at time of acceptance by the Owner.

TABLE 11334-1

CARTRIDGE FILTER DESIGN CRITERIA

Design Criteria	**Feed Water**
Number of Units	2
Equipment Numbers	MF-0504 MF-0505
Filter Vessel Configuration	Horizontal
Cartridge Filter Unit External Diameter, inches	32
Cartridge Length, inches	40
Unit Capacity (gpm)	1,736
Design Flow per 10" Cartridge, (gpm) (Firm)	4.55
Inlet Nozzle, ANSI Class 150 Flange, inches	10
Outlet Nozzle, ANSI Class 150 Flange, inches	10
Unfiltered water drain coupling size, inches	2
Filtered water drain coupling size, inches	2
Design Pressure, psi	50
Maximum Clean Pressure Drop (psi)	1.2
Maximum Differential Pressure (psi)	12
Maximum Liquid Temperature	$40^{O}C$
O-ring Seal Material	EPDM
Filter Cartridge Materials	
Outside	Polypropylene
Core	Polypropylene
Nominal Rating, Micron	5
Construction	Wound-wrapped
Vessel Materials	
Housing (Finish)	316L Stainless Steel (Pickled &Passivated)
Hardware	316 Stainless Steel
Nuts	Brass
Swing Bolts	Stainless Steel
Cartridge Alignment Plate	Stainless Steel

END OF SECTION

Palm Bay Utilities

DIVISION 13

SPECIAL CONSTRUCTION

SECTION 13205

PRESTRESSED CIRCULAR CONCRETE TANKS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Requirements specified in Conditions of Contract and Division 1: General Requirements form a part of this Section. This Section covers the design, furnishing, construction, and testing of one (1), 2.0 MG circular, prestressed concrete finished water ground storage tank. The prestressed concrete tank shall have domed top and shall conform to the dimensions and locations shown on the Drawings. The tank construction company shall furnish all engineering services required for the preparation of design calculations and detailed design drawings, and furnish all materials, labor, equipment, tools, and incidentals for the construction of the prestressed tank as shown on the Drawings and as specified herein.

2. The prestressed concrete tanks shall be of composite steel-shotcrete, wire-wound, prestressed construction. The wire-wound prestressed composite wall shall include a shotcrete core wall in which a steel shell diaphragm of a height equal to the full wall height has been encased. All prestressing shall be done with high tensile wire permanently bonded to the tank wall. The tank floor shall be of concrete or shotcrete construction containing no less than 0.6 percent of reinforcing steel.

3. All components that come into contact with potable water shall conform to ANSI/NSF Standard 61.

B. Related Work Described Elsewhere:

1. Clearing, Grubbing and Stripping: Section 02110.

2. Excavation, Backfilling and Compaction: Section 02200.

3. Cast-In-Place Concrete: Section 03300.

4. Leakage Testing of Hydraulic Structures: Section 03800.

5. Miscellaneous Metals: Section 05510.

6. Pipe and Tube Railings: Section 05510.

7. FRP Fabrications: Section 06610.

8. High Performance Paints and Coatings: Section 09961.

9. Process and Utility piping, fittings, valves and accessories: Division 15.

C. General Design

1. The thickness of the core wall shall be calculated so as to accept the initial compressive forces applied by prestressing, hydrostatic stresses induced by contents, and other applicable loads such as soil backfill and wind.

2. Backfill loads shall not be used in the design of the core wall to counteract hydraulic loads or provide residual compression in the wall.

3. All prestressing shall be done with high tensile steel wire in which a substantial allowance shall be made for loss of prestress due to shrinkage and plastic flow in the shotcrete and to relaxation in the steel wire and diaphragm.

4. Size and Configuration of Tank: The dimensions of the prestressed circular concrete tanks including the floor slopes, sumps, tank diameters and vertical wall heights shall be as indicated on the Drawings.

5. Design of the prestressed tanks shall accommodate the differential and total settlement values reported in the geotechnical investigation provided in the appendix of these specifications.

D. The Contractor shall be responsible for coordinating all activities with the prestressed concrete tank construction company required for a complete installation. Activities requiring extensive coordination would include but not be limited to shop drawing submittals, embedded items required to be installed during construction of the prestressed concrete tank. Construction of the prestressed concrete tank shall not commence until all key dimensions, equipment and pipe locations, and any other interdependent items are approved by the Engineer and any conflicts or ambiguities are resolved. It shall remain the Contractor's sole responsibility to resolve any errors or conflicts arising during construction due to improper coordination with the prestressed concrete tank construction company.

1.02 QUALITY ASSURANCE

A. Design Standards: Unless otherwise indicated, all materials, workmanship and practices shall meet all requirements of the following standards, latest revisions.

1. Florida Building Code.

2. ACI 301: Specifications for Structural Concrete for Buildings.

3. ACI 318: Building Code Requirements for Reinforced Concrete.

4. ACI 506R: Guide to Shotcrete.

5. ACI 372R-03: Design and Construction of Circular Wire and Strand Wrapped Prestressed Concrete Structures.

6. AWWA D110-04 - Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.

7. ASTM A821/A821M - Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks.

8. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

9. ASCE Standard 7-05 - Minimum Design Loads for Buildings and Other Structures.

10. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

11. ASTM A416/A416M - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.

12. ASTM A884/A884M - Standard Specification for Epoxy Coated Steel Wire and Welded Wire Reinforcement.

13. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

14. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

15. ACI 305R - Hot Weather Concreting.

16. ACI 306R - Cold Weather Concreting.

17. ACI 350 - Building Code Requirements for Environmental Engineering Concrete Structures and Commentary.

18. ASTM C31/C31M - Test Methods for Making and Curing Concrete Test Specimens in the Field.

19. ASTM C39/C39M - Test Method for Compressive Strength of Cylindrical Concrete Specimens.

20. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

21. ASTM C143 - Standard Test Method for Slump of Hydraulic -Cement.

22. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.

23. ASTM C33/C33M - Specification for Concrete Aggregates.

24. AWWA C652 - Disinfection of Potable Water Storage Tanks.

25. ASTM D1056 - Standard Specification for Flexible Cellular Material.

B. Qualifications and Experience of Tank Construction Company: The tank construction company shall have the following qualifications and experience:

1. The Tank Construction Company shall specialize in the design and construction of wire-wound circular prestressed composite steel-concrete tanks. The tank construction company shall give satisfactory evidence that it has the skill, reliability, and financial stability to design, build, and guarantee the tank in accordance with the quality required by these specifications. The tank construction company shall have at least ten (10) years experience in this specialty and shall have built completely in its own name in the past five (5) years no less than ten (10) prestressed composite tanks of comparable size, which meet these specifications and are now demonstrating satisfactory service. If all experience requirements cannot be met, an additional bond will be required. This bond shall be in effect for four (4) years after expiration of the standard one (1) year performance bond and shall warrant the tank to be free of defects in materials and workmanship.

2. The tank construction company staff shall include a full-time Professional Engineer Registered in the State of Florida having no less than ten (10) years experience in the design and field construction of circular prestressed composite tanks who will be the responsible engineer in charge of the work to be done. All Working Drawings and design calculations shall carry the seal of such Registered Professional Engineer.

3. Acceptable Tank Manufacturers: The tank shall be as manufactured by the CROM Corporation, Gainesville, Florida or PRECON, Newberry, Florida, or Engineer-approved equal.

C. Design Criteria: To compensate for bending moments and for shrinkage, differential drying, and temperature stresses, the following reinforcing steel shall be incorporated in the core wall:

1. The top two (2) feet of core wall shall have not less than 1% circumferential reinforcing.

2. The bottom three (3) feet of core wall shall have not less than 1% circumferential reinforcing.

3. Inside Face:

   a. 26-gauge steel shell diaphragm continuous the full wall height, without horizontal splices.

   b. Additional vertical and horizontal reinforcing steel bars as required by design computations.

4. Outside Face:

   a. Vertical reinforcing steel: Minimum of #4 bars at 12-inch center to center.

   b. Additional vertical and horizontal reinforcing steel bars as required by design computations.

5. | | | |
   |---|---|---|
   | Allowable Tensile Stress | f_s | 18,000 psi |
   | Yield Strength | f_y | 40,000 psi |

6. Design Loads: Wind loads, including uplift and overturning shall be as required by the Florida Building Code and any local amendments to the Code ASCE-7, or shall be for 155-mph wind loading, whichever is greater.

7. Qualifications of Workmen: The foreman, nozzlemen, and gunmen shall be skilled in their duties and certified in accordance with the guidelines by ACI Committee 506 Certification as outlined in Publication CP-60, latest revision. The Contractor shall submit the names of the men performing the above duties, with a statement of certification as to their qualifications. Certification will be accomplished by a recognized authority such as ELF/FC&PA*, ACI, or approved equal.

*ELF	-	Engineering Laboratory Forum, Florida Institute of Consulting Engineers
FC&PA	-	Florida Concrete and Products Association

8. Design shall account for buried depth of the tank as shown on drawings.

1.03 SUBMITTALS

A. Shop Drawings: The Contractor shall submit a complete set of detailed shop drawings signed and sealed by a Florida Registered Professional Engineer for the work to be done. Inside dimensions, pipe openings and provisions for mechanical equipment shall be

maintained as established by the Engineer. Shop drawings must be approved before construction may begin.

B. Design Computations: The Contractor shall submit complete design computations. The design shall be done under the direction of a Florida Registered Professional Engineer and shall be signed or sealed by name of the design engineer. The design computations shall include all components of the tank, including wall, cantilevered launders, floor and sumps, wall penetrations, pipe supports, the wall reaction to the bottom slab, and the loads imposed by concrete dome covers. The design shall include consideration of temperature differentials under various conditions, stresses at wire winding and completed stages with tank empty and full, flexure in walls and base, anticipated movement of base under circumferential wire stresses, special stresses at wire anchorages and a construction procedure listing in chronological order the various operations of construction. The design computations shall be submitted for approval at least 30 days before the materials are assembled at the job site.

C. Shop drawings shall be submitted showing complete details, dimensions, materials, fastenings, anchorages and special details of wall reinforcement at attachment of accessories and details of interior launder construction.

D. If a sliding waterstop is used in the floor/wall joint, submit load/shear/deflection data to support shear and deflection calculations for base of wall. Tests shall have been generated for the particular waterstop configuration proposed.

E. Submit to the Engineer a guarantee document as specified in Paragraph 1.04, herein following tank construction.

1.04 WARRANTY

A. The tank construction company shall guarantee workmanship and materials on the entire tank structure and all accessories (i.e. manholes, ladders, platforms, handrails, grating, hatches, vents, etc.), including shrinkage cracks and hardware, for a period of five (5) years from substantial completion. In case leakage or other defects appear within the five (5) year period, the tank construction company shall promptly make repairs at its own expense, upon written notice by the Owner that such defects have been found.

B. To satisfy the five-year guarantee, acceptable tank construction companies listed under paragraph 1.02B.3. above shall be required to furnish a written company warranty for the five-year period.

C. If all experience requirements cannot be met as described in Paragraphs 1.02B.1. and 1.02B.2., an additional bond shall be required. This bond shall be in effect for four (4) years after expiration of the standard one (1) year performance bond and shall warrant the tank to be free of defects in materials and workmanship.

D. Leakage is defined as damp spots or visible leaks, appearing on the exterior surface of the tank, indicating the existence of minor leaks or leakage through the base slab, the source of which is from the inside of the tank. Leakage shall be determined by leakage testing as defined in Section 03800: Leakage Testing of Hydraulic Structures.

1.05 DESIGN DATA

A. The tank shall be designed to meet at the minimum the following criteria:

Parameter	Value
Tank Construction Type	Prestressed Circular Concrete Tank
Nominal Tank Capacity	2.0 million gallons (MG)
Inside Diameter	100 feet
High Water Level Depth	35’-7”
Tank Inlet	24-inch
Tank Outlet	30-inch
Tank Overflow	12-inch
Tank Drain	8-inch

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete

1. Concrete shall have a 28 day compressive strength of 4000 psi and shall be in conformance with the requirements of Section 03300: Cast-in-Place Concrete. Cement shall be Portland Type II. Concrete in direct contact with prestressed reinforcement shall not contain chloride ions in excess of 0.06 percent of the weight of the cement in the mix.

B. Shotcrete shall be in accordance with ACI Standard 506, latest revision, except as indicated otherwise herein. Proportions for all shotcrete shall be one part cement to 4 parts moist sand by weight, except that proportions of 1 to 3 shall be used for the cover coat on each side of the steel shell diaphragm and over the wire wrapping; these richer cover coats shall be at least 1/4-inch thick (measured from the outside of the wire for wire wrapping coat). Sand shall be composed of hard, strong, durable, uncoated grains

of quartz in accordance with gradation limits in ACI 506, except that the fineness modulus may be reduced to 2.0.

1. Compressive strength (f_g) shall be 4,000 psi or greater at 28 days.

2. Allowable compressive stress (f_g) shall be determined by the formula 1,250 + 75t with 0.45 f_g maximum where t is the core wall thickness.

3. Allowable compressive stress (f_g) due to initial prestressing force shall be 0.50 f_{gi} or less, with a minimum of 2,000 psi, where f_{gi} is defined as compressive strength at time initial prestressing force is applied.

4. Cement shall be in accordance with the requirements of Section 03300: Cast-in-Place Concrete. Cement shall be Portland Type II. Shotcrete in direct contact with prestressed reinforcement shall not contain chloride ions in excess of 0.06 percent of the cement in the mix.

C. Prestressing Wire:

1. Cold drawn, high-carbon steel wire complying with ASTM A-821 Type B.

2. Wire size shall be 0.162 inch diameter (8 gauge) or larger, but no larger than 0.250 inch.

3. Working stress for wire in the wall (f_s) shall be 115,000 psi.

4. Allowable tensile stress before losses (f_{is}) shall be 145,000 psi or no greater than 0.70 f_s.

5. Ultimate tensile strength (f_{su}) shall be 231,000 psi or greater.

D. Reinforcing Bars:

1. In conformance with ASTM A615, Grade 60, and with the requirements of Section 03200: Concrete Reinforcement.

2. Floor slab bar supports shall be reinforced steel bolster.

E. Wire Fabric Reinforcement:

1. Welded wire fabric (WWF) shall conform to ASTM A185: Welded Wire Fabric for Concrete Reinforcement. Wire fabric shall be electrically welded and not galvanized wire. Welded wire fabric shall be furnished in flat sheets, rolled WWF is not permitted.

2. Welded wire fabric supports shall be plastic bolsters with bar ties galvanized.

F. Steel Shell Diaphragm:

1. Steel tank shell diaphragm shall be cold rolled sheet, minimum 26-gauge, conforming to ASTM A653/A653M for Commercial Quality Cold Rolled Steel, with a Class 2, rolled finish or approved equal.

G. PVC waterstops shall have minimum thickness of 3/8-inch in areas exposed to hydraulic loads. Waterstops shall meet the requirements of CRD-C-572.

2.02 ACCESSORIES

A. Accessories to be provided with the 2.0 MG Potable Water Ground Storage Tank are as follows:

1. Accessories

a. One (1) access manhole.

b. One (1) exterior access aluminum ladder with TS safety rail.

c. One (1) interior fiberglass ladder with TS safety rail.

d. Four (4) precast concrete overflow outlets.

e. One (1) fiberglass access hatch for dome access.

f. One (1) fiberglass dome vent.

g. Aluminum handrailing around the dome hatch openings and around the tank dome perimeter.

h. Two (2) dome probe curbs (as shown in the Drawings).

i. One (1) sample port on access manhole.

j. Fiberglass liquid level indicator.

k. One (1) fiberglass vortex plate for pump outlet.

Accessories shall be provided and installed by the prestressed Concrete Tank Construction Company. Accessories shall be as specified below. Anchor bolts, nuts, and bolts for all accessories shall be Type 316 stainless steel (certified).

B. Access Manholes:

1. One (1) access manhole shall be provided for the prestressed concrete storage tank. The access manhole shall be located on the vertical wall of the tank, at the locations shown on the Drawings. Each access manhole shall include a fabricated Type 316 stainless steel frame and a fabricated Type 316 stainless

steel cover. The cover plate shall be suitably gasketed with a suitable neoprene gasket as necessary to provide permanent water tightness. The manhole shall have a waterstop and be sealed with epoxy on the inside perimeter to preclude leakage. The manhole opening shall be in the shape of a round-ended slot approximately 17 inches high and 52 inches long.

2. All bolting materials shall be ASTM A320, B8M, Class 2, Type 316 stainless steel, high strength bolts and nuts. Washers shall be Type 316 stainless steel. Nuts shall have a hardness that is lower than that of the bolts and the washers by a difference of 50 Brinnell hardness to prevent galling.

C. Aluminum Handrails, Platforms and Grating:

Aluminum platforms shall be designed to support the intended live and dead loads with a minimum factor of safety of 2.0. The maximum deflection for platforms shall be limited to a maximum of 1:360 of the maximum span. Aluminum used for fabrication shall be structural aluminum shapes in accordance with Section 05510 - Miscellaneous Metals. Aluminum grating used for platforms shall be in accordance with Section 05510 - Miscellaneous Metals. Aluminum handrailing installed around the dome access hatch and the aluminum access platforms shall be a three rail type handrail system, with a 4-inch toe board and in conformance with OSHA standards. Handrailing shall be constructed of 1 1/2-inch (1.90" o.d.), Schedule 40 aluminum pipe, Alloy 6063-T6, in accordance with Section 05510 - Miscellaneous Metals.

D. Aluminum Ladders:

Aluminum ladders and cages shall be fabricated from aluminum alloy 6061-T6, or equal. Ladder uprights shall be 3/8-inch by 2 inches and shall be spaced 18 inches apart. Supports shall be 3/8-inch by 2-inch bars bent to shape and shall be spaced not over 5 feet apart. Ladders shall be rigidly supported not less than 7 inches from adjacent surfaces and shall be secured to the shotcrete wall by Type 316 stainless steel bolts embedded in the shotcrete during construction of the wall. Rungs shall be not less than 1 inch diameter, smooth, spaced 12 inches on centers with the ends fitted into and welded to the uprights. Goosenecks shall be provided and anchored to the top of the tank. An approved ladder safety device with stainless steel TS rail and two safety harnesses shall be provided with the ladder which shall be Saf-T-Climb, as manufactured by Norton Company Safety Division, Climbers Buddy Corp., or equal. The ladder and safety device shall be designed, fabricated, and erected in accordance with Part 1910 of the Occupational Safety and Health Standards of the Department of Labor. Provide an aluminum swing out cage gate with padlock brackets.

E. Fiberglass Ladders:

Fiberglass ladders shall be completely fabricated of fiberglass reinforced plastic (FRP) structural shapes. Ladder uprights shall be 2-inch square tubing with a 1/8 inch wall thickness and shall be spaced 18 inches apart. Supports shall be 3/8-inch by 2-inch Type 316 stainless steel bars bent to shape and shall be spaced not over 5 feet apart. Ladders

shall be rigidly supported not less than 7-inches from adjacent surfaces and shall be secured to the shotcrete wall by 316 stainless steel bolts embedded in the shotcrete during construction of the wall. Rungs shall be not less than 1-inch diameter, solid fiberglass bars, spaced 12-inches on centers with the ends fitted into and bonded to the uprights with epoxy. Fiberglass shapes for ladder fabrication shall be in accordance with Section 06610 - FRP Fabrications. An approved ladder safety device with Type 316 stainless steel TS rail and two safety harnesses shall be provided with the ladder, which shall be Saf-T-Climb as manufactured by Norton Company Safety Division, Climbers Buddy Corporation, or equal. The ladder, and safety device shall be designed, fabricated, and erected in accordance with Part 1910 of the Occupational Safety and Health Standards of the Department of Labor.

F. Fiberglass Hatch Cover:

Fiberglass hatch covers shall be fabricated of 1/4- inch thick laminated fiberglass. Laminated Fiberglass fabrications shall be in accordance with Section 06610: FRP Fabrications. Dimensions of the hatch cover shall be as shown on the Drawings. The hatch cover shall be mounted onto a precast concrete curb cast into the dome cover.

The oversized frame for the fiberglass cover shall lap over and down the side of the precast concrete curb to provide weather-tightness. The fiberglass frame shall have an integrally fabricated curb for mounting of the access hatch. The access hatch shall lap over and down the side of the fiberglass frame curb to provide weather-tightness. The fiberglass frame and access hatch shall be gasketed with a suitable neoprene gasket to prevent the entrance of water and insects. The hatch cover shall have a smooth, even, snug bearing in the locked position. All frame anchor bolts, hinges, lock loop, fasteners and other hardware shall be Type 316 stainless steel. The fiberglass hatch cover shall conform to the applicable requirements of Part 1910 of the Occupational Safety and Health Standards of the Department of Labor.

G. Fiberglass Vent:

Fiberglass vents shall be fabricated of 1/4-inch thick laminated fiberglass. Laminated fiberglass fabrications shall be in accordance with Section 06610: FRP Fabrications. The vent shall be mounted onto a precast concrete curb cast into the dome cover. A neoprene gasket shall be provided between the concrete curb and the fiberglass vent to prevent the entrance of water and insects. The fiberglass vent shall have a throat opening of 50-inches in diameter. The vent area shall be adequate for air venting at tank fill and withdrawal rates of 16 MGD. To prevent the entry of birds, animals and insects, the vent throat area and vent rim openings shall be covered with 24x24 mesh, vinyl covered fiberglass screening. All vent anchor bolts, fasteners and other hardware shall be Type 316 stainless steel.

H. Precast Concrete Overflow Vents:

Overflow outlets for domed tanks shall be precast concrete with 24x24 mesh, vinyl covered fiberglass insect screen and fiberglass frame attached with Type 316 stainless

steel bolts of the size and number required. The precast concrete overflow outlets shall be cast into the dome cover. Each overflow outlet shall be sized for a 4.0-MGD minimum outflow.

I. Fiberglass Liquid Level Indicator:

The fiberglass liquid level indicator supplied, shall be the tank construction company's standard unit. The indicator board and target shall be 1/4-inch thick laminated fiberglass. Laminated fiberglass fabrications shall be in accordance with Section 06610 – FRP Fabrications. The indicator board shall be white with 4-inch high black numbers and divisions. The numbers and divisions shall be black resin that is integrally molded into the fiberglass laminate board. All anchor bolts, fasteners, cable and other hardware shall be type 316 stainless steel.

PART 3 - EXECUTION

3.01 CONSTRUCTION

A. Excavation and Compaction: Excavation and compaction prior to tank construction shall be in conformance with the applicable requirements of Section 02200: Excavation, Backfilling and Compaction.

B. Floor:

1. The subgrade shall be prepared by fine grading to ensure proper placement of reinforcing steel with proper bottom cover.

2. A 6-mil polyethylene vapor-barrier shall be placed after subgrade preparation has been completed.

3. Concrete membrane floors (4-inches thick) shall have a minimum thickness of 8-inches of concrete over all pipe encasements. The minimum percentage, 0.6 percent, of reinforcing steel applies to these thickened sections and shall extend a minimum of two (2) feet in to the adjacent 4 inches thick floor.

4. Floors shall be vibratory screeded to effect consolidation of concrete and proper encasement of floor reinforcing steel.

5. The floor shall be sloped to drain with the finishing criteria stated in Section 03300: Cast-in-Place Concrete, except that the finishing tolerance shall be 1/2-inch in 10 feet, as determined by a 10-foot straightedge placed anywhere on the slab in any direction. The floor shall have a light broom finish.

6. Floors shall be continuously water cured until tank construction is completed.

C. Core Wall:

1. The core wall shall be constructed of shotcrete, encasing a steel shell diaphragm continuous the full wall height without horizontal splices. The shotcrete shall be placed in accordance with ACI 506 as outlined in ACI Certification Public CP-60: A Guide to Shotcrete, latest revision.

2. The thickness of the core wall shall be calculated so as to resist the initial compressive forces applied by prestressing, backfill, and other applicable loads. The wall may taper uniformly on the outside face from top to bottom as required by design computations. In no case shall the core wall be less than 3-1/2 inch thick. Horizontal sections of the wall shall form true circles without flats, excessive bumps, or hollows.

3. To compensate for bending moments and for shrinkage, differential drying, and temperature stresses, the following reinforcing steel shall be incorporated in the core wall, as a minimum:

   a. The top two (2) feet of core wall shall have not less than one percent circumferential reinforcing.

   b. The bottom three (3) feet of core wall shall have not less than one percent circumferential reinforcing.

   c. Inside Face:

      1) Vertical reinforcing steel: minimum of #4 bars at 12 inches center to center.

      2) Additional vertical and horizontal reinforcing steel as required by design computations.

   d. Outside Face:

      1) Vertical reinforcing steel: minimum of #4 bars at 12 inches center to center.

      2) Additional vertical and horizontal reinforcing steel bars as required by design computations.

4. Curing:

   a. Interior core wall shall be continuously water cured for a minimum of 7 days or until prestressing starts.

   b. Exterior core wall shall be continuously water cured for a minimum of 7 days or until prestressing starts.

5. Tolerances:

   a. Tank Radius: The maximum permissible deviation from the specified tank radius shall not be greater than 0.1 percent of the radius or 60 percent of the core wall thickness, whichever is less.

   b. Vertical Walls: Walls shall be plumb within 3/8-inch per 10 feet of vertical dimension.

D. Steel Shell Diaphragm:

1. The galvanized steel diaphragm used in the construction of the core wall shall be 26 gauge with a minimum thickness of 0.017-inches 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. The diaphragm shall be formed with re-entrant angles and erected so that a mechanical key is created between the shotcrete and diaphragm. The diaphragm shall be continuous to within 3-inches of the top and bottom of the wall. Horizontal joints or splices will not be permitted. All vertical joints in the diaphragm shall be rolled seamed, crimped and sealed watertight using epoxy injection. 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. All vertical joints in the diaphragm shall be sealed watertight by epoxy injection. This epoxy injection shall be carried out from the bottom of wall to the top of wall, using a pressure pumping procedure, after the steel shell diaphragm has been full encased, inside and outside with shotcrete. The epoxy sealant shall be suitable for bonding to concrete, shotcrete, and steel. The sealant shall conform to the requirements of ASTM C881, Type III, Grade 1, and shall be 100 percent solids, moisture insensitive, low modulus epoxy system. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77 degrees Fahrenheit (°F).

3. The steel shell diaphragm design and the epoxy injection procedure shall have been used and proven satisfactory in the ten (10) tanks required for the tank construction company's experience record.

4. No nail or other holes shall be made in the steel shell for erection or other purposes except for inserting pipe sleeves, reinforcing steel, bolts, or other special appurtenances. Such penetrations shall be sealed with an approved epoxy sealant.

5. In all tanks designed to use a waterstop at the floor/wall joint, the steel shell diaphragm shall be epoxy bonded to this waterstop.

6. The steel shell diaphragm shall be suitably supported by temporary braces to preclude movement during construction. If the steel shell diaphragm is warm

when ready for applications, the steel surfaces shall be sprayed with water for cooling approximately 30 minutes or less before shotcreting and again a few minutes before shotcreting.

E. Shotcrete:

1. All shotcrete shall be placed in accordance with ACI 506, latest revision, and shall be applied by or under direct supervision of experienced nozzlemen certified in accordance with guidelines by ACI Committee 506 as outlined in ACI Certification. Certification shall be accomplished by an independent testing laboratory.

2. Shotcrete mixes, measured by weight, shall be:

   a. First coat on steel shell diaphragm and prestressing wire: One (1) part cement to three (3) parts fine aggregate.

   b. All other shotcrete: One (1) part cement to four (4) parts fine aggregate.

3. Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer. No shotcrete shall be applied to reinforcing steel or diaphragm which is encrusted with overspray.

F. Horizontal Prestressing:

1. Circumferential prestressing of the tank walls shall be achieved by the application of cold-drawn, high-carbon steel wire complying with ASTM A821 Type B, placed under high tension. A substantial allowance shall be made for prestressing losses due to shrinkage and plastic flow in the shotcrete and due to relaxation in the prestressing steel wire.

2. Placement of the prestressing steel wire to the core wall shall be in a continuous and uniform helix of such pitch as to provide in each lineal foot of core wall height an initial predetermined force and unit compressive stress equivalent to that shown on the approved shop drawings. Splicing of the wire shall be permitted only when completing the application of a full coil of wire, or when removing a defective section of wire.

3. Areas to be prestressed shall contain not less than ten (10) wires per foot of vertical wall. A maximum of 24 wires per layer per vertical foot will be allowed. Shotcrete shall be used to completely encase each individual wire, and protect it from corrosion. To facilitate this encasement, the clear space between adjacent wires is to be no less than one (1) wire diameter.

4. 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 approved Shop Drawings.

5. No circumferential movement of the wire along the tank wall shall be permitted during or after stressing of the wire. The steel wire bands on the core wall shall be so placed that the prestress "working force" per foot of wall height shall exceed the hydraulic ring tension forces by not less than 5 percent. The "working force" shall be defined as the force determined by multiplying the area of steel wire by the unit wire stress after an allowance for losses of 20,000 psi has been made from the initial unit wire stresses. Such initial unit wire stress readings shall be made the same day the wire is placed, or if made later and after some stress losses have already occurred due to creep of wire, plastic flow and shrinkage of core wall, allowances shall be made for such losses. The clear space between adjacent wires is to be no less than one wire diameter.

G. Measurement of Wire Stress:

1. Equipment shall be supplied at the construction site by the tank construction company to measure tension in the wire after it is positioned on the tank wall. This stress measuring equipment shall include: electronic, direct reading, stressometer or other device which can demonstrate not less than 2 percent accuracy; calibrated dynamometers; and a test stand to field verify the accuracy of the stressometer. The initial tension in each wire shall be recorded.

H. Exterior Covercoat:

1. After circumferential prestressing wires have been placed by the wire winding machine, they shall be protected by encasement in shotcrete. This shotcrete encasement shall completely encapsulate each wire, and shall permanently bond the wire to the tank wall. The shotcrete over cover shall have a thickness of no less than 1 inch over the wire. When multiple layers of wire are required, shotcrete cover between layers shall be no less than 1/8 inch thick.

I. Wall Openings:

1. When it is necessary for a pipe, access manhole or other appurtenance to pass through the vertical tank wall, the bottom of such appurtenance shall be no less than 18 inches above the floor slab. The prestressing wires required at the pipe or appurtenance elevation shall be distributed equally above and below the opening, leaving an unbanded strip around the entire tank. Ordinarily, unbanded strips shall have a vertical dimension of no more than 36 inches. All pipe sleeves passing through the wall shall be sealed to the steel shell diaphragm by epoxy injection.

J. Shotcrete Finishes:

1. The interior and exterior vertical surfaces of the tank walls shall have a fine, hairbrush broom finish to provide a finely textured, sandy type finish suitable for finish coating. Following finishing, all interior and exterior surfaces of the tank shall be lightly brushed to remove all loose particles of shotcrete or aggregate.

K. Curing of Shotcrete: The finish surfaces of walls shall be cured, starting as soon as possible without damaging surface and not later than two (2) hours after placing, by any of the following methods:

1. Moist-mat cure or moist-cure for seven (7) days.

2. Moist-mat curing shall be moist-curing by covering with at least two (2) layers of burlap, cotton mats, or other approved material. The mat shall be continuously sprayed or intermittently saturated by hosing not less than four (4) times during daylight hours. If intermittently saturated, the mat shall be saturated before 8:30 a.m. and within one and one-half hours of sundown. Saturating of the mat through the night hours will not be required except as may be directed during hot nights if humidity is low and the breeze is more than 5 mph.

3. Moist-curing shall be accomplished by keeping the surface of the concrete continuously wet with water. Sprinklers or soaker hoses may be used to insure continuous complete water coverage of the concrete surfaces. The sprinklers, soaker hoses or other watering equipment shall be operated 24 hours a day for the duration of the curing period. The duration of the curing period shall be seven (7) days. To ensure that sprinkling water is not blown away by wind from its intended location, special attention shall be given to the number and location of sprinklers so that all concrete surfaces are kept continuously wet. The Contractor shall have personnel at the site check the operation of all wetting equipment, the equipment shall be checked out not less than once each daylight hour and once every four hours during the night hours. Daylight hours shall be considered to be from one hour after sunrise to one hour before sundown. The remainder of the day shall be considered night hours.

4. Curing during the multi-layered shotcrete construction: The following curing procedures shall be used for any layer of shotcrete that will remain in place more than three (3) hours before the next layer of shotcrete is applied. During hot weather, to reduce cracks caused by quick drying shrinkage, each layer of shotcrete shall be moist-mat cured or moist-cured within one hour after application. The mat, if used, shall be kept moist until it is removed and shall not be removed until just before the next layer of shotcrete is applied. The mat shall be against the shotcrete surface enough to avoid circulation of warm air between the mat and the shotcrete. The exterior surface of the core wall (the surface to receive wire wrapping) shall not receive curing compound, but shall be continuously cured for at least seven (7) days using the moist-mat or moist-

cured procedure. In hot weather, the surface of shotcrete shall be fogged as soon as possible after application before other curing methods are started to avoid quick loss of moisture from the fresh shotcreted surface.

3.02 FIELD QUALITY CONTROL

A. Shotcrete Compressive Testing:

1. The tank manufacturer shall be responsible for all testing performed and shall pay all testing costs. Each test of shotcrete compressive strength shall consist of the preparation and breaking of five (5) cylinders. The high and low strength cylinders shall not be counted and the strength of the test shall be the average compressive strength in pounds per square inch of the three (3) remaining cylinders.

2. If cylinders are made for determining when wire wrapping can begin, they shall be stored at the site and cured the same as the applicable portion of the structure. All other cylinders shall be removed the next day and stored in a testing laboratory vault similar to standard concrete cylinders. The test cylinders shall be the same mix used in the permanent construction.

3. One test shall be made for each 50 cubic yard (cy) of concrete, but not less than two (2) sets for the inside core wall, two (2) sets for the outside core wall and two (2) sets for the over coat. Capping and breaking of cylinders shall be done similarly to standard concrete cylinders and shall be done by a recognized testing laboratory approved by the Engineer.

B. Disinfection of the completed tank shall be in accordance with AWWA C652.

C. Leakage Testing:

1. Each tank shall be slowly filled with water and examined for leakage. Water for leakage testing shall be made available to the Contractor by the Owner. Leakage shall be defined as a loss of water. Hydraulic testing of the tank shall be in accordance with the requirements of Section 03800: Leakage Testing of Hydraulic Structures.

3.04 PAINTING

A. All piping, supports, and other ferrous metal surfaces shall be coated in accordance with the applicable requirements of Section 09961: High Performance Paints and Coatings. Coatings shall not commence until the concrete is fully cured for at least 28 days and tested for moisture content. All interior surfaces of the storage tanks shall be coated with a coating system that is NSF-61 approved for use with potable water. All curing compounds that shall contact potable water shall be NSF approved. Ground storage tank surfaces shall be prepared according to Section 09961: High Performance Paints and Coatings and shall be coated with the following:

1. Ground storage tank interior (walls and dome):

    a. Prime coat: one (1) coat Tnemec Series 140 Pota-Pox plus polyamide epoxy at 7.0 mils dft per coat, or Engineer approved equal.

    b. Finish coat: two (2) coats Tnemec Series 140 Pota-Pox plus polyamide epoxy at 7.0 mils dft per coat, or Engineer approved equal.

2. GST exterior (dome and walls):

    a. Finish coat: two (2) coats of Tnemec Series 156 Enviro-Crete modified waterborne acrylate at 5.0 mils dft per coat or Engineer approved equal.

END OF SECTION

SECTION 13410

BASIC INSTRUMENTATION, MONITORING AND CONTROL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. General

1. This part of the Contract Documents covers the general requirements for the furnishing and installation of a Primary Instrumentation, Control, and Monitoring System complete in every detail for the purposes specified and shall form a part of any other technical specifications supplied unless otherwise specified.

2. The intent of this specification is to require that the Primary Instrumentation, Control and Monitoring System including all Sections of this Specification, i.e., primary elements, panel mounted and miscellaneous field instruments, etc., shall be furnished by a single Instrumentation and Control System Supplier to assure system uniformity, subsystem compatibility and coordination of all secondary system interfaces. Where specific manufacturers are designated, substitutions will not be accepted. Deviations may be considered in special circumstances but must be approved by the Owner. The Contractor shall include in his bid, the name of the Primary Instrumentation and Control System Supplier that will be used to furnish the system as described herein. The Primary Instrumentation and Control System Supplier shall be required to start work within 10 working days after the award of the contract to the Contractor.

B. Scope of Work:

1. Furnish and install all instrumentation and control systems hereinafter specified to perform the intended function. Work shall include all labor, materials and equipment, performance of all work necessary to complete the manufacture, to make factory tests, to prepare and load for shipment, to deliver to the site, to provide programming, calibration, installation supervision, system start-up, services and incidentals required to completely furnish and install a programmable controller based control and data acquisition system with instruments and control devices for the automation of the pump station and including all work necessary during the Warranty Period, as specified herein, under Section 01740: Warranties and Bonds, and shown on the Contract Drawings. The installation of the system hardware shall be by the Contractor with the supervision by the instrumentation and control Instrumentation System Supplier.

2. Furnish all tools, equipment, materials, and supplies and perform all labor required to complete the furnishing, installation, validation, start-up and

operational testing of a complete Instrumentation, Control and Monitoring System as specified herein.

3. Auxiliary and accessory devices necessary for system operation or performance, such as transducers or relays to interface with existing equipment or equipment provided under other Sections of this Specification, shall be included whether specified or not.

4. Equipment shall be fabricated, assembled, installed, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions and recommendations of the equipment Manufacturer as approved by the Engineer.

1.02 QUALITY ASSURANCE

1. The Primary Instrumentation, Control and Monitoring System as specified in this Specification is an integrated system and therefore shall be provided by a competent, qualified instrumentation and control system supplier who shall have total responsibility for the work of this Specification. Entire system installation including process parameter verification, calibration, validation, start-up, testing, and training shall be performed by qualified personnel, possessing all the necessary equipment and who have had a minimum of 5 years' experience in engineering, programming and installing of similar instrumentation, control and monitoring systems. The system shall be integrated using the latest, most modern and proven design and shall, as far as practical, be of one supplier.

2. The Primary Instrumentation, Control, and Monitoring System Supplier shall be responsible for the correct selection of all instrumentation and installation of all hardware and secondary systems specified in this Specification.

3. Prior to the selection of any device, coming in contact with the process, actual on-site process conditions and the suitability of the device and materials of construction for the stated application shall be verified with the original equipment manufacturer by the Instrumentation and Controls Systems Supplier. Unless notified in writing all devices and component part numbers, when provided, shall be assumed to have been verified as having been selected based on actual process parameters and application. Ultimately, the Contractor shall be responsible for all cost associated with replacements and delays due to improper equipment selection.

4. The Primary Instrumentation, Control, and Monitoring System Supplier shall be responsible to see that all components of the primary as well as secondary Control Systems, including measuring, indicating, transmitting, receiving, totaling, controlling, alarming devices and all appurtenances are completely compatible, correctly sized for actual process conditions, and properly interface to each other and shall function as outlined. The Primary Instrumentation, Control, and Monitoring System Supplier shall furnish and install such additional

equipment, accessories, etc. as are necessary to meet these objectives at no additional cost to the Owner.

5. The Primary Instrumentation, Control, and Monitoring System Supplier shall, in fact, be an Owner recognized supplier of instrumentation, control panels, and systems, etc., of the general type and complexity of the system specified herein and shall have been regularly engaged in providing and engineering instrumentation, control, and monitoring systems on a single system responsibility basis for a minimum of 5 consecutive years. The personnel employed for system engineering, supervision, start-up, operational testing and training shall have been regularly employed and factory trained by the Instrumentation, Control, and Monitoring System Supplier for a minimum of 2 years.

6. A detailed description of the experience of each engineer that will be assigned for the duration of the project shall be submitted for review and approval by the Owner. The Suppliers lead instrumentation engineer shall be an electrical engineer specializing in the selection and implementation of instrumentation, control, and monitoring systems of the type specified herein for the past 5 consecutive years. References shall be provided for all projects successfully completed by each engineer or software programmer assigned to this project.

7. Actual installation may or may not be performed by the Suppliers employees but the Instrumentation, Control, and Monitoring System Supplier shall be responsible for the technical supervision of the installation to insure that it is proper in all respects.

8. Secondary control systems include all instrumentation, switchgear, and controls (including but not limited to gauges, transmitters, panels, process and manual switches, indicators, controllers, etc.) existing or furnished under sections other than section, INSTRUMENTATION, CONTROL AND MONITORING SYSTEMS and are generally considered as a “packaged” system supplied specifically for the equipment being specified under that section.
9. Major constituents of each secondary system shall include, but not limited to, all materials, equipment, and work required to implement a complete and operating system of instrumentation and controls for its associated equipment. The systems shall include primary elements for process variable measurements, analog display and control elements, and discrete display and control elements as noted hereinafter and in the referenced Specification sections.

10. Qualifications of the secondary system suppliers engineers shall be as specified herein above unless otherwise noted. The Owner reserves the right to reject the use of any supplier not meeting the qualifications specified herein and under the specific equipment specification.

11. Approved Instrumentation, Control and Monitoring System Suppliers:

    a. Santis Engineering, Inc.

b. No Equal

1.03 RESPONSIBILITY

1. The Contractor shall be ultimately responsible and shall provide for the verification of process conditions, supply, installation, certification, adjustment, and start-up, of complete, coordinated systems which shall reliably perform the specified functions.

2. All interconnecting conduit and wiring, between elements of a single secondary control system shall be furnished, installed and connected under the same section as is the secondary control system unless the electrical drawings specifically indicate otherwise.

3. All other electrical conduit and wiring are provided, installed and connected under Division 16, ELECTRICAL.

1.04 ENGINEERING SUBMITTALS

1. Before proceeding with any manufacturing, submit the following for approval in complete bound sets indexed by specification number. Describe and verify all component part numbers for the items being submitted. Submit only complete systems, not pieces of equipment from various systems. Show dimensions, physical configurations, methods of connecting instruments together, mounting details, and wiring schematics. Schematics shall be complete with all components identified by a unique tag reference in accordance with ISA-S5.1 Instrumentation Symbols and Identification. Terminal number identification associated with relays, lights, electrical devices, etc., shall be clearly identified on all drawings. Submit fabrication drawings, nameplate legends, and control panel internal wiring and piping schematic drawings clearly showing all equipment and tag numbers for all components. Submit panel graphic drawings when applicable. Include material specifications listed where applicable.

2. Include a draft of the theory of operation for all relay circuits including software logic implemented via programmable controllers, that will eventually be included in the operation and maintenance instruction manuals required below.

3. Each submittal shall indicate the system name, submittal content, project reference, revision date and purpose of the submittal cover which shall also include the owners name, location, and supplier's name.

4. Provide a minimum of each of the following submittals to the Owner for review and approval (PDF format):

A. Hardware Submittal

(1) Index and Comments

a. Provide a detailed index identifying each tabbed section and its content.

b. If there are any deviations or clarifications to the specifications, they shall be documented in writing in this section. If there are no comments or concerns identified in the submittal, it will be presumed that there are no deviations from the Contract Documents for the system being furnished.

(2) Component Data Sheets

a. Component Data Sheets shall be specifically prepared for all components being furnished under these Specifications. The purpose of this material is to supplement the generalized catalog information by providing the specifics of each component (e.g., individual component tag ID reference, service, quantity supplied, part number, breakdown and descriptions for all options, scales, ranges, materials of construction, component location reference, and reference to associated drawings).

b. Include such other necessary data as would provide a complete and adequate specification for re-ordering an exact duplicate of the original item from the manufacturer at some future date. More than one tag numbered item with the same part number may be included on a sheet.

(3) Catalog Cuts

a. Manufacturer's standard specification or data sheets shall be clearly marked to delineate the options or styles to be furnished. Standard manufacturer catalog information, descriptive literature, wiring diagrams, and shop drawings shall be provided for all devices, whether electrical or mechanical, furnished under these Specifications. This includes, but is not limited to, pressure switches, gauges, solenoid valves, controllers, indicators, power supplies, switches, lights, relays, timers, circuit breakers, fuses, etc.

(4) Sizing Calculations

a. Complete certified sizing calculations shall be provided for all control valves and flow elements. The calculations shall include the process data used, minimum and maximum values, permanent head loss and all assumptions made. Equations shall be submitted for all computing modules and function generating modules and shall include the actual scaling factors and units used.

(5) System Hardware Submittal Format

a. Tab 1. Component Index and Comments

b. Tab “N” through “NN” (as required)

c. Component “X” Data Sheet(s) - one tab shall be provided per each component type and shall include the standard manufacturer catalog information and sizing calculations (when required).

B. System Control Panel(s) Drawing Submittal

1) All drawings shall be provided electronically, on a 11 x 17 PDF format.

a. Index and Comments

1. Provide a detailed index identifying each tabbed section and its content.

2. If there are any deviations or clarifications to the specifications, they shall be documented in writing in this section. If there are no comments or concerns identified in the submittal, it will be presumed that there are no deviations from the contract documents for the system being furnished.

b. Panel Layout Drawings

1. Provide detailed shop drawings for all panels and enclosures. Drawings shall show the location of all exterior and internal panel mounted devices to scale and shall include a panel legend and bill of materials. Layout drawings shall show all major dimensions, front, back, side, and mounting details, as well as all elevations, in inches from the base up, of all rows of components.

2. The panel legend shall list and identify all front of panel devices by the components unique tag identifier, all nameplate inscriptions, service legends, and annunciator inscriptions when applicable. Service legends, and nameplate inscriptions shall show size, engraving per line, character height and color. Information may be included on the layout drawing if spacing permits.

3. The bill of materials shall include all components mounted within or on the panel that are not listed in the panel legend, and shall include the component identification tag, description, manufacturer, and complete part number for re-ordering. Information may be included on the layout drawing if spacing permits.

4. Fabrication drawings shall be submitted for review and shall show all cut-out dimensions, support details, brackets, materials of construction, finish, etc. to be used for fabrication of each panel. Fabrication drawings may be submitted separately after the layout drawings have been approved. Construction of panels shall not be started until the approval of the fabrication drawings is received.

c. Detailed Panel Wiring Diagrams

1. Wiring diagrams shall be provided in the form of ladder type schematics with line numbers for all devices. All components shall be identified by a unique identification tag, terminal block numbers, wire sizes and color codes clearly identified, and external interconnections noted. Drawings shall be drawn in “landscape” mode.

2. Provide complete terminal identification of all internal and external elements, panels, and junction boxes.

3. Polarity of all analog signals shall be shown at each terminal as well as all shielded cable connections and grounding requirements.

4. All external panel wiring that must be provided and installed shall be clearly identified as a dashed line. Use unique terminal symbols to denote MCC locations.

5. All special cables that are provided with purchased equipment external to panels shall be identified as being supplied by the Supplier.

6. Wiring diagrams shall show all circuits individually; no common diagrams will be allowed.

7. Provide panel power wiring diagrams for all panels. The diagrams shall include all grounding requirements.

d. Control Panel Submittal Format

1. Tab 1. Index and Comments

2. Tab “N” through “NN” as required:

a. Heat Dissipation and Power Calculations Summary.

b. Panel “A” Layout Drawing (one tab per panel).

c. Panel “A” with Fabrication Drawing Legend/Engravings/Bill of Materials.

d. Panel “A” Power Wiring.

e. Panel “A” Wiring Diagrams.

3. Tab “X”. Loop Drawings (When Applicable)

4. Tab “Y”. Installation Details (When Applicable)

C. Analog Loop Drawing Submittal

1) Provide an individual loop wiring diagram for each analog loop showing all terminal numbers, the location of the DC power source, the location of any dropping resistors, polarity, etc. The loop diagrams shall meet the minimum requirements of ISA standard S5.4 approved October 9, 1981, plus the following requirements:

a. Loop diagrams shall be on 11-inch by 17-inch paper. Only one loop shall be shown on each drawing.

b. Reference to supplementary records and drawings, such as installation details, P&IDs, location drawings, wiring diagrams or drawings, and instrument specifications shall be included. Drawings may be included in the Control Panel Drawing Submittal when only a few drawings are required.

D. Instrument Installation Details Submittal

1) The Supplier shall develop and submit for review, complete installation details for each field mounted device and panel furnished prior to shipment and installation. Common details may be referenced by an index showing the complete instrument tag number, service, location, and device

description. Installation details shall be provided as required to adequately define the installation of the components. Drawings may be included in the Control Panel Submittal when only a few are required.

E. Power Requirement and Heat Dissipation Summary

1) Provide a summary of the power requirements and heat dissipation for all control panels furnished. Power requirements shall state required voltages, currents, and phase(s). Heat dissipations shall be maximums and shall be given in BTU/Hr. Summary shall be supplemented with calculations and show expected temperatures to be maintained for proper control equipment operation.

F. PLC Subsystem Submittal

1) In addition to the detailed hardware submittal requirements noted herein, the following shall also be provided:

a. Theory of Operation and Logic Descriptions.
b. System block diagram and cabling requirements.
c. Annotated software program listing and I/O address mapping.
d. I/O arrangement and wiring drawings.

G. Operation and Maintenance Manuals Submittal

1) Submit two (2) complete sets of Operation and Maintenance Instruction Manuals and Part Lists to the Owner for all equipment provided. Manuals shall be delivered no later than the equipment shipment date. After installation is complete, update the manuals to reflect any changes which occurred during installation and deliver the balance of the six (6) required manuals to the Owner.

2) All manuals shall be original manufacturers literature provided as noted herein above.

3) Include in the manuals not less than the following applicable information for each instrument, component, subsystem and/or control loop.

a. Index and Comments

1. Provide a detailed index identifying each tabbed section and its content.

2. If there are any deviations or clarifications to the specifications, they shall be documented in writing in this section. If there are not comments or concerns identified in the submittal, it will be presumed that there are no deviations from the contract documents for the system being furnished.

b. Bill of Materials

1. A listing of all the panels, racks, instruments, components, and devices furnished. All components shall be grouped by component type, i.e., pressure switches, pressure gauges, indicators, etc. The list shall contain, as a minimum:

a. Instrument, panel, rack or device tag number
b. Description
c. Quantity supplied
d. Reference to component data sheet and/or catalog cut
e. Component type

c. Component Data Sheets

1. Refer to 1.05-A, 4-(2) specified herein before.

d. Catalog Cuts

1. Refer to 1.05-A, 4-(3) specified herein before.

e. Operation and Maintenance Manuals

(1) Operation and Maintenance manuals shall be submitted for all instruments and devices supplied. The O&M manuals shall contain, as a minimum:

a. Operation procedures
b. Installation procedures
c. Maintenance procedures
d. Troubleshooting procedures
e. Calibration procedures
f. Internal device schematics and wiring diagrams
g. Shut-down procedures
h. Component parts list

i. Detailed circuit operational description including programmable controller ladder diagrams

j. Listing of Manufacturers with local telephone numbers and contacts for all instrumentation hardware furnished.

f. Spare Parts and Expendables List

(1) A spare parts and expendables list shall be submitted to include not only those items being supplied, but also any additional items recommended for successful long term operation.

g. Operation and Maintenance Manual Format

(1) Volume I (or as required) - Hardware

a. Tab 1. Component Index and Comments

b. Tab 2. Theory of Operation

c. Tab "N" through "NN" as required:

1. Component "X" Data Sheet(s) (one tab per component type as required).

2. Standard Manufacturer Catalog Information, and Manufacturers O&M Manual.

d. Tab "X" Recommended Spare Parts and Expendables Listing.

e. Tab "Y" Current Manufacturers/Local Representatives Telephone/address listing for all major components.

(2) Volume II

a. Tab 1. Index and Comments

b. Tab "N" through "NN" as required:

1. Panel "X" Layout Drawing
2. Panel "X" Fabrication Drawing
3. Panel "X" Legend/Engravings/Bill of Materials

4. Panel “X” Power Wiring
5. Panel “X” Wiring Diagrams

c. Tab “X” Loop Drawings (When Applicable)

d. Tab “Y” Installation Details (When Applicable)

H. System Calibration and Test Documentation Submittal

(1) The Supplier shall submit an example of each type of Instrument Calibration Report and Loop Functional Test Report that will be used to verify that all preliminary calibration and testing has been performed and the system is considered, by the supplier, to be ready for the Owner’s acceptance testing.

(2) After approval of the examples, the Supplier shall prepare Loop Functional Test Report(s) for each loop and an Instrument Calibration Sheet for each active element (except simple hand switches, lights, etc.). These sheets shall be completed and submitted to the Owner after completion of the operational availability field tests.

a. Instrument Calibration Reports

1. An Instrument Calibration report shall be used to certify that each instrument requiring calibration has been calibrated to its published specified accuracy shall be submitted to the Owner. This report shall include all applicable data as listed below plus an area to identify any defects noted, corrective action required, and corrections made.

a. Facility identification (Name, location, etc.)

b. Loop identification (Name or function)

c. Equipment tag and serial numbers

d. Scale ranges and units

e. Test mode or type of test

f. Input values or settings

g. Expected outputs and tolerances

h. Actual readings at 0, 10, 25, 50, 75, 90 and 100 percent of span

i. Percent of error for each reading

j. Explanations or special notes as applicable

k. Date, time, and weather conditions

l. Tester's certification with name and signature

b. Loop and Functional Test Reports

1. Submit a sample of each type of Loop and Functional Test Report form that will be used in verifying all control system functions as follows:

(a) Loop Status Report - For each function that can be demonstrated on a loop-by-loop basis:

(1) Each form shall include:

a. Project name

b. Loop number

c. Loop description

d. Test procedure description, with a space after each specific test to facilitate sign off on completion of each test.

e. For each component: tag number, description, manufacturer, and data sheet number.

f. Space for sign off and date by the Supplier

(b) Functional Acceptance Test Report - For those functions that cannot be demonstrated on a loop-by-loop basis:

1. Each form shall include a listing of the specific tests to be conducted. With each test description the following information shall be included:

a. Specification page and paragraph of function to be demonstrated

b. Description of function

c. Test procedure description

d. Space after each specific test to facilitate sign off on completion of each test

c. Supplier's Installation Certification Reports

(1) Upon completion of all preliminary calibration and functional testing, the Supplier, shall submit a certified report for each control panel and its associated field instruments certifying that the equipment (1) had been properly installed under his or her supervision, (2) is in accurate calibration, (3) was placed in operation, (4) has been checked, inspected, calibrated, and adjusted as necessary, (5) has been operated under maximum power variation conditions and operated satisfactorily, and (6) is fully covered under the terms of the guarantee.

I. Functional Acceptance Test Procedures Submittal

(1) Submit for approval not later than 30 days prior to the functional acceptance test demonstration, a written plan for demonstrating that each device and function of the equipment provided under these specifications meets the specified operational requirements.

(2) The plan shall detail procedures to be used in the functional acceptance testing of all systems. The plan shall include a description of test methods and materials that will be utilized for testing each system.

(3) Immediately correct defects and malfunctions with approved methods and materials in each case and repeat the testing.

1.05 SYSTEM TESTING AND ACCEPTANCE

A. Factory Tests

(1) Unwitnessed Factory Testing

a. Prior to the arrival of the Owner, each panel shall have been completely tested by the manufacturers personnel. Provide a report certifying the control panel(s) are fully operable and meet the Specifications. If upon arrival of the Owner, the panel tests have not been performed, the Supplier may be liable for back charges for all costs associated with the visit by the Owner. The necessary panel tests shall be repeated in the presence of the Owner. The Owner shall have the right to check all test observations. The Supplier shall demonstrate that the results of the unwitnessed Factory Tests are accurate. As a minimum, tests shall verify the following:

1. Accuracy of panel instruments for 4-20 mA inputs and outputs

2. Location of interface wires on terminal blocks

3. Function of discrete panel components

4. Control logic

(2) Witnessed Factory Testing

a. Inspection and test of materials and equipment shall be made by the Owner (or his representative) at the place of manufacturer prior to shipment, to verify that the completed control panel(s) meet the requirements of the specifications. Shipment shall not be made until receipt of written approval from the Owner after satisfactory completion of shop tests.

b. The manufacturer furnishing materials, equipment and labor for the fabrication of the panel(s) shall afford the necessary facilities for such shop inspection and tests. The Supplier shall give the Owner written notice ten (10) working days prior to the estimated date when the equipment will be ready for the inspection and witnessed shop test.

c. Sufficient time, ample space, and necessary assistance shall be provided by the manufacturer to assure inspection and testing to the satisfaction of the Owner.

d. The Supplier shall furnish all power, labor, materials, and properly calibrated instruments required for the shop tests.

e. The Owner reserves the right to reject defective materials, poor workmanship and items that are not in accordance with the requirements of the specifications.

B. Installation Supervision

(1) Furnish the services of authorized factory personnel specially trained and experienced in the installation of the equipment to: (1) supervise the installation in accordance with the approved Instruction Manuals; (2) be present when the instruments and equipment are first delivered, installed, and put into operation; (3) inspect, check, adjust as necessary, and approve the installation; (4) calibrate the instruments, in accordance with the Specifications herein, until all trouble or defects are corrected and the installation and operation are acceptable.

C. Preliminary Calibration and Functional Testing

(1) After approval of the Loop Status Report and Calibration Worksheets described herein, the Supplier shall prepare Loop Status Report(s) for each loop and an Instrument Calibration Worksheet for each active element (except simple hand switches, lights, etc.). These sheets shall be completed, signed, and submitted to the Owner after the Preliminary Calibration and Functional Testing is completed.

(2) Although the Preliminary Calibration and Functional Testing does not require witnessing, the equipment Supplier shall maintain the reports and calibration worksheets at the job-site and make them available for the Owner's review at any time.

a. Preliminary Calibration

1. Provide the services of factory trained instrumentation technician, tools and equipment to field calibrate each instrument to its specified accuracy in accordance with the manufacturer's specifications and instructions for calibration.

b. Functional Testing

1. Provide Loop Status Report(s) for verifying all control system functions as follows:

(a) Provide the services of factory trained and field experienced instrumentation engineer(s) to validate each system to verify that each system is operational and performing its intended function within system tolerance. System tolerance is defined as the root-mean-square sum of the system components specified accuracys from input to output.

(b) Validate calibration of each system by simulating inputs at the first element in the loop (i.e., sensor) of zero, 10, 25, 50, 75, 90 and

100 percent of span, or on/off and verify loop output devices (i.e., recorder, indicator, alarm, etc. except controllers). During system validation, make provisional settings on levels, alarms, etc. Verify that all logic sequences operate in accordance with the specifications.

(c) Cause malfunctions to sound alarms or switch to standby to check system operation. Check all systems thoroughly for correct operation.

(d) Immediately correct all defects and malfunctions disclosed by tests. Use new parts and materials as required and approved and retest.

c. Supplier's Certified Reports

1. Upon completion of the Preliminary Calibration and Functional Testing, the Supplier shall submit a certified report for each control panel and associated field instruments certifying that the equipment (1) had been properly installed under his supervision, (2) is in accurate calibration, (3) was placed in operation, (4) has been checked, inspected, calibrated, and adjusted as necessary, (5) has been operated under maximum power variation conditions and operated satisfactory.

D. Functional Demonstration Testing

1. Upon completion of the unwitnessed Preliminary Calibration and Functional Testing, re-test all systems in the presence of the Owner (or representative). The intent of this test is to demonstrate and verify the operational interrelationship of all instrumentation systems. This testing shall include, but not be limited to, all specified operational modes, taking process variables to their limits (simulated or actual) to verify all alarms, failure interlocks, and operational interlocks between systems and/or mechanical equipment. Notify the Owner in writing a minimum of 48 hours prior to the proposed date for commencing the test. Upon successful completion of this test the Supplier shall begin the Operational Acceptance Test Demonstration.

E. Operational Acceptance Test Demonstration

1. Upon completion of the Functional Demonstration Testing, re-test all systems under actual process conditions in the presence of the Owner and the Owner's Operators. The intent of this test is to demonstrate and verify the operational interrelationship of all instrumentation

systems to the Owner's Operators. This testing shall include, but not be limited to, all specified operational modes, taking process variables to their limits (simulated or actual) to verify all alarms, failure interlocks, operational interlocks between systems and/or mechanical equipment, and making final adjustments. Notify the Owner in writing a minimum of 48 hours prior to the proposed date for commencing the test. Upon successful completion of this test the Supplier shall begin the 30 Day Availability Test.

F. 30 Day Availability Test

1. After completion of the Operational Acceptance Test Demonstration, the System Supplier shall be responsible for the operation of the supplied system for a period of 30 consecutive days, under conditions of full process operation, without a single non-field repairable malfunction.

2. During this test, plant operating and supplier personnel shall be present as required. While the test is proceeding, the Owner shall have full use of the system.

3. If any failures should occur that cannot be corrected within 24 hours, or more than two similar failures of any duration, the failure will be considered as a non-field-repairable malfunction. The system shall be repaired and the 30 day test period shall be re-started. Owner reserves the right to set the schedule.

4. Total availability of the system shall be greater than 99.5 percent during this test period. Availability shall be defined as "Availability = (Total Down Time) ÷ (Total Time)".

5. Down times due to power outages or other factors outside the normal protection devices or back-up power supplies provided, shall not contribute to the availability test times above.

6. Upon successful completion of the system availability testing, submit a certified report, with substantiating data sheets, indicating that the equipment furnished meets all the functional requirements specified herein. The Owners will countersign this report and it shall constitute acceptance of the control system hardware.

1.07 FINAL DOCUMENTATION

A. Reproducible Drawings

1. The Supplier shall submit one (1) set of full size reproducibles of complete schematics, wiring diagrams and installation drawings to include all installed field and panel instruments, mounting details, point-to-point diagrams with cable, wire, and termination numbers. Drawings

shall be a record of work as actually constructed and shall be labeled "As-Installed". One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder.

a. Loop Diagrams

(1) Refer to Section 1.05 C. specified herein before.

b. Panel Construction Drawings and Wiring Diagrams

(1) Refer to Section 1.05 B. (1) b. and 1.05 B (1) c. specified herein before.

c. Interconnecting Wiring Diagrams

(1) Refer to Section 1.05 B. (1) d specified herein before.

d. Instrument Installation Details

(1) Refer to Section 1.05 D. herein before.

B. Software

(1) In addition to the reproducible hard copy of drawings and literature specifically generated for the project, one (1) set of 3.5 inch, 1.44 MEG capacity diskettes shall be submitted to the Owner which shall include a copy of all files specifically generated to create the drawings, data sheets, bill of materials, operating and test procedures, control logic, etc. Drawing format shall be compatible with "AutoCAD" Release 12. Diskettes shall be clearly labeled with the following:

a. Project Name
b. Volume Number
c. Software Program Name and Version used to generate the files
d. Label "As-Installed"

(2) Provide one copy of all programming software, application programs, and source code utilized to generate, annotate, and debug all software provided. Programming software, detailed programming instructions, software keys, cables, and licenses shall be provided for all programmable devices, i.e., PLC, DCS, SCADA, controllers, and smart transmitters. Special devices used in programming supplied hardware shall be provided. It is the intent that the Owner shall have the full capability to re-program and modify any application on-site without the need to purchase additional software or hardware.

C. Operation and Maintenance Manuals

(1) Furnish the balance of six (6) sets of Operation and Maintenance Manuals for equipment provided under these Specifications. Content shall be as described above for the submittals.

1.08 TRAINING REQUIREMENTS

A. General

(1) Provide the services of a factory trained and field experienced control systems engineer to conduct group training of Owner's designated personnel in the operation of all Instrumentation, Control and Monitoring equipment furnished. Include instruction covering basic system theory, operating principles and adjustments, routine maintenance and repair, and "hands-on" operation. The text for this training shall be the P&IDs, panel wiring diagrams, layouts, ladder listings, and the operation and maintenance manuals furnished under these Specifications.

B. Duration

(1) Training specific to the system hardware shall be provided for a minimum of five days per three operating shifts with a time period necessary to cover complete Operator and Maintenance Training.

C. Operator Training

(1) Operator training shall include instruction in the use of all control system hardware and software furnished. A detailed written description of the system furnished and all equipment start-up, shut-down, troubleshooting, and maintenance procedures shall be provided to each Operator attending the training sessions. Training material shall be organized and bound in appropriate binders. One copy of the training manual shall be submitted to the Owner prior to scheduling any training sessions. As a minimum, the format for the training material shall be as follows:

a. General system description and overview
b. Process and Instrumentation Diagrams
c. Sequence of Operation
    1. Panel Layout Drawing
    2. Legend
    3. Alarm Handling
    4. System Start-Up
    5. System Shut-Down
    6. Operator Adjustment & Setpoints
    d. General Troubleshooting Techniques
    e. Recommended Maintenance Procedures
    f. Recommended Spare Parts

D. Maintenance Training

(1) Maintenance training shall include instruction in the calibration, maintenance, programming, and repair for all systems furnished.

(2) Maintenance training shall include instruction in the maintenance of all control system hardware and software furnished. A detailed written description of the system furnished and all equipment start-up, shut-down, troubleshooting, and maintenance procedures shall be provided to each person attending the training sessions. Training material shall be organized and bound in appropriate binders. One copy of the training manual shall be submitted to the Owner prior to scheduling any training sessions. As a minimum, the format for the training material shall be as follows:

a. General system description and overview
b. Process and Instrumentation Diagrams
c. Sequence of Operation
    1. Panel Layout Drawing
    2. Legend
    3. Alarm Handling
    4. System Start-Up
    5. System Shut-Down
    6. Operator Adjustment & Setpoints
        d. Detailed review of all schematic diagrams
        e. Detailed review of all software functions using actual software listings
        f. Detailed programming instruction of hardware furnished unless otherwise noted
        g. Detailed calibration procedures for all furnished
        h. Recommended Maintenance Procedures
        i. Recommended Spare Parts

E. Final Acceptance

(1) Final Owner acceptance is defined as a point in time when (1) all training has been performed, (2) final "As Installed" documentation and software (when applicable) have been received and approved, (3) the system has successfully passed the availability test period, and (4) all punch list items have been resolved. Only at this time, will final payment be released.

F. Guarantee And Warrantees

(1) Guarantee all work of these Specifications for a period of one (1) year from the date of final acceptance by the Owner. With respect to instruments and equipment, guarantee shall cover (a) faulty or inadequate design; (b) improper assembly or erection; (c) defective workmanship or materials; and (d) leakage, breakage, or other failure not caused by Owner misuse. For equipment bearing a manufacturer's warranty in excess of one year, furnish a copy of the warranty to Owner with Owner named as beneficiary.

PART 2 - PRODUCTS

2.01 JOB CONDITIONS

A. Exercise care (1) to secure neat arrangement of all piping, valves, conduit, and like items, and (2) to overcome structural interferences. Verify dimensions and conditions at the place of work, and install materials and equipment in the available spaces.

2.02 MATERIALS AND STANDARD SPECIFICATIONS

A. Provide instruments, equipment and materials suitable for service conditions and meeting standard specifications such as Instrument Society of America (ISA). The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the facilities; i.e., all instruments furnished by the Supplier of the same type of function shall be by the same manufacturer. This allows the stocking of the minimum number of spare parts.

2.03 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Box, crate or otherwise enclose and protect instruments and equipment during shipment, handling and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids, and gases or any element which could degrade the equipment. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repair any damage as directed and approved.

2.04 MOUNTING

A. Mount and install equipment as required. Mount field instruments according to the best standard practice on pipe mounts, pedestal mounts, or other similar means in accordance with manufacturers recommendations.

B. Equipment specified for field mounting shall be suitable for direct pipe mounting, pedestal mounting, or surface mounting. Non in-line indicators and equipment with calibration adjustments or requiring periodic inspection shall be mounted not lower than three (3) feet nor high than five (5) feet above walkways, platforms, catwalks, etc. All such equipment shall be weather and splash proof, and electrical equipment shall be in NEMA 4X cases unless otherwise noted.

2.05 COMPONENT TAG NUMBERING SCHEME

A. All control equipment shall be identified by unique alphanumeric code or tag number based on the latest Instrument Society of America standards S5.1.

Tag Numbering Scheme: a-b-c-d

Equipment tagging shall be based on the following scheme:

	Description	TAG	Explanation
a.	ISA Functional Identification	HS	Hand Switch
b.	Loop Number	23	Loop 23
c.	Component Number	2	Second HS in Loop
d.	Unit	3 (When Required)	Third Identical Process Control System

Example 1: HS-23-2-3

Tag number identifies a Hand Selector Switch. It is part of Loop 23 and the second hand selector switch in the loop. This is the third identical process unit (i.e., three identical pump control stations). It is also the only hand selector switch in the loop.

Example 2: HS-23

Tag number identifies a Hand Selector Switch in Loop 23. It is also the only hand selector switch in the loop.

2.06 INSTRUMENT IDENTIFICATION

A. All components provided, both field and panel mounted, shall be provided with permanently mounted name tags bearing the entire tag number of the component. Panel mounted tags shall be white with black lettering lamicoid plastic; field mounted tags shall be stamped stainless steel.

B. Nameplates for panels and panel mounted equipment shall be as indicated on the Drawings.

C. Field mounted tags shall be 16-gauge, 304 stainless steel with 3/16 inch high characters.

D. Tags shall be attached to equipment with a commercial tag holder using a stainless steel band with a worm screw clamping device or by a holder fabricated with standard

stainless steel hose clamps and meeting the same description. In some cases where this would be impractical, use 20 gauge stainless steel wire.

E. For field panels or large equipment cases use stainless steel screws, however, such permanent attachment shall not be on an ordinarily replaceable part. In all cases, the tag shall be plainly visible to a standing observer and not obscure adjustment ports or impair the function of the instrument. Field mounted control stations, recorders or indicators shall have a nameplate indicating their function and the variable controlled or displayed. Nameplate shall be attached by one of the above methods.

2.07 STANDARD LIGHT COLORS AND INSCRIPTIONS

Unless otherwise noted, the following color code and inscriptions shall be followed:

Tag Function	**Inscription(s)**	**Color**
ON	ON	RED
OFF	OFF	GREEN
OPEN	OPEN	RED
CLOSED	CLOSED	GREEN
LOW	LOW	GREEN
FAIL	FAIL	RED
HIGH	HIGH	AMBER
AUTO	AUTO	WHITE
MANUAL	MANUAL	YELLOW
LOCAL	LOCAL	WHITE
REMOTE	REMOTE	AMBER

Lettering shall be black on white and amber lenses. Lettering shall be white on red and green lenses.

2.08 STANDARD PUSHBUTTON COLORS AND INSCRIPTIONS

Tag Function	Inscription(s)	Color
OO	ON	RED
OC	OFF	GREEN
OC	OPEN	RED
	CLOSED	GREEN
OCA	OPEN	RED
	CLOSED	GREEN
	AUTO	WHITE
OOA	ON	RED
OC	OFF	GREEN
	AUTO	WHITE
MA	MANUAL	YELLOW
	AUTO	WHITE
SS	START	RED
	STOP	GREEN
RESET	RESET	RED

All unused or non inscribed buttons shall be black. Lettering shall be black on white and yellow buttons. Lettering shall be white on black, red, and

2.09 ELECTRONIC EQUIPMENT

A. If the equipment is electronic in nature, provide industrial duty, solid state equipment to the greatest extent practicable. Select components of construction for their suitability and reliability. Employ adequate component derating to preclude failures because of transients and momentary overloads reasonably expected in normal operation. Where conduit connection is provided for mounting a surge/lightning suppressor directly to the instrument, the arrestor shall be so mounted.

2.10 EQUIPMENT OPERATING CONDITIONS

A. All equipment shall be rated for normal operating performance with varying operating conditions over the following ranges:

(1) Power:

120 Vac ± 10%, 60 Hz ±1 Hz except where specifically stated otherwise on the drawings or in the specifications.

(2) Environmental Conditions:

a. Equipment rated NEMA 1 or NEMA 12 shall be suitable for the following environmental conditions:

1. Temperature: 40 to 105 degrees F.
2. Relative Humidity: 10 to 80 percent.
3. Classification: Non-hazardous.

B. Equipment rated NEMA 4X shall be suitable for the following environmental conditions:

(1) Temperature: 20 to 105 degrees F.
(2) Relative Humidity: 10 to 100 percent.
(3) Classification: Non-hazardous.
(4) Atmosphere: Corrosive.

2.11. SIGNAL ISOLATORS, CONVERTERS AND CONDITIONERS

A. Insure that input-output of all instruments and control devices (whether furnished by the Supplier or not) are compatible. Analog signals between field and panels shall be 4 to 20 mA dc unless specifically approved otherwise. Granting such approval does not relieve the Supplier from the compatibility requirement above. Provide signal isolators and converters as necessary to obtain the required system performance. Mount the devices behind control panels or in the field at point of application, as required for accurate signal acquisition.

2.12. AUXILIARY CONTACTS BY OTHERS

A. Provide instruments and equipment to connect to auxiliary contacts provided by others for alarms, status of equipment, interlocking, and other functions as indicated and as specified herein.

2.13. ELECTRICAL

A. The construction work shall include all power supply wiring, instrumentation wiring, interconnecting wiring and equipment grounding as indicated, specified, and required.

B. Wiring installations shall include cables, conductors, terminals, connectors, heat shrunk wire markers on all terminations, conduits, conduit fittings, supports, hardware, and all other required materials.

C. Provide the materials and complete all the required installations for equipment grounding.

D. Incidental items not specifically included in the Contract Documents that can legitimately and reasonably be inferred to belong in the instrumentation work shall be provided and installed by the Supplier at no additional cost to the Owner.

E. Ring out all signal wiring prior to termination. Provide wire number tags marked in indelible waterproof form of slip-on type and heat shrunk for each wire termination point in the panel and field. Wire tagging shall identify the destination point of the wire and when applicable, shall include the signal polarity for analog signals. Each destination point shall be coded as follows:

(1) Destination ID - Terminal Block ID - Terminal Number - (Polarity)

2.14. ELECTRICAL TRANSIENT PROTECTION

A. All instrument and control equipment mounted outside of protective structures (field mounted equipment) shall be equipped with suitable surge-arresting devices to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby electrical devices. Both power and signal circuits shall be protected with surge and transient protectors installed at the source and destination ends of the circuits. Protective devices used on 120V ac inputs to field mounted equipment shall be secondary valve surge protectors conforming to the requirements of IEEE Standard 28-1972 (ANSI C62.1-1971).

B. Surge and transient protectors shall be normally connected to the electrical system ground. When an electrical system ground is not available near the device, the protectors shall be connected to a ground rod 10 ft. in length by 3/4 inch in diameter and located within 10 feet of the device.

C. Protectors for signal circuits at the field transmitter shall be Joslyn Model No. 1669-06, 1669-02, and 1800-20 in panels. Protectors for 120 volt power circuits shall be UL listed Joslyn Model No. 1250-32 secondary arrestor.

2.15. PROCESS CONNECTIONS

A. Provide instrument piping, tubing, and capillary tubing to meet the intended process service and ambient environmental condition for corrosion resistance, etc. All instrument pneumatic tubing shall be stainless steel with stainless steel fittings. Slope lines according to service to promote self draining or venting back to the process. Terminate connection to process lines or vessels in a service rated block valve that will permit closing off the sense line or removal of the element without requiring shut down of the process. Include drip legs and blow-down valves for terminations of sense lines at the instruments when mounted such that condensation can accumulate.

2.16. MISCELLANEOUS MECHANICAL

A. Three Valve Instrument Equalizing Manifold

1. Manifolds shall be of stainless steel construction for isolation and equalization of differential pressure transducers. Units shall be Anderson, Greenwood and Company Type M1 or equal.

B. Welding of S.S. enclosures and instrument supports shall be TIG welded and finished to provide neat corrosion free appearance.

2.17. PAINTING

A. Provide factory paint for all instruments and equipment. Provide paint as required for non-stainless steel structural supports, brackets, etc.

2.18. CORROSION PROTECTION

A. All control panels, enclosures, and other equipment containing electrical or instrumentation and control devices, including spare parts, shall be protected from corrosion through the use of corrosion-inhibiting vapor capsules. Prior to shipment, the capsules shall be provided within the shipping containers and equipment as recommended by the capsule manufacturer's recommendations. All capsules shall be replaced by the Contractor just prior to Owner's final acceptance of the equipment. The corrosion-inhibiting vapor capsules shall be Northern Instruments Model Zerust VC or Hoffman Model A-HCI. NEMA 4x panels shall be provided with breather/drains, Chrouse-Hinds Model ECD18; or approved equal.

2.19. SPARES AND MAINTENANCE MATERIALS

A. Deliver to Owner, as directed, the following items as specified herein. Include an itemized list in a letter of transmittal with each shipment.

B. Materials shall be delivered in the manufacturer's original containers labeled to completely describe contents and equipment for which it is furnished.

1. One fuse of each size and type for every five used but no less than five of each type.

2. One circuit breaker of each size and type for every five used but no less than one of each type.

3. One relay of each type for every five used but no less than one of each type.

4. One status light bulb for every five used but no less than five of each type.

5. One indicating lamp assembly for every five panel mounted lamp assemblies used but no less than one of each type.

6. One switch assembly for every five used but no less than one of each type.

7. One year supply of charts and ink for each recorder furnished.

8. One transient protector for every five used but no less than one of each type.

2.20. WORKMANSHIP

A. General

1. Install materials and equipment in a workmanlike manner utilizing craftsman skilled in the particular trade. Provide work which has a neat and finished appearance.

2. Coordinate work with the Owner, and work of other trades to avoid conflicts, errors, delays, and unnecessary interference with operation of the facilities during construction.

B. Protection During Construction

1. Throughout this Contract, the Contractor shall provide protection for materials and equipment against loss or damage and the effects of weather. Prior to installation, store items in indoor, dry locations. Provide heating in storage areas for items subject to corrosion under damp conditions. Specific storage requirements shall be in accordance with the Owner reviewed Contractor recommendations.

C. Material and Equipment Installation

1. Follow manufacturers' installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between manufacturers' instructions, and these Contract Documents, follow the Owners decision, at no additional cost to the Owner. Keep copy of manufacturers' installation instructions on the jobsite available for review at all times.

D. Removal or Relocation of Materials and Equipment

1. Where existing materials and equipment are removed or relocated, remove and deliver to the Owner all materials no longer used unless otherwise directed by the Owner. Repair affected surfaces to conform to the type, quality, and finish of the surrounding surface in a neat and workmanlike manner. Follow any specific instructions by the Owner.

E. Cleaning and Touchup Painting

1. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touch-up scratches, scrapes, or chips in interior and exterior surfaces of panels and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish.

F. Panels and Panel-Mounted Equipment

1. Panels and panel-mounted equipment shall be assembled as far as possible at the factory. No work, other than correction of minor defects or minor transit damage, shall be done on the panels at the jobsite.

G. Electrical

1. Arrange wiring neatly, cut to proper length, and remove surplus wire. Provide abrasion protection for any wire bundles which pass through holes or across edges of sheet metal.

2. Wiring shall not be spliced or taped except at the device terminals or terminal blocks.

3. Use manufacturer's recommended tool with the proper sized anvil, for all crimp terminations. No more than one wire may be terminated in a single crimp lug and no more than two lugs may be installed on a single screw terminal.

H. Inspections

1. All materials, equipment, and workmanship shall be subject to inspection at any time by the Owner. Correct any work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to the Owner at no additional cost to the Owner.

END OF SECTION

SECTION 13610

DATA ACQUISITION AND PROCESS CONTROL SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. The Primary Instrumentation and Control System Supplier (System Supplier) shall furnish all labor, materials, modifications to existing equipment, programming, services and incidentals required to install and place into operation a digital computer-based data acquisition and process control system (DACS) in a distributed network configuration as specified and shown on the Contract Drawings, Section 13410: Basic Instrumentation, Monitoring and Control System, Section 13615: Process Instrumentation and Controls Products, and herein.

2. The System Supplier shall supply all equipment, materials, programming, and services, hereinafter termed the system. The System Supplier shall provide all equipment, materials, programming, software, modifications to existing equipment, calibrations and services that are required to successfully interface and interconnect the and any other control systems and associated equipment that are specified or designated in any drawings or specification provisions in Division 11: Equipment, Division 13: Special Construction, Division 15: Mechanical and Division 16: Electrical of these Specifications for the purpose of providing a fully integrated and functional control system as specified herein. Successful integration and interconnection of the data acquisition and process control system to any of the areas of interface specified shall require that the System Supplier to provide the necessary extension to the existing data highways and I/O capability.

3. The System Supplier shall be responsible for providing accessory devices, revising existing control systems including furnishing and installation of control switches and signal converters and changes to software necessary to perform the intent as shown P&IDs and as specified in the functional process descriptions, providing services to re-calibrate all existing analog transmitters which provide inputs to the system, and services necessary to achieve a fully integrated and operational system as shown on the Contract Drawings, Section 13615 and described hereinafter. Repair of existing transmitters and field devices found to be out of operation shall not be included under this Section.

4. The System Supplier shall furnish for installation by the Contractor all cabling and cable accessories, including tools necessary for connecting the control system peripherals.

5. The System Supplier shall furnish startup assistance and operator and maintenance training necessary to successful operation and maintenance of the integrated control system.

B. Related Work Described Elsewhere:

1. Basic Instrumentation, Monitoring and Control Requirements: Section 13410.

2. Process Instrumentation and Controls - Products: Section 13615

3. Electrical: Division 16.

C. General Description of the System:

1. A computer-directed monitoring, automatic control and management system shall be furnished to provide control logic, monitoring of process variables and operational records of system operation. It shall also be used to provide other management functions, including government reports and operational reporting.

2. The data acquisition and process control system shall operate as a stand-alone system with local inputs/outputs and shall interface with wide area data network. The data acquisition and process control system software shall be completely standard and consist of groups of functional software modules that have been developed and thoroughly tested. Operator prompting with menu selection shall configure the data acquisition and process control system. It shall not require knowledge of any programming language.

1.02 QUALITY ASSURANCE: Qualification requirements are specified under Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

1.03 SUBMITTALS: Refer Section 01005 Project Requirements and Section 13410 Basic Instrumentation, Monitoring and Control Requirements.

1.04 DOCUMENTATION: Refer to Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING: Refer to Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

1.06 WARRANTY AND GUARANTEES (SEE SECTION 01730: WARRANTIES AND BONDS)

A. All equipment supplied under this section shall be warranted for a period of one (1) year by the System Supplier.

B. The System Supplier's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

PART 2 - PRODUCTS

A. Fiber-Optic Cable: All fiber-optic connection shall be multi-mode 62.5/125µm gel-filled cable (pre-manufactured by a fiberoptic cable manufacturer).

2.01 SYSTEM SOFTWARE

A. General Description:

1. The supervisory system shall be an operator interface control system that includes support for process control, data acquisition, alarming, trending, and management reports, operating under the latest version of Windows® at the Facility.

2.02 REPORTS

A. Reports shall be implemented through the specified Report Generator. Provide the following reports:

1. Monthly Operations Report: The data for this report shall be daily totals and averages calculated by the DACS. Configure handling of report data and generation of the report so that loss of Random Access Memory (RAM) during the month shall not cause loss of report data. The report shall provide totals by week of all process flows. The report shall also provide a monthly total for each process flow. Format of the report shall be decided at the first coordination meeting.

2. Daily Operations Report: The data for this report shall be the hourly values of all process values monitored by the DACS.

3. Daily Equipment Maintenance Report: A table to indicate totalized elapse runtime of all pumps, blowers and process equipment shall be configured daily at the same time of day and automatically down loaded to the maintenance program.

4. Status/Alarm Report: The data for this report shall be the last 200 change of status or alarm conditions monitored at the plant.

2.06 FUNCTION DESCRIPTIONS

A. General Requirements:

1. The Data Acquisition System (DACS) shall perform the following as a minimum:

a. Monitor the status of all selector switches in the field.

b. Display on each facility screen the run status and totalized run hours of all equipment.

c. Display, indicate and record alarm status as required by other divisions of the specification.

d. Provide interlocking signals between unit processes.

e. Display and configure graphics. Graphics shall include facility structure and major process piping and alarms. The graphics shall include facility name, specifics areas, time and date stamp, flow direction arrows, adjacent to and from process icons, valves and equipment tags, each process equipment shall be called-out (i.e. High Pressure Pump No.1 etc.) and equipment status shall be indicated. A color code system shall be submitted for approval.

f. Trend all flow, level and analytical signals including min. max. and avg. for each.

g. Configure tables of real-time data for access by other users on the network.

h. Configure tables of elapse time of all equipment and relational data as required by the Owner.

i. Alarm events shall be tagged to allow the user to mouse click to the alarmed facility.

B. In addition to the Functional Requirements shown on the P&ID drawings and the General Requirements under 2.06 General Requirements, the DACS shall be configured to monitor the digital and analog inputs listed in Table 13615-1 for the City of Palm Bay South Regional Water Treatment Plant.

1. Water Treatment Plant Graphic Requirements

a. Plant Overview Screen shall be configured to indicate major structures and piping systems including names of facilities. The Owner shall be capable to click-on to the facility to initiate the specific facility graphic.

b. In addition to the configuration of overview screen facility graphics there shall be provided as a minimum the following graphics modification:

1) Raw Water Well No. 4
2) High Pressure Pumping
3) Degasifier
4) Transfer Pumping
5) High Service Pumping
6) RO Skids
7) Sodium Hydroxide Feed System
8) Sodium Hypochlorite Feed System
9) Blower Room
10) Ground Storage Tank
11) Carbon Dioxide Feed System

2. Trending: Trending shall be configured for all analog process signals located at the water plant. The X and Y-axis shall be configured using engineering units percent of scale is not acceptable.

3. Tables: Tables shall be configured to indicate elapses time for all pumps, blowers and process equipment. In addition, tables for all totalized flow and a table for control set points shall be configured.

4. Bar Graphs: Bar graphs shall be configured to indicate all analog processes, flow, level and analytical signals. The horizontal axis shall be scaled in engineering units.

C. Plant Automation:

1. Raw Water

a. The control system shall include on (1) raw water production well #4.

b. The proposed control system shall monitor and control the raw water wellfield and provide MANUAL control of the proposed raw water well pumps and motor generated valves. All alarms, flows, levels and status signals shall be indicated and made available to operations.

2. RO Membrane and High Pressure Pumping (Typical for Two Skids)

a. The automatic control logic for the proposed membrane skids will be detailed following contract award to ensure full compatibility with the final skid design. The following paragraphs describe the control sequences in general terms for bidding purposes.

1. Start-up and Shutdown Initiation. Normal start-up and shutdown sequences for the proposed membranes shall be initiated manually by the plant operator. Manual initiation shall be achieved through keyboard entry at the plant computer.

2. Auto/Manual Sequencing. When the auto control logic receives the call to start up or shutdown a membrane, it shall proceed with the sequence automatically. Programming shall allow for the operator to step through the sequence, with the PLC holding the sequence after each step until commanded by the operator to proceed with the next.

3. Start-up Sequence. The following steps describe the normal start-up of a membrane:

    a. The control system will initiate a plant bypass and start chemical feed systems as required when initial conditions are stable skid will be given permission to start. Under manual operation, the plant operator will establish initial conditions.

    b. Verify initial conditions.

        Feed water valve closed.
        Feed water valve under PLC control.
        Reject valve under PLC - control.

    c. Open plant by-pass valve fully.

    d. Verify raw water characteristics.

    e. Open the feed water valve to modulate feed water flow to a predetermined value for pre-flush and close the plant bypass valve.

    f. After a predetermined pre-flush period, close the feed water valve to a predetermined position.

    g. Call for high pressure pump start.

    h. Open and throttle back the concentrate valve to modulate the reject flow to a predetermined value.

    i. Verify the pump has started, and then open the feed water valve to modulate feed water flow to a predetermined value.

4. Normal Shutdown Sequence. The following steps describe the normal shutdown of a membrane:

a. Shutdown high pressure pump(s).

b. Modulate the feed water valve for a predetermined feed water flow for the post flush.

c. After a predetermined post flush time, fully close the feed water valve.

5. Emergency Shutdown. The emergency shutdown sequence shall be identical to the normal shutdown except that it is initiated by the shutdown logic rather than the operator and there is no post flush period.

3. Degasifiers

a. The control system shall monitor and control the degasifiers. The monitoring shall include indicating the status of the selector switches located near the blower and in the odor control panel. Monitor the air flow to the degasifiers and provide system ready status generated when the field HOR near the motor is in REMOTE position, odor control HOA is in the AUTO position and the MCC motor breaker and local disconnect are closed.

b. Blower failure signal shall be generated based upon the lack of air flow as detected by a duct mounted pressure switch.

c. The control system shall provide the start and stop control of new degasifier blower based upon indication of permeate flow.

1. The control sequence shall be as follows:

a.) The operator selects which blowers are in service. (BL-1, BL-2 and/or BL-3)

b.) The operator is prompted by the computer to start.

1. The control system will start the blower(s) in software and field AUTO as required based upon the permeate flow indication.

4. Transfer Pumping

a. One (1) transfer pumps shall be automatically controlled as a function of the water level in the transfer pump station wetwell.

1. The control sequence shall be as follows:

a.) The operator selects which pumps are in service. (TP-1, TP-2 and/or TP3.

b.) The operator adjusts the desired AUTO level setpoints via a control matrix on the CRT.

c.) The operator set the desired alternation sequence via a control matrix on the CRT. (1-2-3/2-3-1/3-1-2)

d.) The operator selects the pumping units "in emergency service". (TP-1 and/or TP-2 and/or TP-3)

e.) The operator selects which pumping units will be controlled as either AUTO or MANUAL.

f.) The operator is prompted by the computer to begin pumping.

1. The control system will start the pumping unit(s) in software and field AUTO as required based upon the alternation and clearwell level.

2. The control system will start the pumping unit(s) in MANUAL, the pumping units shall remain running until the operator prompts the software HOA to OFF or the local HOA is set in the OFF position or the low level float is activated.

2. The control system will control the pump(s) in AUTO as function of water level in the transfer pump station wetwell and a field adjustable operator setpoint. The pump station shall be programmed as a "pump down" scenario.

3. Pump ready signal shall be generated when the field HOA is in AUTO position, MCC HOR is in the REMOTE position and the MCC motor breaker and local disconnect are closed

4. Pump failure signal shall be generated based upon the lack of incremental increase or decrease in flow as detected by a limit switch on a check valve.

5. In the event of an emergency high level alarm as indicated by a float located in the clearwell, the control system shall start the emergency pumping units selected by the operator. The pump shall remain running until the emergency low level float is activated at which time the emergency pumping units will stop.

5. High Service Pumping

a. High Service Pumping control system shall automatically start and stop and adjust the speed of up to six (6) pumping units as a function distribution pressure. The sequence of operation shall be as follows in any order:

(1) The operator sets the discharge pressure to be maintained. (0-100 psi.) (Password protected)
(2) The operator sets the distribution system minimum and maximum pressure set points. (Password protected)
(3) The operator sets the minimum and maximum pressure set points between pump staging. (Password protected)
(4) The operator sets the minimum and maximum VFD speed set points. (Password protected)
(5) The operator selects either manual or automatic alternation.
(6) If manual alternation is selected, the operator will select the pumping units to start at each pumping stage.
(7) The operator sets the start and stop time delays for each pump. (Password protected)
(8) The operator sets the start and stop time delays between each pumping stage. (Password protected)
(9) The operator positions the VFD Local/Off/Remote selector switch in the REMOTE position.
(10) The operator sets the HMI HOA in the AUTO position.
(11) The operator selects the pressure alarm setpoints. (Password protected)
(12) The operator selects the ground storage “all pumps off” and “reset” level. (Password protected)
(13) The operator is prompted to initiate automatic control.
(14) After operator prompt to start, the control system shall confirm equipment status and shall prompt the operator if there is a condition where automatic control is not possible. The control system shall provide error messages to alert the operator of a problem. If the control system determines acceptable operating parameters, the control system shall automatically start, stop and adjust speed to maintain setpoint.

b. On falling pressure the control system shall start the jockey variable speed pump and adjust speed to maintain setpoint, if pressure continues to fall and the lead pump is at the VFD maximum speed setpoint, the jockey pump shall stop and the 1st. main variable speed pump shall start and adjust speed to maintain setpoint. If pressure continues to fall and the 1st main pump is at the VFD maximum speed setpoint, the control system shall start the 2nd lag main pump and adjust speed in unison with the lead and 1st lag pump to maintain setpoint. If pressure continues to fall, the pumping units shall continue to be staged "on" in the same manner as the previous pumps until all pumps are on-line. On rising pressure, the control system shall lower speed to maintain setpoint until minimum VFD speed set points are detected and the upper pressure setpoint is reached at which time the control system shall shutdown-pumping units in a "first-on first-off" sequence.

c. The control system shall allow the operator to control each pumping unit manually.

d. The control system shall alarm the operator in the event of a pump failure as a function of lack of increase of flow as indicated by a limit switch mounted on a check valve.

e. Pump ready signal shall be generated when the VFD HOR switch is in the REMOTE position and the drive transmits a "READY" signal.

f. The pumping unit(s) that are not "ready" shall be considered "out-of-service". The control system will automatically control the next pumping unit as required by the operator setpoint(s) and the process.

g. The VFD shall be programmed to ramp up / down pump speed upon receiving an on /off commands to prevent check valves from slamming shut.

h. Furnish auto/manual type graphic bar-graph PID controls for HMI VFD operation to include Auto/Manual, set point, process variable, output, and PID tuning adjustments.

i. Furnish one HMI display page for all high service pump VFD and PID controllers.

j. Furnish pump run timers and start counters.

k. Furnish pump failure and reset required alarms based on no flow switch inputs.

l. Input and output shall be in accordance to Table 13615-1

6. Carbon Dioxide System

a. Refer to Section 11300 Carbon Dioxide Storage and Pressurized Solution Feed System.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION: The computer system, peripherals, and accessory equipment shall be installed in accordance with the requirements set forth under Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

3.02 TESTS AND ACCEPTANCE: Field and system tests, and acceptance requirements are specified under Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

3.03 MAINTENANCE CONTRACT: Maintenance contract requirements are specified under Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

3.04 WARRANTY: Provide a system warranty in accordance with the requirements of Section 01740: Warranties and Bonds.

3.05 INSTRUCTION: Personnel training requirements are specified under Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

END OF SECTION

SECTION 13615

PROCESS INSTRUMENTATION AND CONTROLS PRODUCTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Attention is drawn to the requirement that all instrumentation and control equipment specified herein shall be furnished by the same System Supplier who shall provide all other related equipment as specified in Section 13410 and 13610.

B. System Supplier shall furnish all labor, materials, equipment, and services required to install and place into operation the field instrumentation and controls specified herein and as shown on the Contract Drawings.

C. Any auxiliary devices such as lightning/surge protectors, relays, timers, isolators, signal boosters, etc., which are necessary for complete operation of the system, or to perform the functions specified, shall be included whether or not they are specifically shown on the drawings.

D. System Supplier shall coordinate programming of the programmable logic controllers with the membrane supplier, chemical feed pump supplier, motor control center supplier and all other related equipment supplied by other vendor.

1.02 RELATED WORK

A. System Supplier shall be responsible for supplying and installing all equipment as defined in this section and the following related sections:

1. Section 13410 - Basic Instrumentation, Monitoring and Control Requirements

2. Section 13610 - Data Acquisition and Process Control System

B. System Supplier shall be responsible for coordinating with the work to be performed as defined in section 13410.

1.03 QUALIFICATIONS

A. All interested System Suppliers shall comply fully with the qualification requirements stated in specification section 13410.

1.04 SUBMITTAL REQUIREMENTS

A. Refer to Section 13410 - Basic Instrumentation, Monitoring and Control Requirements

1.05 FINAL DOCUMENTATION

A. Final Documentation requirements are defined in specification Section 13410.

1.06 QUALITY CONTROL

A. Quality Control requirements are defined in specification Section 13410.

1.07 PRODUCT HANDLING

A. Product handling requirements are defined in specification Section 13410.

1.08 TOOLS AND TEST EQUIPMENT

A. In addition to the general tools and test equipment defined in specification section 13410, the System Supplier shall provide any items, such as calibration fixtures, patch cables, test leads, etc. necessary for properly checking field operation of equipment supplied under this section.

1.09 SPARE PARTS

A. Spare parts shall be provided for all field replaceable components so there is one spare for every five like items or part thereof.

B. All spares shall be packed in a manner suitable for long-term storage and shall be adequately protected against corrosion, humidity and temperature.

C. Storage and handling instructions shall be provided with each spare part.

D. One year's supply of paper, ink cartridges, calibration gases, etc., as required for the equipment being supplied, shall be provided. Items with less than one year's shelf life shall be provided at required intervals to ensure reliable systems operation throughout the first year following system acceptance.

PART 2 - PRODUCTS

2.01 FIELD MOUNTED INSTRUMENTS

A. Flow Element-Magnetic Meter

Tags:

ISA Designation	Line Size (Inches)	Service
FE/FIT-104	12	Well #4
FE/FIT-731	6	RO Skid #3
FE/FIT-732	8	RO Skid #3
FE/FIT-733	4	RO Skid #3
FE/FIT-741	6	RO Skid #4

FE/FIT-742	8	RO Skid #4
FE/FIT-743	4	RO Skid #4
FE/FIT-0000		Uninstalled Spare
FE/FIT-0000		Uninstalled Spare

1. Electromagnetic flowmeters shall operate on electromagnetic induction principle and give an output signal directly proportional to the liquid rate of flow.

2. Primary (Flow Head)

   a) Each meter shall have a stainless steel metering tube and a non-conductive liner of hard rubber (NSF approved), suitable for the liquid being metered. End connections shall be steel flanged for sizes 1/2-inches and greater, ANSI Class 150#, for meter sizes up to 24-inches and AWWA Class B or D for meters larger than 24-inches. The housing shall be epoxy coated steel welded at all joints. Bolted coil enclosures shall not be acceptable.

   b) The field coils of the meter shall be supplied with a precisely adjusted bi-polar direct current. The coils must be located on the outside of the flow tube.

   c) There shall be no electronic components on the primary flowhead. Coil drive power shall be supplied by an integral or remote converter. Output signal from the primary shall be fed through 'DS' proprietary cable supplied with the meter for remote signal converters.

   d) The primary flowhead shall have a housing rated for:

      1) Weatherproof, NEMA 4X.

      2) Electrode material shall be corrosion resistant Hasteloy C.

      3) Meters sized 3/8-inches and 1/2-inches shall be lined with PTFE Teflon. Meters sized 1-inches to 120-inches shall be hard rubber, NSF approved.

   e) Build-up of foreign substances on the electrodes shall be prevented, while meter is in service, in the following manner: "Hot Tap" removable electrodes shall be provided on sizes 14-inches to 120-inches. High Impedance circuits shall not be acceptable in lieu of hot tap removable electrodes.

   f) The instrument shall be manufactured in an ISO 9001 approved facility.

   g) When installed in lined or non-metallic piping, the meter shall be provided with corrosion resistant grounding rings. Grounding electrodes shall not be acceptable.

h) Meter calibration shall be performed by a direct volumetric comparison method. A calibration certificate shall accompany each meter. Calibration facility shall be certified to .02% accuracy and be traceable to NIST standards.

i) The meter shall be the Krohne Aquaflux series, ABB or Rosemount.

B. Pressure Switch

Tags:

ISA Designation	Service
PSL-104	Well #4
PSH-603	High Pressure Pump #3
PSH-604	High Pressure Pump #4
PSH-2131	Booster Pump #1
PSH-2132	Booster Pump #2
PSH-2133	Booster Pump #3
PSH-2134	Booster Pump #4
PSH-2001	Sodium Hydroxide Feed System
PSH-2002	Sodium Hydroxide Feed System
PSH-2003	Sodium Hydroxide Feed System
PSH-1401	Sodium Hypochlorite Feed
PSH-1402	Sodium Hypochlorite Feed
PS-0000	Uninstalled Spare
PS-0000	Uninstalled Spare
PS-0000	Uninstalled Spare

1. Type:

a. Bourdon tube pressure actuated.

b. One or two SPDT switches as required.

2. Operation:

a. Purpose - To provide a contact output at a predetermined pressure value.

b. Operating Principle - Bourdon tube pressure element coupled to a magnetic mercury switch.

3. Functional:

a. Contact Rating - 10 amp to 120 volts ac.

b. Adjustable Differential automatic reset.

c. Range - As required.

4. Physical:

a. Case Size - Approximately 6-inch.

b. Case Material - Stainless Steel.

c. Process Connection - 1/4-inch NPT.

d. Double setpoint external to switch cover.

5. Manufacturer:

a. Mercoid DA/DS series Nema 4X, or approved equal.

Diaphragm Seal

1. Operation:

a. Purpose - To protect instruments or gauges from the process medium.

b. Operating Principal - A flexible diaphragm separates process medium and instrument element. Space on instrument side of diaphragm to be completely filled with a suitable silicone or instrument oil. The process pressure is transmitted by the liquid filled system to the instrument element.

2. Functional:

a. Filling Screw - Include on all units.

b. Pressure Limits - 1,000 psi.

c. Flushing Connection - Include on all units.

d. Capillary tubing as required.

3. Physical:

a. Top Housing - 316L stainless steel.

b. Diaphragm - Tantalum.

c. Exposed Surfaces - 316 stainless steel.

d. Bolts, Nuts and Plugs - 18-8 stainless steel or 316 stainless steel.

e. Capillary - 1/4-in stainless steel armor shielded.

f. Teflon 0-rings.

g. Deadband: 1.5psi

4. Diaphragm Seal

a. Thread attached.

b. Welded metal diaphragm above 15 psi.

c. Clamped Viton for below 15 psi and vacuum

d. Exposed Surfaces - 316 stainless steel.

e. Continuous duty

5. Manufacturer:

a. Ashcroft or approved equal.

C. Submersible Level Sensor and Transmitter

Tags:

ISA Designation	Service
LE/LT-1202	Ground Storage Tank No. 2
LE/LT-0000	Uninstalled Spare

1. A submersible level transmitter shall be provided to sense the liquid level of the ground water storage tank at the location as shown on the plan drawings and in accordance with the manufacturer's recommendations.

2. The transducer housing shall be fabricated of PVC with a 2.5" diameter diaphragm. Silicone oil shall be used as a hydraulic fill. The sensor shall be mounted using its signal cable. The internal air pressure of the sensor assembly shall be relieved to atmospheric pressure through a sealed breather system.

3. The sensor's signal cable shall be thermoplastic elastomer jacketed. The signal cable shall contain an integral breather tube which shall be connected to the factory supplied sealed breather system and in accordance with the manufacturer's mounting instructions.

4. The transmitter shall be a 4-20mA DC, 2 wire, 10-30 VDC loop-powered type, with its output signal directly proportional to the measured level excursion. The transducer shall be UL 508 listed.

5. The transducer shall be:
    a) Contegra model SLX 130-M-30-100W-B. Provide surge protection model EDCO SS65 series, or approved equal.
    b) Cable length: 100 feet
    c) Cable support: provide cable hanger model CH-SLX1c, or approved equal.
    d) Level Display: Precision Digital model PD765, or approved equal. Provide sunshield protection.

D. Conductivity

Tags:

ISA Designation	Service
AE/AIT-731	RO Skid No. 3
AE/AIT-732	RO Skid No. 3
AE/AIT-741	RO Skid No. 4
AE/AIT-742	RO Skid No. 4
AE/AIT-0000	Uninstalled Spare

1. Type:

    a. Non-fouling electrodes.

    b. Insertion type. (insert into continuously flowing line).

    c. Contacting type.

    d. Measurements up to 50,000 micro-siemens/cm.

2. Operation:

    a. To measure the conductivity level of a fluid stream.

3. Functional:

    a. Process connection 3/4" - 1" MPT.

    b. Pressure rating 75 to 150 PSIG at 80 degrees C.

    c. Temperature limits 0-60 degrees C.

4. Physical:

a. Completely encapsulated.

b. Temperature compensated.

c. Insertion mounting.

d. Complete with interconnecting cable.

e. Cable length to 300 ft.

f. Cell constant as required.

5. Performance:

a. Range as shown on loop drawings.

b. Repeatability .1% of span.

6. The unit shall be as manufactured by ABB Kent Taylor 4600 series to match existing or approved equal.

7. Conductivity Indicating Transmitter

a. Type:

1) Conductivity input.
2) NEMA 4X.

b. Operation:

1) The controller shall be of the solid state design. It shall supply a stabilized a-c voltage to the cell and series resistor, rectify the voltage drop across the resistor and indicate the resultant d-c signal.

b. The conductivity controller shall be multirange with at least three ranges on the scale indicator and a front panel selector switch to choose input range.

c. Each conductivity controller shall be correctly matched to the appropriate conductivity sensor and cell constant.

d. The controller shall provide a 4-20 mA DC output.

c. Functional:

1) Input - conductivity.

b. Output - 4-20 mA DC.

c. Power 110 VAC.

d. The unit shall be as manufactured by:

a. Rosemount
b. Endress-Hauser
c. ABB Taylor

E. Pressure Indicating Transmitter

Tags:

ISA Designation	Service
PE/PIT-104	Well #4
PE/PIT-731	RO Skid No. 3
PE/PIT-732	RO Skid No. 3
PE/PIT-733	RO Skid No. 3
PE/PIT-734	RO Skid No. 3
PE/PIT-741	RO Skid No. 4
PE/PIT-742	RO Skid No. 4
PE/PIT-743	RO Skid No. 4
PE/PIT-744	RO Skid No. 4
PE/PIT-0000	Uninstalled Spare
PE/PIT-0000	Uninstalled Spare

1. Type:

a. Capacitance Cell

b. Electronic Output.

c. NEMA 4X enclosure.

2. Operation:

a. Purpose - To sense variations in pressure and produce a standard current output signal linear with the pressure.

b. Sensing Element - differential-capacitance cell

c. Indicator - integrally mounted.

3. Functional:

    a. Over Pressure Limits - 3600 psig (min) unless otherwise required.

    b. Power Supply - 10-55Vdc

    c. Output - 4-20 mA dc.

    d. Process Connections - 1/2-inch NPT-

4. Physical:

    a. Body Material -Low copper aluminum.

    b. Wetted Parts - 316 SST

    c. Electronics Housing - NEMA 4X.

    d. Teflon 0-rings.

    e. Coplanar Flange

    f. Wall Mounting Bracket

5. Performance:

    a. Accuracy - plus or minus 0.1 percent of span.

    b. Indicator Accuracy - plus or minus 2.0 percent of span.

6. Diaphragm Seal

    a. Thread attached.

    b. Welded metal diaphragm above 15 psi.

    c. Clamped Viton for below 15 psi and vacuum

    d. Exposed Surfaces - 316 stainless steel.

    e. Continuous duty

7. Manufacturer:

    a. Rosemount
    b. Endress-Hauser

F. Pressure Indicators

Tags:

ISA Designation	Service
PI-104	Well #4
PI-603	Skid #3 High Pressure Pump
PI-604	Skid #4 High Pressure Pump
PI-731	Skid #3
PI-734	Skid #3
PI-741	Skid #4
PI-744	Skid #4
PI-1102	Transfer Pump No. 2
PI-1305	High Service Pump No. 5
PI-1306	High Service Pump No. 6
PI-2131	Booster Pump No. 1
PI-2132	Booster Pump No. 2
PI-2133	Booster Pump No. 3
PI-2134	Booster Pump No. 4
PI-2191	CAS from CO2 Feed System
PI-2001	Sodium Hydroxide
PI-2002	Sodium Hydroxide
PI-2003	Sodium Hydroxide
PI-1401	Sodium Hypochlorite
PI-1402	Sodium Hypochlorite
PI-0801	Cleaning Pump Discharge
PI-0000	Uninstalled Spare
PI-0000	Uninstalled Spare
PI-0000	Uninstalled Spare
PI-0000	Uninstalled Spare
PI-0000	Uninstalled Spare

1. Type:

   a. Bourdon Tube

2. Functional:

   a. Over Pressure Limits - 1000 psig (min) unless otherwise required.

   b. Process Connections - 1/4-inch NPT-

3. Physical:

   a. Body Material –Black phenolic

b. Wetted Parts – Grade A Bronze

c. Polypropylene-rings.

e. 4.5 inch dial

5. Performance:

a. Accuracy - plus or minus 0.5 percent of scale.

6. Manufacturer:

a. Ashcroft type 1279, or approved equal.

G. Well Casing Level

Tags:

ISA Designation	Service
LE/LT-104	Well #4
LE/LT-0000	Uninstalled Spare

1. Type:

a. Diaphragm

2. Physical:

a. Body and Wetted Material –316 Stainless Steel

b. 10-30V DC

c. 10 ohms impedance

d. 3C/ cable polyurethane 100 feet

5. Performance:

a. Accuracy - plus or minus 0.25 percent of scale.

6. Manufacturer:

a. Keller PSI Series 710, or approved equal.

H. Limit Switch

Tags:

ISA Designation	Service
FS-1102	Transfer Pump #2
FS-0000	Uninstalled Spare

1. Limit switches shall be of the proximity type, NEMA 4X, hermetically sealed, brass epoxy coated, suitable for submergence, UL and CSA listed, snap action form C contacts, SO-4 conductor cable. This flow switch shall be provided as shown on the instrumentation drawings and shall substitute the limit switch specified in 15050.

2. The limit switch shall be manufactured by GO systems 20 series, fully potted or approved equal.

I. Air Flow Switch

Tags:

ISA Designation	Service
FS-802	Blower #2
FS-0000	Uninstalled Spare

1. The automatic flow switch shall be vane operated to actuate two single pole double throw snap switches. Motion of the switch shall actuate switch by action of a magnet linked to the switch inside the single piece sealed switch body. Vane shall be 316 stainless steel and silver solder. Switch body shall be constructed of 316 stainless steel, one piece milled and bored.

2. The flow switch shall be manufactured by W.E. Anderson Series V4 to match existing or approved equal.

J. pH Meter

Tags:

ISA Designation	Service
AE/AIT-2121	RO Blended Water
AE/AIT-0000	Uninstalled Spare

1. The pH Analyzer Element and Transmitter shall be a microprocessor based process control instrument with measurement ranges of 0 to 14 pH units, and 0

to ± 2000 mV. The controller shall provide automatic temperature compensation and measurements from 0-60 degree C. The pH controller shall be housed in a NEMA 4X, ABS plastic case. The power requirement shall be 120/240 ± 10% VAC, 50/60 Hz, 2.5 W. A 3-VDC lithium cell shall be used for backup during power failure. Accuracy shall be ± 0.05 pH units, ±10 mV and ±1 degree C. Repeatability and resolution shall be ±0.1 pH unit, ±3 mV and ±1 degree C. Operator selectable functions for pH, mV, and temperature and alarm set-point selection shall be provided by front panel mounted, touch-sensitive switches. Results of measurements shall be displayed on a liquid crystal display (LCD).

2. Two independent SPDT n.o./n.c. relays with dry contacts shall be provided for high and low alarm outputs. Alarm points shall be fully adjustable over the entire measurement range of the instrument for pH and mV functions. An isolated 4-20 mA recorder output also shall be provided.

3. The controller shall be capable of operation in either of two recorder output modes. Mode 1 shall provide a 4-20 mA current output proportional to 0-14 pH units and a 15-112 pulses-per-minute programmable frequency output for proportional control of other process equipment. Mode 2 shall provide a 4-20 mA programmable current output over any pre-selected pH range of 0.5 units or greater and a 15-112 pulses per minute frequency output proportional to the full range of 0-14 pH units.

4. A sensor for in-line installation shall be provided. The sensor shall incorporate a replaceable, non-clogging, flat bulb glass combination Ag/AgCL pH electrode housed in a CPVC enclosure containing 316 stainless steel guards with solution ground and Viton 0-ring seals. The sensor shall have a measurement range of 0-14 pH units and operate at a line pressure of 150 psig at 25 degree C.

5. The pH analyzer element shall be model PC series and the controller shall be SC100 as manufactured by Hatch or approved equal.

K. Flow Switch

Tag:

ISA Designation	Service
FE/FS-1305	High Service Pump #5
FE/FS-1306	High Service Pump #6
FE/FS-2131	Booster Pump #1
FE/FS-2132	Booster Pump #2
FE/FS-2133	Booster Pump #3
FE/FS-2134	Booster Pump #4
FE/FS-0000	Uninstalled Spare
FE/FS-0000	Uninstalled Spare

1. Sensor, ¾-inch NPT screw connection, 316 SS construction, standard response sensor, 2-inch insertion length, for flows of .01-3.0 FPS water, .01-5.0 FPS hydrocarbons, or .25-120 FPS air, .25""sensitivity for level in vertical or horizontal installation, -40 to +350°F range, selectable .75 to 3.0 heater wattages

2. Electronics, housing transmitter, one adjustable DPDT output, rated 6A at 120 VAC power, can be configured as two SPDT relays for combinations of flow, level and/or temperature, requires 120 V AC, 240 V AC or 24 VDC power, NEMA 4/7 housing, powder coated aluminum condulet enclosure, probe top mounting

3. Manufacturer: FCI FLT93S Flex Switch, or approved equal.

L. Level Switch (Float Type)

Tags:

ISA Designation	Service
LE/LSL-1002	Transfer Pump #2
LE/LSL-1202	Ground Storage Tank
LE/LSH-1202	Ground Storage Tank
LEL/LSL-0000	Uninstalled Spare

1. Type:

   a. Tilting float actuation.

   b. SPDT non-mercury switch.

   c. Polypropylene casing.

2. Operation:

   a. Function - To produce a contact output at a predetermined liquid level.

   b. Operating Principle - A sealed mercury switch encased in a weighted float freely suspended from a cable is actuated by the tilting motion of the float when it is displaced by the liquid level.

3. Functional:

   a. Output - Form C (SPDT) hermetically sealed non-mercury switch, rated 6 amps at 250 volts ac.

4. Physical:

   a. Float - Hermetically sealed, molded polypropylene casing.

   b. Cable - Three-conductor No. 19 AWG PVC-jacketed.

   c. Mounting - Cable suspended by waterproof compression connector.

5. Performance:

   a. Angular operating Differential 20 degrees.

   b. Vertical operating Differential 1/2-inch.

6. Manufacturer:

   a. Float switch shall be Roto-Float, 3- or 4-wire, or equal.

7. Accessories:

   a. Support bracket with adjustable clamp for setting switch height.

   b. NEMA 4X junction box.

M. Hydrogen Sulfide Monitor

Tags:

ISA Designation	Service
AE/AIT-0802	Odor Control Scrubber Stage 2
AE/AIT-0000	Uninstalled Spare

1. System utilizes a special sensor designed to operate in condensing gas streams without the water vapor blinding typical of standard sulfide sensors.

2. Automatic Sensor Air Purge: An automatic system for purging accumulated droplet water from the face of the sensor insures long-term operation without loss of sulfides in condensed water on the sensor face.

3. Two Internal Alarm Relays: One relay is used to control the air-purge system and the other is available for external alarms. Relays are programmable for setpoint, hysteresis, and delay functions.

4. LCD Display: Gas Concentration shall be displayed in large, easy to read numbers. The display shall also provide a second information line indicating raw sensor output, and mA output. Programming using the 4 keys located on the front panel.

5. Properties:
   a) Gas Type: Hydrogen Sulfide
   b) Sensor Type: Special wet gas sensor design
   c) Display: 0-2.000 PPM, 0-20.00 PPM, 0-200.0 PPM (programmable)
   d) Response Time: 90% in 60 seconds
   e) Accuracy: ±10% of value
   f) Sensitivity: 0.1 PPM minimum
   g) Zero Stability: ± 0.04 PPM
   h) Electronic Linearity: ±0.5%
   i) Analog Output: Isolated 4-20 mA, 575 ohms maximum
   j) Power: 115 or 230 VAC, 50/60 Hz., 5 VA max.
   k) Alarm Relays: Two SPDT, 5 A @ 230 VAC resistive
   l) Relay Coil: Programmable either normally energized or normally de-energized
   m) Enclosure: Nema 4X Polycarbonate, Wall, pipe, or panel mounted
   n) Controls: 4 membrane switches on front of monitor
   o) Operating Temperature: -20º to +50º C
   p) Operating Pressure: -0.2 to 10 PSIG

6. Manufacturer:
   a. Analytical Technology, Inc., model Q45S, or approved equal.

N. Vane Operated Flow Switch

Tags:

ISA Designation	Service
FSL-104	Well #4
FSL-000	Uninstalled Spare

1. Description:

   a) Service: Gases or liquids compatible with wetted materials.
   b) Wetted Materials: Vane: 316 SS; Body: Brass or 316 SS standard; Magnet Keeper: 430 SS standard, 316 SS optional; Options: Other materials also available, consult factory (e.g. PVC, Hastelloy, Nickel, Monel, Titanium).
   c) Temperature Limit: -4 to 275°F (-20 to 135°C) standard.

d) Pressure Limit: 316 SS body 2000 psig (138 bar).
e) Enclosure Rating: Weatherproof and Explosion-proof.
f) Switch Type: SPDT snap switch standard.
g) Electrical Rating: 10 A @ 125/250 VAC.
h) Conduit Connection: 3/4" female NPT.
i) Process Connection: 1-1/2" male NPT.

1. Manufacturer:
   a. Dwyer, model V4-SS-U-SPDT, or approved equal.

P. Rupture Disk Sensor

Tags:

ISA Designation	Service
YS-731	RO # 1 Skid
YS-732	RO # 2 Skid
YS-733	RO # 3 Skid
YS-734	RO # 4 Skid
YS-7XXO	Uninstalled Spare

1. Description:
   a) Non-asbestos gaskets.
   b) 316 SS conductor.
   c) Minimum burst pressure: 1 psi @ 72 ^{o}F
   d) Nominal indicator thickness: 3/16”
   e) Max Temperature: 700 ^{o}F
   f) Max continuous temperature: 400 ^{o}F
   g) Max voltage: 24 VDC
   h) Max. Current: 20mA

2. Manufacturer:
   a. Sensor to be Zook BA series or approved equal. Provide shielded cable, length as indicated on the plans.
   b. Provide Zook ZAM Plus monitor, or approved equal.

P. Limit Switches

Tags:

ISA Designation	Service
LS-601-2	HPP-1
LS-601-3	HPP-1
LS-602-2	HPP-2
LS-602-3	HPP-2
LS-603-2	HPP-3
LS-603-3	HPP-3

LS-604-2	HPP-4
LS-604-3	HPP-4
LS-000	Uninstalled Spare
LS-000	Uninstalled Spare

1. Description:
    a. Function: Position Detection
    b. Type: Heavy-duty, bi-rotational travel
    c. Contact Arrangement: DPDT contacts, 10 amps @ 120 VAC
    d. Construction: NEMA 4 rated
    e. Mounting: Surface
    f. Accessories: Adjustable roller arm

2. Manufacturer:
    a. Square D (Class 9007), Allen-Bradley, Eaton Cutler-Hammer, General Electric or approved equal.

2.02 OTHER FIELD EQUIPMENT

A. Intrinsic Safety Barriers

1. 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.
2. Unit shall be Factory mutual approved and certified for use in accordance with National Fire Protection Association (NFPA 493 of 1978).
3. Unit shall be as manufactured by R. Stahl, Inc. or approved equal.

B. Beacon Light

1. Beacon lights shall be provided and mounted, for hazardous gas warnings, as shown on the Drawings.
2. The beacon lights shall be NEMA 4x weatherproof, 120 volt AC, xenon strobe flasher with unbreakable, red, Lexan globe.
3. Beacon lights shall be Benjamin Electric Mfg. Co., or equal.

C. Alarm Buzzer

1. Buzzers or horns shall be provided and mounted in areas where hazardous gas is to be monitored, as shown on the Drawings.
2. The units shall be rated explosion proof for use in Class 1, Group D, Division 1 areas.
3. Units shall be equal to those manufactured by Benjamin Electric Mfg. Co., or Edwards a unit of General Signal, or equal.

D. Selector Switch

1.	Function:	Manual control mode selection
2.	Type:	Heavy-duty, Oil-tight or weatherproof, as required
3.	Application:	See contract Drawings
4.	Positions:	Two-three-four (as required)
5.	Contacts:	Form a or Form b (as required) (Form c not acceptable)
6.	Operator:	Knob level type
7.	Contact Rating:	120 VAC - 10 amp continuous (60 amp make - 6 amp break)
8.	Mounting:	Mounting hole 1-13/16" D
9.	Size: 30 mm	
10.	Options:	(1) Spring return as required
		(2) Cylinder key lock as required

E. Hatch Limit Switch

1.	Function:	Position Detection
2.	Type:	Heavy-duty, bi-rotational travel
3.	Contact Arrangement:	DPDT contacts, 10 amps @ 120 VAC
4.	Construction:	NEMA 4 rated
5.	Mounting:	Surface
6.	Accessories:	Adjustable roller arm
7.	Manufacturer:	Square D (Class 9007), Allen-Bradley, Eaton Cutler-Hammer, General Electric

F. Panel Meters (Indicators, LI-1202):

1.	Function:	Provide visual indication of process variables
2.	Type:	4-digit LCD with field selectable decimal point
3.	Adjustments:	Field adjustable zero and span
4.	Housing:	NEMA 4X
5.	Input:	4 to 20 maDC
6.	Power:	24 VDC loop powered
7.	Manufacturer:	Precision Digital or approved equal

2.03 PROPOSED RAW WATER WELL No.4 CONTROL PANEL

A. 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 a back plate and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required by the manufacturer to protect equipment from vibration. Component mounting shall be oriented in accordance with the component manufacturer's and industry standard practices. All internal components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with the drawings, specifications, and System Supplier's data.

1. Pushbuttons: The pushbuttons shall be NEMA 4X, with momentary contacts. Switches shall be supplied with the number of poles required for the application, an escutcheon plate, and contacts rated for 10 amperes at 120 volts AC. The units shall be Class 9001 type SK 30.5mm as manufactured by Square-D or approved equal.

2. Relays shall be industrial grade double-pole, double-throw, octal plug-in type with a transparent dust cover. The relay shall be equipped with an indicating light to indicate when its coil is energized. The relays shall have 5 amperes, 120 volts AC contacts. The mechanical life of the relay shall be 1,000,000 operations minimum.

3. Hand Switches: Contact blocks shall be heavy-duty NEMA 4X with fine silver, butting-type contacts. Contact rating shall be 10 amps continuous current at 120 volts AC. Contact blocks for electronic duty shall contain sliding gold contacts for solid-state millivolt and milliamp dry circuits. Contact rating shall be 1 amp resistive load at 28 volts DC. The units shall be Class 9001 type K 30.5mm with gloved hand knob as manufactured by Square-D.

4. Time Delay Relay: The time delay relays shall be industrial grade with time delay and instantaneous contacts as manufactured by Square D Class 8505 or equal.

5. Sufficient terminal blocks shall be provided to terminate all spare annunciator points and spare conductors. In addition, the greater of 15 percent or four unused spare terminals shall be provided.

6. All panels shall be designed to permit continuous operation of all components mounted therein with panel ambient temperatures of up to 105 degrees F.

7. Each panel will be provided with one or more 120VAC, 60-Hz feeder circuit from the associated circuit breaker distribution panel provided under Division 16, ELECTRICAL. On each panel, make provisions for feeder circuit conduit entry and provide a terminal board for termination of the wires. Each panel shall include a 20 ampere GFIC receptacle.

8. All electrical wiring shall be in accordance with the applicable requirements of Division 16, ELECTRICAL. Wires shall be 600-volt, PVC installed stranded copper and shall be of the sizes required for the current to be carried, but not below 14 AWG enclosed in either sheet metal raceway or plastic wiring duct.

9. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. All wires shall be identified at each end.

10. All relays shall have a screw terminal interface with the wiring. Terminals shall have a permanent, legible identification. Relays shall be mounted such that the terminal identifications are clearly visible and the terminals are readily accessible.

11. All components provided under this section, both field and panel (interior and exterior) mounted, shall be provided with permanently mounted name tag. Panel mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.

12. Service legends and nameplates shall be engraved, rigid, laminated plastic type with adhesive back. Unless otherwise noted, color shall be black with white letters and letter height shall be 3/16 inch.

13. Pilot lights shall be NEMA 4X push-to-test transformer type. Bulbs shall be of the transformer reduced voltage type to have a life exceeding 10,000 hours and allow relamping from the front. The units shall be Class 9001 type SK, 30.5mm as manufactured by Square-D or approved equal.

14. Panels shall be constructed to prohibit the entry of corrosive gases.

15. The control panel enclosure shall be free-standing, 18-inch minimum depth, NEMA 4X 316 stainless steel with an aluminum deadfront door. The outer door shall include a 3-point stainless steel door handle as manufactured by Hoffman # A-LIBR or approved equal. The complete enclosure shall be as manufactured by Hoffman or approved equal.

16. Panels shall be provided with switched 18 inch fluorescent (F15T8) back-of-panel light. One light shall be provided for every 4 feet of panel width and shall be mounted inside and in the top of the back-of-panel area. Lights shall be as manufactured by Hoffman Series X-LF or approved equal.

17. Panels shall be provided with one electric heater with thermostat and fan. The heater assembly shall be manufactured by Hoffman Series D-AH or approved equal.

18. Motor starter shall be reduced-voltage starters shall be solid state type with isolation contactor and surge protection with water hammer control option.

    A. Construction

        1. The power section shall be three phase, 60 hertz, and rated for the HP, current, and voltage as shown on the drawings. It shall consist of three sets of back-to-back phase controlled power semi-conductors. Maximum current-limit shall be 500% for standard units.

        2. Resistor/Capacitor snubber networks shall be used to prevent false firing of SCR's due to dv/dt characteristics of the electrical system.

        3. Fan cooled units shall be supplied with thermal sensors on the heat sink to trip the control protective logic for over temperature condition. Thermal sensors shall be rated 90 degree C maximum.

4. The one piece logic board shall be mounted for easy testing, service and replacement.

5. Three-phase current sensing via current transformers for closed loop control to insure motor stability shall be provided.

6. A contactor shall be placed on the line side of the starter to automatically isolate the solid state starter from the line when starter is not energized.

B. The logic circuitry shall include as a minimum:

1. Short circuit electronic trip overcurrent protection. Time not to exceed 1/2 cycle.

2. Inverse time running overcurrent protection.

3. Auxiliary trip circuitry.

4. Gate firing circuit lockout protection on trip.

5. Fault relay lockout protection.

6. 250% - 500% current limit adjustment

7. Minimum and maximum voltage adjustments.

8. Voltage stability adjustment.

9. Adjustable ramp time (0.5 to 30 seconds)

C. The logic board shall include, as standard, current and voltage sensing circuitry that continually monitor motor load and regulate motor voltage to minimize motor kWh energy consumption.

D. External interface circuitry shall include 120 volt relay logic interface capability.

E. Tripped functions shall be designed to be cleared by removing power from the solid state logic board.

F. The solid state logic shall provide phase sequence protection.

G. Two ground lugs shall be furnished, one for incoming and one for outgoing ground connections.

H. Power terminations shall consist of pressure type terminals for top or bottom entrance.

I. Testing

1. The manufacturer shall supply certified test results, upon request, to confirm that the controller has been tested to substantiate designs according to applicable ANSI and NEMA Standards. The tests shall verify not only the performance of the unit and integrated assembly, but also the suitability of the enclosure venting, rigidity and bus bracing. In addition, the unit shall be factory tested in accordance with ANSI standards.

2. Manufacturer shall be prepared to show proper evidence of having tested for noise immunity on both input and output power connections. Noise testing shall be performed in accordance with NEMA ICA 2-230.40.

19. Control Panel Electrical:

a. Power Distribution Within Panels:

1) Each panel will be provided with one 480vac, 3-phase, 3 wire, 60-Hz feeder circuit as shown. On each panel, make provisions for feeder circuit conduit entry and provide a terminal board for termination of the wires.

2) Each motor control circuit shall have its own transformer to provide 120 volts 60Hz control power. Each control power transformer shall be fused on both primary and secondary sides.

b. Signal Distribution Within Panels:

1) All signals shall be 24 VAC DC 4 to 20 mA signals.

2) Signals distributed outside panels shall be isolated 4 to 20 mA signals.

3) All signal wiring shall be twisted, shielded pairs.

4) All 4-20mA signals shall be isolated with an isolator AGM model AWD 1161 or equal.

c. Surge Protection:

1) 480-Volt protection APT# TE/4XF

2) TVSS on all wiring to remote field devices as manufactured by EDCO or approved equal

20. Panel shall be ventilated by supply air fans, flush mounted on panel side. Fan package shall be aluminum with filter and stainless steel grille, capable to deliver 100 CFM. Fan shall be controlled by a thermostat. Fan package shall be manufacture by Hoffman Series A-PA with thermostat Hoffman T-TEMA or equal.

21. Power Supplies:

a. Provide dc power supplies as required to power instruments requiring external dc power, including two-wire transmitters and dc relays.

b. Power supplies shall convert 120V ac, 60-Hz power to dc power of the appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that the instruments being supplied can operate within their required tolerances.

c. Output overvoltage and overcurrent protective devices shall be provided with the power supply to protect the instruments from damage due to power supply failure and to protect the power supply from damage due to external failure. Provide NEMA 1 enclosure for all power supplies. Power supplies shall be mounted such that dissipated heat does not adversely affect other components.

d. Provide an indicating fuse for each dc supply line to each individual two-wire transmitter. Fuses shall be mounted and located so that they can be easily seen and replaced.

22. Phase Monitor:

a. The panel shall include a loss of phase, undervoltage, overvoltage, phase unbalance, frequency and phase shift monitor relay as manufactured by Diversified SLM series or approved equal.

23. Programmable Controller:

a. The panel shall include programmable controller with Ethernet port, fiberoptic media converter and input/output as required.

2.04 SKID INSTRUMENT PANELS

A. Skid Monitoring Panel. Provide two (2) Skid Monitoring Panels, each containing indicators and controls or monitoring a pair of membrane softening trains. The following features shall be provided:

1. The panel shall include a NEMA 4X wire termination cabinet for single point entry of conduit and wire from remote SCADA system

4. The panel plate shall be constructed of fiberglass and be mounted utilizing fiber or stainless steel hardware.

2.05 PROGRAMMABLE CONTROLLER I/O CABINETS

A. Components

1. General

a. Panel shall be completely fabricated, instruments installed, wired, and plumbed at the factory.

b. Panel shall be free standing with concrete house keeping pad, double door , of sufficient size to adequately enclose all instruments plus 25 percent ample interior clearance to allow for installation, general servicing, future additions, and maintenance of the instruments. Weight of instruments shall be supported by channel supports where required.(See Indoor Panel Construction this section)

c. Circuit Protection

1. Main Circuit Breakers – MCB This breaker shall control the supplied 115 VAC primary power to all branch circuits within the panel.

2. Utilities Circuit Breakers – UCB This breaker shall control the supplied 115 VAC power to the service outlet, internal lamp and light switch.

3. UPS Power Supply Branch Circuit Breaker CB-1. This breaker shall control the supplied 115 VAC power to the UPS power supply.

4. PLC Power Supply Branch Circuit Breaker CB-2.This breaker shall control the supplied 115 VAC UPS supplied power to the PLC 24Vdc power supply and radio modem.

5. I/O and Control Branch Circuit Breaker CB-3. This breaker shall control the supplied 115 VAC UPS supplied power to the dedicated PLC I/O and control additional 24V power sources.

6. I/O and Control Branch Circuit Breaker CB-4. This breaker shall control the supplied 115 VAC UPS supplied power to the dedicated chart recorders.

d. Panel Mounting

1. Panel Component Arrangements

a. Panel face mounted equipment shall consist of pilot lights, pushbuttons, selector switches, meters, indicating timers, etc. Spacing between horizontal rows of components shall be 1-1/2 inches center-to-center minimum; spacing between vertical columns of

components shall be 1-7/8 inches center-to-center minimum.

b. The distance from the bottom row of components to the floor shall be not less than 36-inches. The top row of recording and indicating instruments shall be centered approximately 60 inches above the floor. In general, all indicating lights, pushbuttons, etc. shall be mounted in accordance with the sequence of operation from left to right and top to bottom.

2. Rear of Panel Component Arrangements

a. All relays, timers, etc. installed on each panel sub plate, shall be provided with a minimum spacing between the component and the wire duct of 1-1/2 inches above and one inch below. Minimum spacing between adjacent components shall be 1/4-inch.

b. A minimum of 2-inches shall be provided between terminal strips and wire ducts or terminal strips and terminal strips. In general, terminal strips shall be mounted vertically near the outer edges of the sub plate.

c. Sub plates shall have a minimum of 25% spare mounting space, and terminal strips shall have a minimum of 20% installed spare terminal blocks.

B. Temperature Control:

1. Indoor panels, except for those with their backs directly adjacent to a wall, shall be provided with one louver filter fan and one louver filter exhaust grill on the rear of the panel located on the top and bottom of each access door. For panels mounted with their backs directly adjacent to a wall, or with front access only, louvers shall be located on the top and bottom of same side with fan motor on bottom as per manufacturers instructions. Exhaust grill shall be constructed of non-metallic material. Forced air ventilation fans, where used, shall be provided with washable or replaceable filters. Fan motors shall operate continuously on 120-volt, 60-Hz power.

2. Louvered fans shall be the Pro-Air SF Filter Fan Package Series manufactured by McLean Midwest, Rittall Corp. or approved equal.

C. Indoor Panel Construction:

1. Floor Mount panels shall be provided with welded floor stands/legs, free standing panels with 4-6” concrete housekeeping pad, interlocking double doors and adequate internal bracing, free of a center brace between doors, to support the

weight of all instruments and wiring. Internal bracing shall permit panel lifting without racking or distortion. Panel shall be NEMA 4X 316 stainless steel rated. All doors shall be rubber gasketed.

2. Removable lifting rings designed to facilitate simple, safe rigging and lifting of the panel during installation shall be provided. Plugs shall be provided to fill the lifting ring holes after installation and shall match the panel color.

3. When applicable, floor standing cabinets shall match adjacent floor standing cabinets in height, depth, general access, and color, unless otherwise noted. Panels shall not require any additional external supports or bracing to maintain freestanding integrity.

4. All installation details shall be verified by the Contractor/System Supplier. Unless otherwise noted, all panels shall be properly sized to fit in the allotted spaces as noted or shown in the Contract Drawings.

5. The panels shall be so constructed that no seams or bolt heads are visible when viewed from the front. Panel cutouts for instruments and other devices (e.g., lights and switches) shall be punched, or drilled and smoothly finished with rounded edges.

6. Provide steel angle and/or plate stiffeners 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 steel 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 panel during installation. Where two or more panels are shown mounted immediately adjacent to one another, they shall be securely bolted together with their front faces parallel. All internal components shall be mounted on removable sub pans and not directly to the enclosures. Sub pans shall be painted with white enamel. Additional print storage pockets shall be provided on the inside of each panel. Its size shall be sufficient to hold all of the prints required servicing the equipment. All control operations and overload reset shall be accessible without opening panel.

7. Each enclosure shall be provided with full height, fully gasketed access doors where shown. Doors shall be provided with three-point latches. Handles shall be stainless steel lever, quarter turn type. All panel access doors shall be provided with full length, continuous, piano type, and steel hinges with steel pins.

8. Panels shall be internally lighted by 30W fluorescent lights, provided with protective shields and a switch box mounted control switch. One light shall be provided for every 4.0 feet of panel width.

9. Each panel shall be provided with one 15-amp ground fault protected, duplex service outlet. One outlet shall be provided for every 3.0 feet of panel width and mounted to the panel sub plates.

10. Service lights and/or receptacles shall be wired to a separate main disconnect circuit breaker and connected to the incoming 110-volt, 60-hertz, single-phase supply. Receptacles shall be labeled as "Service Outlet"

11. Provide single steel handle, 3-point latch lock option on panel door(s).

12. Panel shall be manufactured by Hoffman, Hammond, Electromate, Saginaw or approved equal.

13. Panel finish, in addition to manufacturers finish, all surfaces shall be painted with no less than three (3) coats of industrial type gloss polyurethane enamel paint light gray in color on exterior and gloss white on interior and back panel.

14. Panel shall be secured to concrete floor with no less than six (6) 3/8" stainless steel wedge anchors.

D. PANEL GROUNDING

1. Contractor shall exercise care and furnish additional grounding to insure good ground continuity in particular with equipment surge protection devices located within panel and to meet or exceed surge equipment manufacturers recommendations. (See section 16450 Grounding Systems).

E. Uninterruptible Power Source

1. The control panel shall operate from an Uninterruptible Power Source (UPS). Battery-supplied power shall be provided to operate the system for at least 5 minutes. The UPS shall utilize low maintenance, rechargeable, sealed batteries, maintained at a float charge during normal power conditions. The UPS shall output a synchronized 60 Hz sine-wave output, in phase with the commercial line power sine wave. The sine-wave output shall be synchronized during switching from commercial AC power source to battery source and during switching from battery source back to commercial AC power source. The UPS shall switch to and from battery in less than 4 milliseconds. The UPS shall visually indicate its current mode of operation. The UPS shall provide silencing audible and visible alarms indicating commercial AC line power failure and low battery. The UPS shall support a serial port interface to communicate with the central site computer. This interface shall provide information to programmable controller to alert the utility staff in case of a power or UPS alarm or failure.

2. The load center and UPS shall be protected by an Adaptive Surge Filter Model OM-20-120-LB as manufactured by Zero Surge or approved equal.

F. Details:

1. General

a. All components and circuits used shall be subject to review and approval by the Owner. All switching circuits shall be checked and verified for specified performance by testing before shipment. All wiring shall comply with the latest applicable local and N.E.C. codes. Non-conforming circuits shall be corrected and re-tested.

b. Each device requiring power shall be wired so that when wires are removed from any one device, power will not be disrupted to any other device.

c. One isolated, N.O. spare contact shall be provided on each relay.

d. Control device contacts going to high voltage equipment for motor control shall be rated 240 V ac/125 V dc at 10 amps. The contacts shall handle 50 amps inrush on "make" at 120 V ac and one amp on "break" at 125 V dc.

e. Fuses shall not be allowed where protection by circuit breakers will not void the warranty of the device.

f. Fuse holders shall be lever operator terminal block type with blown fuse indicator model M4/8.SFL for 110VAC and M4/8.SFD for 24VDC manufactured by Entrelec, Square D or equal.

g. Nameplates shall be plastic engraved type white in color with black letters.

2. Power Distribution within Panels:

a. A 120 volt, 1 phase panel board shall be provided within the control panel with a 30 ampere, 1-pole main circuit breaker and a branch breakers for the service outlet and other panel loads. A service description for each breaker shall be clearly identified inside the distribution panel board.

b. Additional branch breakers shall be added as required. No more than 20 devices shall be feed from any one branch breaker. Fuse protection shall not be permitted unless provided as an integral part of a device or where breaker protection can not be provided. Where fuse blocks are provided, they shall be the fusible disconnect switch type with blown fuse indicators. Branch circuit breakers rated for services of 0.1 to 15 amps shall be panel mounted as manufactured by Square "D" type GCB or equal.

c. A summary of the power requirements for each control panel furnished shall be submitted and indicated within each panel. Power requirements shall state required voltages, currents, and phase(s). Summary shall be supplemented with calculations.

3. Signal Distribution within Panels:

   a. All signals shall be 24 VAC DC 4 to 20 mA signals.

   b. Signals distributed outside panels shall be isolated 4 to 20 mA signals.

   b. All signal wiring shall be twisted pairs.

   c. All field 4-20mA dc signals shall be isolated with an din rail mount isolator, as manufactured by Moore Industries model SCX or M-Systems model M2VS,.

   e. All field 4-20mA dc signal isolators shall be protected with a surge protector, as manufactured EDCO model PC642/PC1B or Ditek model DTK-2MLPH24BW/MB-10.

4. Signal Switching:

   a. Signals shall be switched by dry circuit type relays or switches.

   b. 4 to 20 mA loops shall not be interrupted during switching.

   a. Switching transients in any associated signal circuit shall not exceed ±0.2 mA or ±0.05V depending on the signal type.

3. Discrete Control Distribution within Panels:

   a. All discrete I/O control points shall be 120VAC power.

   b. All discrete field I/O control points entering panel shall be protected with a surge protection unit, as manufactured by Entrelec-Protechline, model DATA PU2-200 or equal.

   b. Refer to Appendix for addition information on existing controls

   c. Programmable Logic Controller (PLC)

      1. General:

         a. The programmable logic controller (PLC), as specified herein, shall be provided under this section and located within the control panel. RAM capacity shall be determined by size of project.

      2. Programmable Controller:

a. The plant shall be automatically controlled by a Modicon M580 programmable logic controller (PLC) with two Modbus and one Modbus-Plus communication capabilities. The CPU, power supply and input/output modules shall be mounted on panel mounted 16 slot I/O racks. The PLC CPU shall contain no less than 512k of memory as manufactured by Modicon, M580 BMEP58 or as sized to project. The I/O Rack shall be as manufactured by Modicon, M580 BMEXBP.

b. Each discrete input module shall accept up to sixteen (16) 120Vac input signals received from devices such as pushbuttons, selector switches, pressure switches, temperature switches, or limit switches and converts them into voltage logic levels that can be processed by the controller. Input signals shall be wired in two (2) groups of eight signals per module. Each group of eight points shall be protected by a .16 amp external indicating fuse block. Each input shall be optically isolated and protected with a red LED to indicate the presence of the 24Vdc power (circuit closed indication). A green LED shall be provided to indicate the presence of the I/O module supply voltage of each group. Discrete input modules shall be as manufactured by Modicon, M580 BMXDAI1604.

c. Each discrete output module shall provide sixteen (16), relay switched, 120Vac output signals that can drive loads up to 1 amp such as relays, starters, and solenoid valves. The outputs shall be optically isolated from the system. Output signals shall be field wired in two groups of four (4) outputs per module. Each group of four points shall be protected by an external .16A indicating fuse block. Each output shall be isolated and provided with a red LED to indicate the output is turned "on". A green LED shall be provided to indicate the presence of the required 24Vdc supply voltage. External, panel mounted, 10Amp, interposing relays shall be provided for interfacing to control devices that are external to the local control panel or to devices that exceed the rating of the output module. Where LED type status indicators are used, a loading resister shall be installed to prevent leakage current from keeping the lamps falsely lit. Discrete output modules shall be as manufactured by Modicon, M580 BMXDRA1605.

d. Analog input modules shall be eight channels with opto-isolation. Inputs shall accept 4-20mA DC signals. Input shall be set for Unipolar with Offset and Extended Resolution mode to detect loss of signal or low input indication. Resolution shall be 11 bit plus sign with a 10 ms conversion time. The four points shall be protected by an external .16A indicating fuse block. A green LED shall be provided to indicate the presence of the required 24Vdc supply voltage. A second green LED shall be provided to indicate the module is healthy. Removal of any panel-mounted devices shall not interrupt the input signals to the PLC. Analog values shall continue to function properly. Inputs shall be provided for Flow and Level. Analog input modules shall be as manufactured by Modicon, M580 BMXAMI0810.

e. Analog Output Module shall be four channels with opto-isolation. Outputs shall drive 4-20mA DC signals. Output shall be set for Unipolar with Offset and Extended Resolution mode to detect loss of signal or low input indication. Resolution shall be 11 bit plus sign with a 10 ms conversion time. The four points shall be protected by an external .16A indicating fuse block. A green LED shall be provided to indicate the presence of the required 24Vdc supply voltage. A second green LED shall be provided to indicate the module is healthy. Removal of any panel-mounted devices shall not interrupt the input signals to the PLC. Analog values shall continue to function properly. Outputs shall be provided for VFD speed pacing. Analog output modules shall be as manufactured by Modicon, M580 BMXAMO0410.

f. Power supply Modules shall be sum able, rack mounted and provide DC power to CPU. Power supply modules shall be as manufactured by Modicon, M580 BMXCPS3500.

g. Operation of the PLC processor shall be continuously monitored, and in the event the controller should stop functioning, or the branch circuit breaker is opened, the pumps shall automatically revert to ultrasonic control or float as required.

h. Battery-backed memory shall be protected by a 3.6V Lithium battery with the battery condition monitored by the processor. When the battery needs replacement, as indicated by the "low Battery" status lamp on the

processor or "PM required" lamp on the front of the local panel, a remote alarm will be initiated.

j. Modbus Plus Cables, Taps and Drops shall be manufactured by Modicon Cable P/N Belden 9841, Tap P/N 990 NAD 230 00, Drop cable P/N 990 NAD 211 30.

k. Serial Port surge protection shall be used on all Serial, Modbus and Modbus Plus ports. Serial Port surge protection shall be manufactured by APC, Model PS9-DCE or approved equal.

3. PLC Ladder Logic Software

a. The System Integrator shall program PLC to perform, and warrant proper system operation as described in this document.

b. The Owner shall be sole owner of all programming software described in this contract, the use of any proprietary software other than described in this contract will not be accepted.

c. All points used in Ladder logic shall be documented and labeled so Owners personnel can identify each point and its function.

d. Control (Command) points shall be programmed such that control can be performed from HAND field devices (such as a selector switch) or from REMOTE by operator interface or MMI SCADA system, as described in contract. In some applications this will require that OR logic be in the program. The control description shall include how the MMI software should handle the commands.

e. PLC Command points shall be “SET” from MMI or Remote SCADA system. Command example: To start Pump #1, the MMI system shall set the bit to a 1 at address 02001.2 and to stop the pump the MMI shall set the same bit to a 0 (zero) at the same address 02001.2.

f. Programmer shall keep the amount of points needed to control equipment to a minimum; project is licensed to a limited amount of MMI points to be used.

g. Provide a Device Specific, Control Description in one (1) document. The document shall provide all information

about controlling each specific device in the same area of the document. This prevents the user from looking in four (4) different places for information on one (1) device.

h. All descriptions shall be grouped by piece of equipment, functional description and address in the PLC. The documentation shall be created in a Excel spreadsheet format on USB or DVD disk.

EXAMPLE:

Device	Description	0 State	Address
Pump 101	Run Status	Stopped	10001
Pump 101	Failed Status	OK	10022

i. All Analog values in the PLC ladder logic program documentation shall include scaling values and engineering units. The documentation shall be in a Excel spreadsheet format on USB or DVD disk.

EXAMPLE:

Description	Address	Data Type	Raw Zero	Raw Full Scale	Eng Units Zero	Eng Units Full Scale	Units
Flow	300010	INT	0	4095	0	300	GPM

j. Documentation shall also state any special conditions that must be met to control a piece of equipment. For example if a pump must be in manual for the MMI system to turn the pump on or off this shall be documented. (IE. Pump 101 can only be directly controlled by the MMI system if it is in the manual condition).

k. Provide documentation and 3.5 disks for all PLC logic.

l. All PLC logic instructions (all coils, contacts and registers), shall be programmed and labeled using "Modicon, EcoStruxure Control Expert", PLC programming software.

m. System Integrator shall furnish Owner Technicians with Basic PLC Operation training.

n. All Data to be exchanged with the MMI SCADA system shall be "Block Moved" to a contiguous group of "Super blocks" that contain contiguous registers for the purpose

of read write routine polling efficiency. Furnish 25 percent spare "Super blocks" in-group for future additions.

EXAMPLE:

40206 shall contain 16 discrete inputs
40207 shall contain 16 discrete outputs
40208 shall contain 1 analog input
40209 shall contain 1 analog output

o. All "Super block" register used shall contain the prefix "MMI" in its description label for ease of identifying in its logic.

p. All analog I/O programming shall be based on a range of 0 to 4095 bits.

q. To simplify program troubleshooting, PLC ladder logic program shall be written in a segment specific format as logic relates to field device control loops. (I.e. "For Example only": Ladder logic written for chlorine pacing system shall be contained in segment 07, logic to start and stop constant speed transfer pumps shall be contained in segment 08, etc.). Furnish ladder logic segment table of contents document listing segment numbers and control loop descriptions.

d. Relays:

1. Relays shall be provided as necessary to perform switching functions required of control panels and other control circuits. All relays shall have screw type terminal interface. Terminals shall have a permanent, legible identification. Relays shall be mounted such that the terminal identifications are clearly visible and all terminals are readily accessible.

2. General-purpose relays shall be used for logic and switching power to external loads and shall be DIN rail mounted, general purpose, medium power, and industrial type. Minimum mechanical life expectancy shall be 10,000,000 operations and electrical life expectancy of 100,000 operations at rated load. They shall be of the dust cover enclosed, plug-in type, with 8 or 11 pin, screw terminal, snap-on sockets. Relays shall have a maximum of three form C contacts rated for 10 amperes at 120V ac and be equipped with coil status indicator lamps and hold down springs. Relays shall be as manufactured by Potter-Brumfield series KRPA, KUP, or Omron Type G2R or approved equal.

e. Power Supplies:

1. Provide dc power supplies as required to power instruments requiring external dc power, including two-wire transmitters, dc relays.

2. Power supplies shall convert 120V ac, 60-Hz power to dc power of the appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that the instruments being supplied can operate within their required tolerances.

3. Output over voltage and over current protective devices shall be provided with the power supply to protect the instruments from damage due to power supply failure and to protect the power supply from damage due to external failure. Provide NEMA 1 enclosure for all power supplies. Power supplies shall be DIN rail mounted such that dissipated heat does not adversely affect other components.

4. Power supplies shall be manufactured by Omron or Equal.

f. Internal Panel Lights and Service Outlets:

1. Panels shall be provided with switched 30-watt fluorescent back-of-panel lights. One light shall be provided for every 4 feet of panel width and shall be mounted inside and in the top of the back-of-panel area. Lights shall be provided with a protective metal shield.

2. Panels shall be provided with a 15-amp, 120-volt, service outlet circuit within the back-of-panel area. The circuit shall be provided with three-wire, 120-volt, 15-ampere, duplex receptacles, one for every 4 feet of panel width (two minimum per panel) and spaced evenly along the back-of-panel area.

g. Wiring: Wiring within panels, consoles, racks, and cabinets shall meet the following requirements:

1. AC power wiring shall be 600 VAC, 12 AWG tinned stranded unless otherwise noted.

2. All Discrete Output control wiring to be orange in color, 300 VAC no less than, 16 AWG, Tinned Stranded Copper type B/N 16/19 or Belden 8500 or XHHW, insulated wire or equal.

3. All Discrete Input control wiring to be red in color, 300 VAC no less than, 16 AWG, Tinned Stranded Copper type B/N 16/19 or Belden 8500 or XHHW, insulated wire or equal.

4. Control wiring routed to MCC and field shall be no less than 14 AWG multi-conductor Tray Cable, Stranded Copper type PVC, THWN or XHHW, insulated wire or equal.

5. All internal analog wiring, (PLC to field terminal), shall be properly labeled and color coded White for positive and Black for negative polarity, no less than 18 AWG, Shielded Tinned Stranded Copper type Belden or equal.

6. All analog field signal cable exiting enclosure, outer jacket shall be labeled with dot matrix printed shrink tube type wire labels. All shield drain wire shall be insulated and properly terminated per ISA and OEM standards. Labels shall identify terminal number, PLC logic reference number and affiliated process variable, properly color coded white for positive and black negative, no less than 16 AWG, Shielded Stranded Tinned Copper Signal type wire, Belden # 8719 or equal.

7. Wiring shall be numbered and tagged at each termination. Heat shrunk dot matrix wire markers shall be provided at each wire termination point internal and external to each panel(s). Wire tags shall be marked with legible machine printed markings and numbers. Adhesive or taped on tags will not be accepted. Each wire shall have a unique tag number assigned and be clearly identified on the approved shop drawings. Tagging scheme shall identify the designated component tag and terminal number destination.

8. Wiring for special signals such as communications, digital data, and multiplexed signals shall be labeled and use manufacturer's standard cables.

9. All wires to internal components shall be connected to the "inside" of the field interface terminal strip. All wires to external components shall be connected to the "outside" of the field interface terminal strip. No more than two wires shall be connected to any one terminal point.

10. All panel wiring not run in wire ducts shall be bundled and tied.

11. Wiring shall not be spliced or tapped except at device terminals or terminal blocks.

12. Control and signal wiring shall be restrained by plastic ties or ducts. Hinge wiring shall be secured at each end so that any bending or twisting will be around the longitudinal axis of the wire and the bend area shall be protected with a sleeve.

13. Where panel components are provided for future equipment, wiring from the components to the panel terminal blocks shall be provided.

h. Wire Color Coding

1. Power Wiring: Phase A shall be black with brown phasing tape, Phase B black with orange tape, and Phase C black with yellow tape.

2. Internally powered AC Control Wiring: Control panel wiring associated with control circuits that are de-energized when the main panel disconnect is opened shall be color coded "Red".

3. Externally powered AC Control Wiring: Control panel wiring associated with control circuits that remain "Hot" when the main panel disconnect is opened shall be color coded "Yellow".

4. All yellow wiring leaving panels shall be brought to an isolated set of terminal blocks.

5. Low voltage, DC Wiring: Blue (DC+); White with Blue or White with red and black -tracer (DC-).

6. DC Control Wiring: Dark Blue (+) and White with Blue tracer (-).

7. Neutral: White

Exception: Where prefabricated wire bundles are used, it is permissible to identify the neutral at every termination with a white shrink tube at least 12 inches long.

8. Ground: Green

9. Field interface wiring shall be black and white pairs unless otherwise noted or required by the National Electrical Code.

10. Intrinsically safe Light Blue

11. 24 VAC power wire shall be orange and brown.

j. Wire Duct

1. Panel wire duct shall be provided between each row of components and adjacent to each terminal strip. Wire ducts shall be a minimum of one inch wide and three inches deep with removable snap-on covers and perforated walls for easy wire

entrance. Wire ducts shall be constructed of non-metallic materials with voltage insulation in excess of the maximum voltage carried therein.

2. Empty panel wire duct shall be provided for all field connections to the terminal blocks.

3. A minimum of two inches shall be provided between wire duct and terminal block assemblies

4. Wiring duct shall not be filled to more than 60% visible fill.

k. Wiring Interface: All wiring including spares entering or leaving each panel, console, rack or cabinet shall be terminated and identified as follows:

1. Analog and discrete signal wiring shall be terminated at numbered terminal blocks. All wire shall be labeled with terminal number and PLC logic reference number.

2. Wiring for special signals such as communications, digital data, and multiplexed signals may be terminated at manufacturer's standard connectors.

l. Terminal Blocks: Terminal blocks for panels, consoles, racks, and cabinets shall meet the following requirements:

1. All terminal blocks shall be 600-volt rated and shall be provided for termination of all circuits entering or leaving all panels. Terminal blocks shall have screw clamp compression, dead front barriers with current bar providing direct contact with wire between the compression screw and yoke. Yoke, current bar, and clamping screw shall be constructed of high strength and high conductivity metal. Yoke assembly shall guide all strands of wire into the terminal. Current bar shall provide dependable vibration-proof connections. Terminals shall be constructed to allow connection of wires without any special preparation other than stripping. Individual terminals shall be rail mounted to create a complete assembly such that jumpers can be installed with no loss of space on terminal or rail.

2. Terminal block components shall be sized to allow insertion of all necessary wire sizes and types. Legible, factory machine printed markings and numbers shall be provided for terminal block identifications on both the inside and outside tracks of the terminal block assembly. Terminal blocks shall be numbered in numerical order.

3. Sufficient terminal blocks shall be provided to terminate all wires routed to the panel, all spare points and spare conductors. In addition, the greatest of 20 percent or four unused spare terminals shall be provided

4. All connections for future functions shall be wired to numbered terminal blocks, grouped separate from the terminal blocks in use. Terminal blocks shall be grouped to keep 120V ac circuits separate from the 24V dc circuits.

5. Terminal blocks shall be CSA certified and UL approved.

6. Control type terminal blocks shall be as manufactured by WAGO, Entrlec, SQ-D or Owner approved equal. Analog signals (4-20 mA dc) shall be connected to knife type disconnect terminal. Shields required to be grounded shall be terminated. Signal shields shall be grounded at only point within a loop. Use blocks when passing the shields through.

m. Grounding: Panels, consoles, racks and cabinets shall be provided with an isolated tinned copper grounding bus and lugs for all signal and shield ground connections. This ground bus shall be grounded at a common signal ground point. The signal grounding system shall meet National Electrical Code requirements. (See section 16450 Grounding System)

1. Each analog loop shall be grounded at a single point for the loop. This single point shall be at location of the dc power supply for the loop. Keep all in separate conduit away from parallel runs or AC wiring.

2. Each analog loop shall have its wire shields connected to ground at a single point for the loop. Shields shall be grouped and connected to ground at the same point as the analog signal ground.

n. Analog Signal Isolators and Surge Protectors: Instruments on different panels, cabinets, or enclosures shall not be wired in series. Provide din rail mount analog signal isolators as manufactured by Moore Industries model SCX or M-Systems model M2VS, for analog signals that are sent from one panel or cabinet to another. All analog signals entering or leaving the control system shall be protected at both ends of loop by a surge arrester as manufactured by EDCO PC642-030/PCB1B or Ditek DTK-2MLPH24BW/MB10BASE. Surge arresters shall be labeled.

PART 3 - EXECUTION

3.01 GENERAL

A. Instrumentation and accessory equipment shall be installed in accordance with specification section 13410 and as specified herein.

B. Unless specifically shown otherwise in the Drawings, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands as detailed on the installation detail drawings. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, three-way valve manifolds shall also be provided. For slurries, chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

C. All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adapters, and shut-off valves.

D. Field instruments requiring power supplies shall be provided with local electrical shut-offs and fuses as required.

E. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the manufacturer of the instrumentation equipment, but in no case shall more than one ground point be employed for each shield.

F. Lifting rings shall be removed from all panels and assemblies once in position. Plugs of the saw color as the panel shall then be installed in the holes.

G. System Supplier shall coordinate the installation, placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the Engineer's approval.

H. System Supplier shall ensure that all field wiring for power and signal circuits are in accordance with best industry practice, and provide for all necessary system grounding to insure a satisfactory functioning installation.

END OF SECTION

TABLE 13615-1
I/O SCHEDULE
6/18/2020

Description	ISA Tag	Type	Signal	Range/ Off Status	Units/ On Status	Field Wiring Data					Remarks
						ISA Signal Source	Field Panel	Field FTC	SCADA Panel	Spec. Section	
Raw Water											
Well #4 Run Status	YIQR-104	DI	Form C	Normal	Running	YS-104	I/O-8	I/O-8	I/O-8	13410	EVT, CRT, DRT, DSC
Well #4 Command	YC-104	DO	Form C	Stop	Start	YR-104	I/O-8	I/O-8	I/O-8	13410	
Well #4 Low Pressure	PAL-104	DI	Form C	5-100	psi	PSL-104	I/O-8	I/O-8	I/O-8	13410	EVT
Well #4 Discharge Pressure	PIR-104	AI	4-20mA	0-100	psi	PIT-104	I/O-8	I/O-8	I/O-8	13410	MX, MN, MA, HH, LL
Well #4 Flow Switch	FAL-104	DI	Form C	Normal	Alarm	FS-104	I/O-8	I/O-8	I/O-8	13410	EVT
Well #4 Flow	FIQR-104	AI	4-20mA	0-2000	gpm	FIT-104	I/O-8	I/O-8	I/O-8	13410	MX, MN, MA, HH, LL, DT, CT, MT
Well #4 Level	LI-104	AI	4-20mA	0-100	ft.in	LI-104	I/O-8	I/O-8	I/O-8	13410	MX, MN, MA, HH, LL
Well #4 "In AUTO"	ZIR-104	DI	Form C	Normal	Auto	ZS-104	I/O-8	I/O-8	I/O-8	16140	EVT
Well #4 Feed Valve In Remote	ZIR-104A	DI	Form C	Normal	Remote	ZS-104A	I/O-8	CV-104	I/O-8	15100	EVT
Well #4 Feed Valve Fail	YA-104	DI	Form C	Normal	Alarm	YS-104	I/O-8	CV-104	I/O-8	15100	EVT
Well #4 Feed Valve Open Command	YC-104A	DO	Form C	Normal	Open	YR-104A	I/O-8	CV-104	I/O-8	15100	EVT
Well #4 Feed Valve Close Command	YC-104B	DO	Form C	Normal	Close	YR-104B	I/O-8	CV-104	I/O-8	15100	EVT
Well #4 Feed Valve Opened Position	ZIO-104	DI	Form C	Normal	Opened	ZSO-104	I/O-8	CV-104	I/O-8	15100	EVT
Well #4 Feed Valve Closed Position	ZIC-104	DI	Form C	Normal	Closed	ZSC-104	I/O-8	CV-104	I/O-8	15100	EVT
Well #4 Feed Motor Over Temp	TAH-104	DI	Form C	Normal	Alarm	TS-104	I/O-8	I/O-8	I/O-8	13410	EVT
High Pressure Pumps											
High Pressure Pump #3 Run Status	YQIR-603	DDH	PU	Normal	Running	YS-603	VFD-HPP3	VFD-HPP3	I/O-2	16151	EVT, CRT, DRT, DSC
High Pressure Pump #3 VFD Fail	EAR-603	DDH	PU	Normal	Alarm	ES-603	VFD-HPP3	VFD-HPP3	I/O-2	16151	EVT
High Pressure Pump #3 VFD in Remote	ZIR-603	DDH	PU	Normal	Remote	ZS-603	VFD-HPP3	VFD-HPP3	I/O-2	16151	EVT
High Pressure Pump #3 VFD Ready	YIR-603	DDH	PU	Normal	Ready	YS-603	VFD-HPP3	VFD-HPP3	I/O-2	16151	EVT
High Pressure Pump #3 Motor Current	YIR-603A	DDH	PU	0-400	amps	JT-603A	VFD-HPP3	VFD-HPP3	I/O-2	16151	EVT
High Pressure Pump #3 Motor Voltage	YIR-603B	DDH	PU	Normal	Ready	ET-603B	VFD-HPP3	VFD-HPP3	I/O-2	16151	EVT
High Pressure Pump #3 VFD Speed	ZI-603	DDH	4-20mA	0-100	%	ZT-603A	VFD-HPP3	VFD-HPP3	I/O-2	16151	MX, MN, MA
High Pressure Pump #3 Motor Over Temp	TAH-603	DDH	PU	Normal	Alarm	TS-603	VFD-HPP3	VFD-HPP3	I/O-2	13410	EVT
High Pressure Pump #3 Run Command	YC-603B	DO	Form C	Stop	Start	YR-603	I/O-2	I/O-2	I/O-2	13410	EVT
High Pressure Pump #3 Speed Command	ZC-603	DDH	4-20mA	0-100	%	ZT-603B	I/O-2	I/O-2	I/O-2	13410	
High Pressure Pump #3 High Pressure	PAH-603	DI	Form C	10-300	psi	PSH-603	PE-603	PE-601	I/O-2	13410	EVT
High Pressure Pump #3 Valve Open Position	YI-603-2	DI	Form C	Normal	Opened	YI-603-2	I/O-2	BFV4-03-2	I/O-2	15100	EVT
High Pressure Pump #3 Valve Open Position	YI-603-3	DI	Form C	Normal	Opened	YI-603-3	I/O-2	BFV4-03-3	I/O-2	15100	EVT
High Pressure Pump #4 Run Status	YQIR-604	DDH	PU	Normal	Running	YS-604	VFD-HPP4	VFD-HPP4	I/O-2	16151	EVT, CRT, DRT, DSC
High Pressure Pump #4 VFD Fail	EAR-604	DDH	PU	Normal	Alarm	ES-604	VFD-HPP4	VFD-HPP4	I/O-2	16151	EVT
High Pressure Pump #4 VFD in Remote	ZIR-604	DDH	PU	Normal	Remote	ZS-604	VFD-HPP4	VFD-HPP4	I/O-2	16151	EVT
High Pressure Pump #4 VFD Ready	YIR-604	DDH	PU	Normal	Ready	YS-604	VFD-HPP4	VFD-HPP4	I/O-2	16151	EVT
High Pressure Pump #4 Motor Current	YIR-604A	DDH	PU	0-400	amps	JT-604A	VFD-HPP4	VFD-HPP4	I/O-2	16151	EVT
High Pressure Pump #4 Motor Voltage	YIR-604B	DDH	PU	Normal	Ready	ET-604B	VFD-HPP4	VFD-HPP4	I/O-2	16151	EVT
High Pressure Pump #4 VFD Speed	ZI-604	DDH	4-20mA	0-100	%	ZT-604A	VFD-HPP4	VFD-HPP4	I/O-2	16151	MX, MN, MA
High Pressure Pump #4 Motor Over Temp	TAH-604	DDH	PU	Normal	Alarm	TS-604	VFD-HPP4	VFD-HPP4	I/O-2	13410	EVT
High Pressure Pump #4 Run Command	YC-604B	DO	Form C	Stop	Start	YR-604	I/O-2	I/O-2	I/O-2	13410	EVT
High Pressure Pump #4 Speed Command	ZC-604	DDH	4-20mA	0-100	%	ZT-604B	I/O-2	I/O-2	I/O-2	13410	EVT
High Pressure Pump #4 High Pressure	PAH-604	DI	Form C	10-300	psi	PSH-604	PE-604	PE-601	I/O-2	13410	EVT
High Pressure Pump #4 Valve Open Position	YI-604-2	DI	Form C	Normal	Opened	YI-604-2	I/O-2	BFV4-04-2	I/O-2	15100	EVT
High Pressure Pump #4 Valve Open Position	YI-604-3	DI	Form C	Normal	Opened	YI-604-3	I/O-2	BFV4-04-3	I/O-2	15100	
											EVT

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Description	ISA Tag	Type	Signal	Range/ Off Status	Units/ On Status	Field Wiring Data					Remarks
						ISA Signal Source	Field Panel	Field FTC	SCADA Panel	Spec. Section	
High Pressure Pump #1 Valve Open Position	ZI-601-2	DI	Form C	Normal	Opened	ZS-601-2	I/O-1	BFV-601	I/O-1	15100	EVT
High Pressure Pump #1 Valve Open Position	ZI-601-3	DI	Form C	Normal	Opened	ZS-601-3	I/O-1	BFV-601	I/O-1	15100	
											EVT
High Pressure Pump #2 Valve Open Position	ZI-602-2	DI	Form C	Normal	Opened	ZS-602-2	I/O-1	BFV-602	I/O-1	15100	EVT
High Pressure Pump #2 Valve Open Position	ZI-602-3	DI	Form C	Normal	Opened	ZS-602-3	I/O-1	BFV-602	I/O-1	15100	
RO Membranes											
Skid #1 Total Permeate Rupture Disk	YA-711	DI	Form C	Normal	Alarm	YS-711	I/O-1A	I/O-1A	I/O-1A	11250	EVT
Skid #2 Total Permeate Rupture Disk	YA-721	DI	Form C	Normal	Alarm	YS-721	I/O-1A	I/O-1A	I/O-1A	11250	EVT
											MX, MN, MA, HH, LL, DT, CT, MT
Skid #3 2nd Array Flow	FIR-731	AI	4-20mA	0-500	gpm	FIT-731	FIT-731	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL, DT, CT, MT
Skid #3 Total Permeate Flow	FIR-732	AI	4-20mA	0-1500	gpm	FIT-732	FIT-732	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL, DT, CT, MT
Skid #3 Concentrate Flow	FIR-733	AI	4-20mA	0-750	gpm	FIT-733	FIT-733	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL
Skid #3 Feed Pressure	PIR-731	AI	4-20mA	0-300	psi	PIT-731	PIT-731	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL
Skid #3 Permeate Pressure	PIR-734	AI	4-20mA	0-50	psi	PIT-734	PIT-734	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL
Skid #3 Stage 2 Array Feed Pressure	PIR-732	AI	4-20mA	0-300	psi	PIT-732	PIT-732	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL
Skid #3 Stage 2 Array Concentrate Pressure	PIR-733	AI	4-20mA	0-300	psi	PIT-733	PIT-733	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL
Skid #3 Permeate Conductivity	AIR-731	AI	4-20mA	0-1000	umhos	AIT-731	AIT-731	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL
Skid #3 Concentrate Conductivity	AIR-732	AI	4-20mA	0-50000	umhos	AIT-732	AIT-732	SKCP3	I/O-1A	13410	EVT
Skid #3 Feed Valve In Remote	ZIR-731	DI	Form C	Normal	Remote	WS-731	CV-731	CV-731	I/O-1A	15100	EVT
Skid #3 Feed Valve Fail	YA-731	DI	Form C	Normal	Alarm	YR-731	CV-731	CV-731	I/O-1A	15100	EVT
Skid #3 Feed Valve Command	YC-731	DO	Form C	Normal	Start	ZT-731	CV-731	CV-731	I/O-1A	15100	EVT
Skid #3 Feed Valve Position Setpoint	ZC-731	AO	4-20mA	0-100	%	ZR-731	CV-731	CV-731	I/O-1A	15100	EVT
Skid #3 Feed Valve Position Feedback	ZIR-731	AI	4-20mA	0-100	%	ZS-732	CV-731	CV-731	I/O-1A	15100	EVT
Skid #3 Concentrate Valve In Remote	ZIR-732	DI	Form C	Normal	Remote	WS-732	CV-732	CV-732	I/O-1A	15100	EVT
Skid #3 Concentrate Valve Fail	YA-732	DI	Form C	Normal	Alarm	YR-732	CV-732	CV-732	I/O-1A	15100	EVT
Skid #3 Concentrate Valve Command	YC-732	DO	Form C	Normal	Start	ZT-732	CV-732	CV-732	I/O-1A	15100	EVT
Skid #3 Concentrate Valve Position Setpoint	ZC-732	AO	4-20mA	0-100	%	ZR-732	CV-732	CV-732	I/O-1A	15100	EVT
Skid #3 Concentrate Valve Position Concentrate	ZIR-732	AI	4-20mA	0-100	%	ZR-732	CV-732	CV-732	I/O-1A	15100	EVT
Skid #3 Total Permeate Rupture Disk	YA-731	DI	Form C	Normal	Alarm	YS-731	I/O-1A	I/O-1A	I/O-1A	11250	
											MX, MN, MA, HH, LL, DT, CT, MT
Skid #4 2nd Array Flow	FIR-741	AI	4-20mA	0-500	gpm	FIT-741	FIT-741	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL, DT, CT, MT
Skid #4 Total Permeate Flow	FIR-742	AI	4-20mA	0-1500	gpm	FIT-742	FIT-742	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL, DT, CT, MT
Skid #4 Concentrate Flow	FIR-743	AI	4-20mA	0-750	gpm	FIT-743	FIT-743	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL
Skid #4 Feed Pressure	PIR-741	AI	4-20mA	0-300	psi	PIT-741	PIT-741	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL
Skid #4 Permeate Pressure	PIR-744	AI	4-20mA	0-50	psi	PIT-744	PIT-744	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL
Skid #4 Stage 2 Array Feed Pressure	PIR-742	AI	4-20mA	0-300	psi	PIT-742	PIT-742	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL
Skid #4 Stage 2 Array Concentrate Pressure	PIR-743	AI	4-20mA	0-300	psi	PIT-743	PIT-743	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL
Skid #4 Permeate Conductivity	AIR-741	AI	4-20mA	0-1000	umhos	AIT-741	AIT-741	SKCP3	I/O-1A	13410	MX, MN, MA, HH, LL
Skid #3 Concentrate Conductivity	AIR-742	AI	4-20mA	0-50000	umhos	AIT-742	AIT-742	SKCP3	I/O-1A	13410	EVT
Skid #4 Feed Valve In Remote	ZIR-741	DI	Form C	Normal	Remote	WS-741	CV-741	CV-741	I/O-1A	15100	EVT
Skid #4 Feed Valve Fail	YA-741	DI	Form C	Normal	Alarm	YR-741	CV-741	CV-741	I/O-1A	15100	EVT
Skid #4 Feed Valve Command	YC-741	DO	Form C	Normal	Start	ZT-741	CV-741	CV-741	I/O-1A	15100	EVT
Skid #4 Feed Valve Position Setpoint	ZC-741	AO	4-20mA	0-100	%	ZR-741	CV-741	CV-741	I/O-1A	15100	EVT
Skid #4 Feed Valve Position Feedback	ZIR-741	AI	4-20mA	0-100	%	ZS-742	CV-741	CV-741	I/O-1A	15100	EVT

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Description	ISA Tag	Type	Signal	Range/ Off Status	Units/ On Status	Field Wiring Data					Remarks
						ISA Signal Source	Field Panel	Field FTC	SCADA Panel	Spec. Section	
Skid #4 Concentrate Valve In Remote	ZIR-742	DI	Form C	Normal	Remote	WS-742	CV-742	CV-742	I/O-1A	15100	EVT
Skid #4 Concentrate Valve Fail	YA-742	DI	Form C	Normal	Alarm	YR-742	CV-742	CV-742	I/O-1A	15100	EVT
Skid #4 Concentrate Valve Command	YC-742	DO	Form C	Normal	Start	ZT-742	CV-742	CV-742	I/O-1A	15100	EVT
Skid #4 Concentrate Valve Position Setpoint	ZC-742	AO	4-20mA	0-100	%	ZR-742	CV-742	CV-742	I/O-1A	15100	EVT
Skid #4 Concentrate Valve Position Concentrate	ZIR-742	AI	4-20mA	0-100	%	ZR-742	CV-742	CV-742	I/O-1A	15100	EVT
Skid #4 Total Permeate Rupture Disk	YA-741	DI	Form C	Normal	Alarm	YS-741	I/O-1A	I/O-1A	I/O-1A	11250	
Degasifier											
Blower #2 Run Status	YIQR-802	DDH	Form C	Normal	Running	YS-802	MCC-4	16421	I/O-3	16421	EVT
Blower #2 Fail	YA-802	DI	Form C	Normal	Alarm	YS-802A	YS-802A	16421	I/O-3	13410	EVT
Blower #2 in Local/Remote	ZIR-802A	DI	Form C	Normal	Auto	HS-802A	HS-802A	OCP	I/O-3	16140	EVT
Blower #2 MCC Ready	ZIR-802B	DDH	Form C	Normal	Ready	HS-802B	MCC-4	16421	I/O-3	16421/16140	
Blower #2 Command	YC-802	DDH	Form C	Start	Stop	YR-802	PLC-CB	16421	I/O-3	13410	
Blower #2 Motor Over Temp	TAH-802	DI	Form C	Normal	Alarm	TS-802	TS-802	MCC-4	I/O-3	13410	EVT
Blower #2 No Flow	FA-802	DI	Form C	Normal	Alarm	FS-802	FS-802	16421	I/O-3	13410	EVT
											EVT, CRT, DRT, DSC
Recirculation Pump #4 Run Status	YIQR-804	DDH	PU	Normal	Running	YS-804	MCC-4	MCC-4	I/O-3	16421	EVT
Recirculation Pump #4 Fail	YA-804	DDH	PU	Normal	Alarm	YS-804A	MCC-4	MCC-4	I/O-3	16421	EVT
Recirculation Pump #4 Motor Over Temp	TAH-804	DI	Form C	Normal	Alarm	TS-804	TS-804	MCC-4	I/O-3	13410	EVT
Recirculation Pump #4 Command	YC-804	DDH	Form C	Start	Stop	YR-804	I/O-3	16421	I/O-3	13410	
Recirculation Pump #4 in Local/Remote	ZIR-804	DI	Form C	Normal	Auto	HS-804	HS-804	16421	I/O-3	16140	EVT
Scrubber #2 H_2S	AIR-802	AI	4-20mA	0-14	ppm	AIT-802	I/O-3	I/O-3	I/O-3	11300	MX, MN, MA, HH, LL
Blended RO Water pH	AIR-2121	AI	4-20mA	0-14	unitless	AIT-2121	CO2 PNL	CO2 PNL	I/O-3	13410	
Transfer Pumping											
Transfer Pump #2 Run Status	YIQR-1102	DDH	PU	Normal	Running	YS-1102	MCC-4	MCC-4	I/O-3	16421	EVT
Transfer Pump #2 No Flow	FA-1102	DI	Form C	Normal	Alarm	FS-1102	FS-1102	FS-1102	I/O-3	13410	EVT
Transfer Pump #2 in Local/Remote	ZIR-1102A	DI	Form C	Normal	Auto	HS-1102A	HS-1102A	HS-1102A	I/O-3	16140	EVT
Transfer Pump #2 MCC Ready	ZIR-1102B	DI	Form C	Normal	Ready	HS-1102B	MCC-4	MCC-4	I/O-3	16421/16140	
Transfer Pump #2 Command	YC-1102	DDH	PU	Start	Stop	YR-1102	I/O-3	I/O-3	I/O-3	13410	EVT
Transfer Pump #2 Low Well	LAL-1102	DI	Form C	Normal	Alarm	LS-1102	LS-1102	LS-1102	I/O-3	13410	
Transfer Pump #2 Fail	YA-1102	DI	Form C	Normal	Alarm	YS-1102B	MCC-4	MCC-4	I/O-3	13410	EVT
Transfer Pump #2 Motor Over Temp	TAH-1102	DI	Form C	Normal	Alarm	TS-1102	TS-1102	MCC-4	I/O-3	13410	EVT
Storage											
											MX, MN, MA, HH, LL
GSR Level	LIR-1202	AI	4-20mA	0-35	ft.in	LT-1202	LI-1202	LI-1202	I/O-2	13615	EVT
Emergency High Level	LAH-1202	DI	Form C	Normal	Alarm	LSH-1202	LSH-1202	LSH-1202	I/O-2	13615	and TSH
Emergency Low Level	LAL-1202	DI	Form C	Normal	Alarm	LSL-1202	LSL-1202	LSL-1202	I/O-2	13615	EVT
Hatch Intrusion Alarm	YA-1202	DI	Form C	Normal	Alarm	YS-1202	YS-1202	YS-1202	I/O-2	13615	EVT

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Description	ISA Tag	Type	Signal	Range/ Off Status	Units/ On Status	Field Wiring Data					Remarks
						ISA Signal Source	Field Panel	Field FTC	SCADA Panel	Spec. Section	
High Service Pumping											
											EVT, CRT, DRT, DSC
High Service Pump #5 Run Status	YQIR-1305	DDH	PU	Normal	Running	YS-1305	VFD-HSP5	VFD-HSP5	I/O-2	16151	EVT
High Service Pump #5 VFD Fail	EAR-1305	DDH	PU	Normal	Alarm	ES-1305	VFD-HSP5	VFD-HSP5	I/O-2	16151	EVT
High Service Pump #5 VFD in Remote	ZIR-1305A	DDH	PU	Normal	Remote	ZS-1305A	VFD-HSP5	VFD-HSP5	I/O-2	16151	EVT
High Service Pump #5 VFD Ready	YIR-1305	DDH	PU	Normal	Ready	YS-1305	VFD-HSP5	VFD-HSP5	I/O-2	16151	EVT
High Service Pump #5 VFD Speed	ZI-1305	DDH	4-20mA	0-100	%	ZT-1305	VFD-HSP5	VFD-HSP5	I/O-2	16151	EVT
High Service Pump #5 Run Command	YC-1305B	DO	Form C	Stop	Start	YR-1305	I/O-2	I/O-2	I/O-2	13410	EVT
High Service Pump #5 Speed Command	ZC-1305	DDH	PU	0-100	%	ZT-1305B	I/O-2	I/O-2	I/O-2	13410	EVT
High Service Pump #5 Motor Over Temp	TAH-1305	DDH	PU	Normal	Alarm	TS-1305	VFD-HSP5	VFD-HSP5	I/O-2	13410	EVT
High Service Pump #5 No Flow	FA-1305	DI	Form C	Normal	Alarm	FS-1305	FS-1305	FS-1305	I/O-2	13410	MX, MN, MA, HH, LL
High Service Pump #5 Motor Current	YIR-1305	DDH	PU	0-400	amps	JT-1305	VFD-HSP5	VFD-HSP5	I/O-2	16151	MX, MN, MA, HH, LL
High Service Pump #5 Motor Voltage	YIR-1305	DDH	PU	Normal	Ready	ET-1305	VFD-HSP5	VFD-HSP5	I/O-2	16151	
											EVT, CRT, DRT, DSC
High Service Pump #6 Run Status	YQIR-1306	DDH	PU	Normal	Running	YS-1306	VFD-HSP6	VFD-HSP6	I/O-2	16151	EVT
High Service Pump #6 VFD Fail	EAR-1306	DDH	PU	Normal	Alarm	ES-1306	VFD-HSP6	VFD-HSP6	I/O-2	16151	EVT
High Service Pump #6 VFD in Remote	ZIR-1306	DDH	PU	Normal	Remote	ZS-1306A	VFD-HSP6	VFD-HSP6	I/O-2	16151	EVT
High Service Pump #6 VFD Ready	YIR-1306	DDH	PU	Normal	Ready	YS-1306	VFD-HSP6	VFD-HSP6	I/O-2	16151	EVT
High Service Pump #6 VFD Speed	ZI-1306	DDH	4-20mA	0-100	%	ZT-1306	VFD-HSP6	VFD-HSP6	I/O-2	16151	EVT
High Service Pump #6 Run Command	YC-1306B	DO	Form C	Stop	Start	YR-1306	I/O-2	I/O-2	I/O-2	13410	EVT
High Service Pump #6 Speed Command	ZC-1306	DDH	PU	0-100	%	ZT-1306B	I/O-2	I/O-2	I/O-2	13410	EVT
High Service Pump #6 Motor Over Temp	TAH-1306	DDH	PU	Normal	Alarm	TS-1306	VFD-HSP6	VFD-HSP6	I/O-2	13410	EVT
High Service Pump #6 No Flow	FA-1306	DI	Form C	Normal	Alarm	FS-1306	FS-1306	FS-1306	I/O-2	13410	MX, MN, MA, HH, LL
High Service Pump #6 Motor Current	YIR-1306A	DDH	PU	0-400	amps	JT-1306	VFD-HSP6	VFD-HSP6	I/O-2	16151	MX, MN, MA, HH, LL
High Service Pump #6 Motor Voltage	YIR-1306B	DDH	PU	Normal	Ready	ET-1306	VFD-HSP6	VFD-HSP6	I/O-2	16151	
Carbon Dioxide System											
Refer to Section 11300 for complete list of signals											

Provide 10% Spare I/O of each type including programming/display of a typical status or alarm for all DI, process indication, trending and historical database for typical AI, and typical interlocking for DO, plus signal retransmit for spare AO.

Abbreviations:

MCC	Motor Control Center	MX	Daily Maximum	ATS	natic Transfer Switch
MA	Daily Average	MN	Daily Minimum	OCP	dor Control Panel
DT	Daily Flow Total	HH	High Level Alarm	FTC	iring Terminal Cabinet
CT	Continuous Flow Total	LL	Low Level Alarm	SFCP	Feed Control Panel
DRT	Daily Run Time	DI	Discrete Input	NPCP	ble Water Control Panel
CRT	Continuous Run Time	DO	Discrete Output	MS	Motor Starter
Form C	Dry Contact Form C*	AI	Analog Input	LS	Limit Switch
EVT	Log Event of Status Change	AO	Analog Output	ACP	ation Control Panel
PO	Pseudooperation	DDH	**Digital Data Highway	FPMR	el Modification Required
DSC	Daily Start Counter	DRT	Daily Run Time	MT	Monthly Total
EGCP	Entrance Gate Control Panel	PU	Parameter Unit	TMP	nsfer Meter Panel
AMCP	Ammoniator Control Panel+D343			FFCP	e Feed Control Panel
CFCP	Caustic Feed Control Panel			SHCP	e Feed Control Panel
PFCP	Phosphate Feed Control Panel			LSCP	tation Control Panel

* All Discrete Input Contacts shall be powered from input location
** Display and record all equipment information available from manufacturer

Palm Bay Utilities

DIVISION 15

MECHANICAL

SECTION 15000

MECHANICAL - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. All equipment furnished and installed under this contract shall conform to the general stipulations set forth in this section except as otherwise specified in other sections.

2. Contractor shall coordinate all details of equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alternations in the Work required to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

B. Related Work Described Elsewhere:

1. General Requirements: Division 1.

2. Concrete: Division 3.

3. Metals: Division 5.

4. Painting: Division 9.

5. Equipment: Division 11.

6. Special Construction: Division 13.

7. Electrical: Division 16.

C. General Design:

1. Contract Drawings and Specifications: The Contract Drawings and Specifications shall be considered as complementary, one to the other, so that materials and work indicated, called for, or implied by the one and not by the other shall be supplied and installed as though specifically called for by both. The Contract Drawings are to be considered diagrammatic, not necessarily showing in detail or to scale all of the equipment or minor items. In the event of discrepancies between the Contract Drawings and Specifications, or between either of these

and any regulations or ordinances governing work of these specifications, the bidder shall notify the Engineer in ample time to permit revisions.

1.02 QUALITY ASSURANCE

A. Materials and Equipment: Unless otherwise specified, all materials and equipment furnished for permanent installation in the work shall conform to applicable standards and specifications and shall be new, unused, and undamaged when installed or otherwise incorporated in the work. No such material or equipment shall be used by the Contractor for any purpose other than that intended or specified, unless such use is specifically authorized in writing by the Owner. No material shall be delivered to the work site workout prior acceptance of drawings and data by the Engineer.

B. Equivalent Materials and Equipment:

1. Whenever a material or article is specified or described by using the name of a proprietary product or the name of a particular manufacturer or vendor, the specific item mentioned shall be understood as establishing the type, function, and quality desired. Other manufacturers' products will be accepted provided sufficient information is submitted to allow the Engineer to determine that the products proposed are equivalent to those named. Such items shall be submitted for review in accordance with Section 01340: Shop Drawings, Working Drawings, and Samples.

2. Requests for review of equivalency will not be accepted from anyone except the Contractor and such requests will not be considered until after the contract has been awarded.

C. Governing Standards: Equipment and appurtenances shall be designed in conformity with ANSI, ASME, ASTM, IEEE, NEMA, OSHA, AGMA, and other generally accepted applicable standards. They shall be of rugged construction and of sufficient strength to withstand all stresses which may occur during fabrication, testing, transportation, installation, and all conditions or operations. All bearings and moving parts shall be adequately protected against wear by bushings or other acceptable means. Provisions shall be made for adequate lubrication with readily accessible means.

D. Tolerances: Machinery parts shall conform to the dimensions indicated on the drawings within allowable tolerances. Protruding members such as joints, corners, and gear covers shall be finished in appearance. All exposed welds shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.

E. Clearances: Ample clearances shall be provided for inspection and adjustment. All equipment shall fit the allotted space and shall leave reasonable access room for servicing and repairs. Greater space and room required by substituted equipment shall be provided by the Contractor and at his expense.

F. Testing:

1. When the equipment is specified to be factory tested, the results of the tests shall be submitted to the Engineer and approval of the test results shall be obtained before shipment of the equipment.

2. When an item of equipment, including controls and instrumentation, has been completely erected, the Contractor shall notify the Engineer, who will designate a time to make such tests as required, and operate the item to the satisfaction of the Contractor. All testing shall be done in the presence of the Contractor. "Completely erected" shall mean that the installation is erected, all necessary adjustments have been made, all required utility connections have been made, required lubricants and hydraulic fluid have been added and the unit has been cleaned and painted.

G. Pressure Test:

1. After installation, all piping shall be pressure tested. Piping shall be tested in accordance with Section 15044.

2. All tests shall be made in the presence of and to the satisfaction of the Construction Manager and also, to the satisfaction of any local or state inspector having jurisdiction.

   a. Provide not less than three days notice to the Construction Manager and the authority having jurisdiction when it is proposed to make the tests.

   b. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Construction Manager shall be retested in part or in whole as directed by the Construction Manager.

   c. The piping systems may be tested in sections as the work progresses by no joint or portion of the system shall be left untested.

3. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.

4. All defects and leaks observed during the tests shall be corrected and made tight in an approved manner and the tests repeated until the system is proven tight.

5. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.

6. Provide test pumps, gauges, or other instruments and equipment required for the performance of all tests. Provide all temporary bracing, test plugs,

additional restraint, and thrust blocking which may be required for test pressures above normal working pressures.

7. All tests shall be maintained for as long a time as required to detect all defects and leaks but not less than the duration specified for each type of pipe or piping system in this Division.

H. Failure of Test:

1. Defects: Any defects in the equipment, or deviations from the guarantees or requirements of the Specifications, shall be promptly corrected by the Contractor by replacements or otherwise. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligations under the Contract shall be final and conclusive. If the Contractor fails to correct any defects or deviations, or if the replaced equipment when tested shall f ail again to meet the guarantees or specified requirements, the Owner, notwithstanding his having made partial payment for work and materials which have entered into the manufacturer for such equipment, may reject that equipment and order the Contractor to remove it from the premises at the Contractor's expense.

2. Rejection of Equipment: In case the Owner rejects a particular item of equipment, then the Contractor hereby agrees to repay to the Owner all sums of money paid to him to deliver to the Contractor a bill of sale of all his rights, title, and interest in and to the rejected equipment provided, however that the equipment shall not be removed from the premises until the Owner obtains from other sources other equipment to take the place of that rejected. The bill of sale shall not abrogate the Owner's right to recover damages for delays, losses or other conditions arising out of the basic Contract. The Owner hereby agrees to obtain the alternate equipment within a reasonable time and the Contractor agrees that the Owner may use the original equipment furnished by him without rental or other charge until the other equipment is obtained.

I. Responsibility During Tests: The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

J. Acceptance of Materials:

1. Only new materials and equipment shall be incorporated in the work. All materials and equipment furnished by the Contractor shall be subject to the inspection and acceptance of the Owner. No material shall be delivered to the work without prior submittal approval of the Engineer.

2. The Contractor shall submit to the Project Manager and Professional Engineer data relating to materials and equipment he proposes to furnish for the work. Such data shall 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.

3. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the work, the Contractor shall submit samples of materials for such special test as may be necessary to demonstrate that they conform to the specification. Such sample shall be furnished, stored, packed, and shipped as directed at the Contractor's expense. Except as otherwise noted, the Owner will make arrangements for and pay for tests.

4. The Contractor shall submit data and samples sufficiently early to permit consideration and acceptance before materials are necessary for incorporation in the work.

K. Safety Requirements:

1. In addition to the components shown and specified, all machinery and equipment shall be safeguarded in accordance with the safety features required by the current codes and regulations of ANSI, OSHA, and local industrial codes.

2. The Contractor shall provide for each V-belt drive or rotating shaft a protective guard which shall be securely bolted to the floor or apparatus. The guard shall completely enclose drives and pulleys and be constructed to comply with all safety requirements.

3. For double inlet fans, the belt guard shall be arranged so as not to restrict the air flow into the fan inlet. Guards shall not interfere with lubrication of equipment.

4. Any overhead mechanical equipment, systems, or components shall have a minimum clearance of 7 feet-6 inches above the finished floor.

1.03 SUBMITTALS (SEE SECTION 01340: SHOP DRAWINGS, WORKING DRAWINGS AND SAMPLES)

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packaging: All equipment shall be suitably packaged to facilitate handling and protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times.

B. Protection: All machined surfaces and shafting shall be cleaned and protected from corrosion by the proper type and amount of coating necessary to assure protection during shipment and prior to installation. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage as specified in Sections 09961 and

09905. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

C. Lubrication: Grease and lubricating oil shall be applied to all bearings and similar items as necessary to prevent damage during shipment and storage.

D. Marking: Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

E. Fabricated sub-assemblies, if any, shall be shipped in convenient sections as permitted by carrier regulations and shall be properly match-marked for ease of field erection.

F. Responsibility:

1. The Contractor shall be responsible for all material, equipment, and supplies sold and delivered to the site 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 shall replace same without additional cost to the Owner.

2. Should the Contractor fail to take proper action on storage and handling of equipment supplied under this Contract within seven 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.

G. Delivery: The Contractor shall arrange deliveries of products in accordance with construction schedules and coordinate to avoid conflict with work and condition at the site.

1. The Contractor shall deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.

2. Immediately on delivery, the Contractor shall inspect shipments to assure compliance with requirements of Contract Documents and accepted submittals, and that products are properly protected and undamaged.

3. Under no circumstances shall the Contractor deliver equipment to the site more than one month prior to installation without written authorization from the Construction Manager. Operation and maintenance data shall be submitted to the Engineer for review prior to shipment of equipment as described in Section 01730: Operating and Maintenance Data.

H. Storage and Protection of Products:

1. The Contractor shall furnish a covered, weather-protected storage structure providing a clean, dry noncorrosive environment for all mechanical equipment, valves, architectural items, electrical and instrumentation equipment, and special equipment to be incorporated into this project. Storage of equipment shall be in strict accordance with the "Instructions for Storage" of each equipment supplier and manufacturer including connection of space heaters, and placing of storage lubricants in equipment. Corroded, damaged, or deteriorated equipment and parts shall be replaced before acceptance of the project. Equipment and materials not properly stored will not be included in a payment estimate.

    a. The Contractor shall store products subject to damage by the elements in weathertight enclosures.

    b. The Contractor shall maintain temperature and humidity within the ranges required by manufacturer's instructions.

    c. The Contractor shall store fabricated products above the ground, on blocking or skids, to prevent soiling or staining. The Contractor shall cover products which are subject to deterioration with impervious sheet coverings and provide adequate ventilation to avoid condensation.

    d. The Contractor shall store loose granular materials in a well drained area on solid surfaces to prevent mixing with foreign matter.

2. All materials and equipment to be incorporated in the work shall 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.

3. Cement, sand, lime shall be stored under a roof and off the ground, and shall be kept completely dry at all times. All structural and miscellaneous steel 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, staining, chipping, or cracking. Brick, block, and similar masonry products shall be handled and stored in a manner to reduce breakage, chipping, cracking and peeling to a minimum.

4. All materials which, in the opinion of the Construction Manager, have become damaged and are unfit for the use intended or specified, shall be promptly removed from the site of the work, and the Contractor shall receive no compensation for the damaged material or its removal.

5. The Contractor shall arrange storage in a manner to provide easy access for inspection. The Contractor shall make periodic inspections of stored products to

assure products are maintained under specified conditions, and free from damage or deterioration.

6. Protection After Installation: The Contractor shall provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. The Contractor shall remove covering when no longer needed.

I. Extended Storage Requirements For Equipment: Because of the long period allowed for construction, special attention shall be given to extended storage and handling of equipment onsite. As a minimum, the procedure specified herein shall be followed:

1. If equipment will be stored onsite for more than one month prior to incorporation into the Work, the Contractor shall submit a written request to the Construction Manager outlining any special provision to be made to protect and maintain the equipment while it is being stored. All such provisions shall be acceptable to the Construction Manager. No equipment shall be stored onsite for more than one month without prior written authorization from the Construction Manager.

2. All equipment having moving parts including gears, electric motors, and/or instruments shall be stored in a temperature and humidity controlled building accepted by the Construction Manager, until such time as the equipment is to be installed.

3. All equipment shall be stored fully lubricated with oil and grease unless otherwise instructed by the manufacturer.

4. Manufacturer's storage instructions shall be carefully studied by the Contractor and reviewed by him with the Construction Manager. These instructions shall be carefully followed and a written record of this review kept by the Contractor.

5. 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, and operate loaded when possible, weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.

6. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. Mechanical equipment to be used in the work, if stored for longer than ninety days, shall have the bearings cleaned, flushed, and lubricated prior to testing and startup, at no extra cost to the Owner.

7. 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 guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective, and it shall be removed and replaced at the Contractor's expense.

8. A maintenance log shall be maintained by the Contractor outlining the schedule of maintenance required for each piece of equipment as well as the date on which the maintenance was actually performed and the initials of the individual performing the work. Submit a copy of the maintenance log monthly with the progress pay application.

1.05 WARRANTY AND GUARANTEES

A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for 2 years after the time of completion and acceptance.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555.320(3) Florida Administrative Code.

2.02 MATERIALS AND EQUIPMENT

A. Fabrication and Manufacture:

1. Workmanship and Materials:

a. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage or other failure. Materials shall be suitable for service conditions.

b. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and gages 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 tests.

c. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch thick.

2. Lubrication:

a. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrications systems shall not require attention during startup or shutdown and shall not waste lubricants.

b. Lubricants of the type recommended by the equipment manufacturer shall be furnished by the Contractor in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Owner. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

c. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

3. Electric Motors: Unless otherwise specified, motors furnished with equipment shall meet the following requirements:

a. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

b. Rated for continuous duty at 40 C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

c. Insulated with Class B, Class F, or Class H insulation and designed for a service factor of 1.00, 1.15, or greater.

d. Three phase motors used in conjunction with variable speed drives shall be inverter duty MG-1 Part 31, 1000 peak voltage, 10,000 dv/dc.

e. When operating at service factor load, maximum observable temperature rise of insulation and motor parts, as determined by resistance or thermometer methods, shall not exceed the NEMA allowable limits for the type of motor, the type of enclosure, and the particular application with regard to continuous or intermittent duty.

f. To ensure long motor life, nameplate horsepower, regardless of service factor, shall be at least 115 percent of the maximum load imposed by the driven equipment.

g. Designed for full voltage starting.

h. Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion per IEEE Standard 519.

i. Derated, if required, for the altitude at which the equipment is installed.

j. Clamp-type grounding terminal shall be inside motor conduit box.

k. External conduit boxes shall be oversized at least one size larger than NEMA standard.

l. Totally enclosed motors shall have a continuous moisture drain which also excludes insects.

m. Bearings shall be either oil or grease lubricated.

n. Manufacturer's standard motor may be supplied on integrally constructed, packaged assemblies such as appliances, tools, unit heaters, and similar equipment specified by model number, in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

o. Totally enclosed motors shall be furnished on:

    1) Outdoor equipment.

    2) Equipment for installation below grade.

    3) Chemical feeding and chemical handling equipment.

    4) Equipment operating in wet or dust-laden locations.

p. Totally enclosed fan cooled motors may be furnished in lieu of open dripproof motors on equipment in indoor, above-grade, clean, and dry locations.

q. Explosion proof or submersible motors shall be furnished as required by applicable codes, as specified in other sections, or at the supplier's option.

r. Motors shall be rated and constructed as follows:

1) Below 1/2 hp:

115 volt, 60 Hz, single phase.

Built-in manual-reset thermal protector, or integrally mounted stainless steel enclosed manual motor starter.

2) 1/2 hp and above:

460 volt, 60 Hz, 3 phase.

Where specified or required by the drawings, motors used on 208 volt systems shall be 200 volt, 60 Hz, 3 phase.

s. Premium efficient motors shall be provided for the motor driven equipment, except where explosionproof motors are required or where used in ventilation equipment above the roof and for submersible use. Certification shall be supplied for each size, speed and type of motor indicating the guaranteed minimum efficiency at full load and that the efficiency tests were done in accordance with IEEE Standard 112, Test Method B, using accuracy improvement by segregated loss determination including stray load loss improvement as specified in NEMA Standard MGI-12.53a.

t. Power factor correction capacitors shall be provided for each constant speed, across-the-line start motor sized 10 hp and larger. Capacitors shall be weatherproof type with a corrosion-resistant finish, complete with mounting hardware, 480 volts, and shall be connected to the motor terminals except as otherwise indicated on the drawings. Capacitors shall be sized to improve power factor at motor full load rating to approximately 95 percent, but not greater than the applicable motor manufacturer's recommendations, for the particular motors to which the capacitors are applied. Motor overloads shall be sized, taking into account the reduced motor current when connected with capacitors.

u. Six certified copies of the shop test results shall be furnished for each motor larger than 50 horsepower. Balance and vibration tests shall be

included to meet NEMA Standards MG 1-12.05 and MG 1-12.06. The Contractor shall submit shop drawings and data sheets covering all items listed herein including frame dimensions, mounting, coupling details and full load power factor, efficiency of full load and maximum KVAR factor for the Engineer's acceptance. The Contractor shall furnish operation and maintenance manuals as specified in Section 01730: Operating and Maintenance Data.

4. Drive Units: The nominal input horsepower rating of each gear or speed reducer shall be at least equal to the nameplate horsepower of the drive motor. Drive units shall be designed for 24 hour continuous service.

   a. Gear Reducers:

      1) Each gear reducer shall be a totally enclosed unit with oil or grease lubricated antifriction, rolling element bearings throughout.

      2) Helical, spiral bevel, combination bevel-helical, and worm gear reducers shall have a service factor of at least 1.50 based on the nameplate horsepower of the drive motor. Shaft-mounted and flange-mounted gear reducers shall be rated AGMA Class 11. Helical gear reducers shall have a gear strength rating to catalog rating of 1.5. Each gear reducer shall bear an AGMA nameplate.

      3) The thermal horsepower rating of each unit shall equal or exceed the nameplate horsepower of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100 F above the ambient air temperature in the vicinity of the unit and shall not exceed 200 F.

      4) Each grease lubricated bearing shall be installed in a bearing housing designed to facilitate periodic regreasing of the bearing by means of a manually operated grease gun. Each bearing housing shall be designed to evenly distribute new grease, to properly dispose of old grease, and to prevent overgreasing of the bearing. The use of permanently sealed, grease lubricated bearings will not be acceptable. An internal or external oil pump and appurtenances shall be provided if required to properly lubricate oil lubricated bearings. A dipstick or sight glass arranged to permit visual inspection of lubricant level shall be provided on each unit.

      5) Gear reducers which require the removal of parts or periodic disassembly of the unit for cleaning and manual regreasing of bearings will not be acceptable.

6) Certification shall be furnished by the gear reducer manufacturer indicating that the intended application of each unit has been reviewed in detail by the manufacturer and that the unit provided is fully compatible with the conditions of installation and service.

b. Variable Speed Drives: Each variable speed drive shall have a service factor of at least 1.75 at maximum speed based on the nameplate horsepower of the drive motor. A spare belt shall be provided with each variable speed drive unit employing a belt for speed change. Unless specifically permitted by the detailed equipment specifications, bracket type mounting will not be acceptable for variable speed drives.

c. V-Belt Drives: Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 maximum speed based on the nameplate horsepower of the drive motor.

5. Safety Guards: All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated form 16 USS gage or heavier galvanized or aluminum-clad sheet steel or 1/2 inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

6. Equipment Foundation Supports:

a. All foundations, platforms and hangers required for the proper installation of equipment shall be furnished and installed by the Contractor.

b. Unless otherwise indicated or specified, all equipment shall be installed on reinforced concrete bases at least 6 inches high and shall conform to Section 03300. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection. Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout as specified in Section 03600: Grout. All open equipment bases shall be filled with nonshrinking grout sloped to drain to the perimeter of the base.

c. The Contractor shall furnish, install and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other

appurtenances required for the installation of equipment. These shall be of ample size and strength for the purpose intended.

d. Equipment suppliers shall furnish suitable anchor bolts for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed. Anchor bolts shall comply with Section 05500: Miscellaneous Metals and, unless otherwise specified, shall have a minimum diameter of 3/4 inch. Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

e. Structural steel supports and miscellaneous steel required for supporting and/or hanging equipment and piping furnished under this Division shall be provided and installed by Contractor.

f. All foundations, anchor pads, piers, thrust blocks, inertia blocks and structural steel supports shall be built to template and reinforced as required for loads imposed on them.

g. The Contractor shall assume all responsibility for sizes, locations and design of all foundations, anchor pads, pier, thrust blocks, inertia blocks, curbs and structural steel supports.

7. Equipment weighing more than 100 pounds shall be furnished with lifting eyes.

8. Shop Painting:

a. All steel and iron surfaces shall be protected by suitable paint or coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Exposed surfaces shall be finished smooth, thoroughly cleaned, and filled as necessary to provide a smooth uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with a high-grade oil resistant enamel suitable for coating in the field with an alkyd enamel. Coatings shall be suitable for the environment where the equipment is installed.

b. Surfaces to be painted after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Unless otherwise specified, the shop primer for steel and iron surfaces shall be Cook "391-N-167 Barrier Coat", Koppers "No. 10 Inhibitive Primer", or equal.

c. Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound, Houghton "Rust Veto 344", Rust-Oleum "R-9", or equal.

9. Nameplates: Contractor shall provide equipment identification nameplates for each item of equipment. Nameplates shall be 1/8-inch Type 304 stainless steel and shall be permanently fastened. Plates shall be fastened using round head metallic drive screws, or where metallic drive screws are impractical, with stainless steel pop rivets. Metallic drive screws shall be brass or stainless steel, Type V and No. 8 by 3/8-inch long. Names and/or equipment designations shall be engraved on the plates and the engraving painted with a primer and black paint system compatible with stainless steel. Contractor shall submit a list of proposed names and designations for review prior to fabrication of nameplates. At a minimum, each nameplate shall include equipment manufacturers name, year of manufacture, serial number and principal rating data.

10. Pipe Identification:

a. All pipe (except underground) shall have code letters and flow arrows painted as per specification Section 09905. The contractor shall ensure that the pipes are properly marked.

b. Underground pipe and tube: Pipe and tube shall be located by laying 2-inch wide plastic tape continuously along the run of pipe or tube. Where possible, color of tape shall be consistent with the color of bands on interior pipe and as approved by the Engineer, or shall bear an imprinted identification of the line.

1) Location: Tape shall be laid approximately 12 inches below ground surface and directly over pipe location.

2) Manufacturer: Tape shall be an inert plastic film highly resistant to alkaline, acids or other destructive chemical components likely to be encountered in soils and shall be Terra Tape as manufactured by Griffolyn Company, or underground warning tape by Seton Name Plate Corporation or equal. Pipe of PVC shall be protected with a detectable tape with a metallized foil core and shall be Terra Tape "D" or equal.

11. Valve Identification: On all valves, except shut-off valves located at a fixture or piece of equipment, the Contractor shall provide a coded and numbered tag attached with brass chain and/or brass "S" hooks.

a. Tag Types:

1) Tags for valves on pipe and tube lines conducting hot medium (steam, condensate, hot water, etc.) shall be brass or anodized aluminum.

2) Tags for all other valves shall be Type 304 stainless steel.

3) Square tags shall be used to indicate normally closed valves and round tags shall indicate normally open valves.

b. Coding: In addition to the color coding, each tag shall be stamped or engraved with wording or abbreviations to indicate the line service. All color and letter coding shall be approved by the Engineer.

c. Valve Schedule: The Contractor shall provide a typewritten list of all tagged valves giving tag shape, letter code and number, the valve size, type, use and general location within building.

12. Noise Attenuation and Control:

a. Unless otherwise specified, the maximum permissible noise level for a complete installed piece of equipment located within or outside a structure shall not exceed 85 dB at 3 feet. A complete piece of equipment includes the driver and driven equipment, plus any intermediate couplings, gears, and auxiliaries. All equipment provided herein that is specified to be factory and field tested shall be tested as specified herein for noise generation at the equipment manufacturer's expense.

b. Maximum permissible noise (sound pressure) levels shall be in decibels as read on the "A" weighting scale of a standard sound level meter (dB); all measurements shall be made in relation to a reference pressure of 0.0002 microbar. Measurements of emitted noise levels shall be made on a sound level meter meeting at least the Type 2 requirements set forth in ANSI S1.4, Specification for Sound Level Meters. The sound level meter shall be set on the "A" scale and to slow response. Unless otherwise specified for a particular piece of equipment, the point of measurement of sound level shall be made at the specified distance from any major surface along the entire perimeter and at midheight of the piece of equipment, or at the specified distance from an outer major surface encompassing the sound source including inlets or outlets.

13. Fire Hazard Rating:

a. All piping, duct work, and equipment insulation, fastener, and jacketing materials shall have a fire hazard rating not to exceed 25 for flame spread, 50 for fuel contributed, and 50 for smoke developed. Rating shall be determined by ASTM Designation E84, "Surface Burning Characteristics of Building Materials". Corresponding ratings determined by Underwriters' Laboratories, Inc., UL-723, "Test Method

for Fire Hazard Classification of Building Materials", will also be acceptable.

b. Flameproofing treatments will not be acceptable.

14. Heating, Ventilation and Domestic Plumbing Equipment:

a. Interchangeability: In all design and purchasing, interchangeability of items of equipment, subassemblies, parts, motors, starters, relays, and other items is essential. All similar items shall be of the same manufacturer, type, model, and dimensions.

2.03 ACCESSORIES

A. Special Tools and Accessories: Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.04 SPARE PARTS

A. Spare parts for certain equipment provided under Divisions 11, 13, 14, 15, and 16 have been specified in the pertinent sections of the specifications. The Contractor shall collect and store all spare parts in an area to be designated by the Engineer. In addition, the Contractor shall furnish to the Engineer an inventory listing of all spare part, the equipment they are associated with, and the name and address of the supplier.

B. Maintenance Materials:

1. 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.

2.. The Contractor shall be responsible for changing the oil in all drives and intermediate drives of each mechanical equipment after initial break-in of the equipment, which in no event shall be any longer than three weeks of operation.

2.05 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.

PART 3 - EXECUTION

3.01 PREPARATION (NOT APPLICABLE)

3.02 INSTALLATION

A. Installation: Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary for proper results. When so specified, or when employees of Contractor or his subcontractors are not qualified, such personnel shall be field representatives of the manufacturer of the equipment or materials being installed.

1. The Contractor shall have on site sufficient proper construction equipment and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory assembled when practical.

2. Equipment shall be erected in a neat and workmanlike manner on the foundations and supports at the locations and elevations shown on the Drawings, unless otherwise directed by the Engineer during installation.

3. All equipment shall be installed in such a manner as to provide access for routine maintenance including lubrication.

4. For equipment such as pumping units, which require field alignment and connections, the Contractor shall provide the services of the equipment manufacturer's qualified mechanic, millwright, machinist, or authorized representative, to align the pump and motor prior to making piping connections or anchoring the pump base.

5. Equipment of a portable nature which require no installation shall be delivered to a location designated by the Owner.

B. Tolerances: Precision gauges and levels shall be used in setting all equipment. All piping and equipment shall be perfectly aligned, horizontally and vertically. Tolerances for piping and equipment installation shall be 1/2 inch to 30 ft horizontal and vertically. All valves and operators shall be installed in the position shown on the Contract Drawings or as directed by the Engineer, if not shown.

C. Alignment and Level: The equipment shall be brought to proper level by shims (1/4 inch maximum). After the machine has been leveled and aligned, the nuts on the anchor bolts shall be tightened to bind the machine firmly into place against the wedges or shims. Grouting shall be as specified in Section 03600: Grout.

D. Grouting: The grout shall be tamped into position with a board, steel bar, or other tool. Tamping should not be so hard as to raise or otherwise displace the plate.

E. Contact of Dissimilar Metals: Where the contact of dissimilar metal may cause electrolysis and where aluminum will contact concrete, mortar, or plaster, the contact surface of the metals shall be separated using not less than one coat of zinc chromate primer and one heavy coat of aluminum pigmented asphalt paint on each surface.

F. Cutting and Patching: All cutting and patching necessary for the work shall be performed by the Contractor.

G. Operation: All equipment installed under this Contract, including that furnished by Owner or others under separate contract, shall be placed into successful operation according to the written instructions of the manufacturer or the instructions of the manufacturer's field representative. All required adjustments, tests, operation checks, and other startup activity shall be provided.

H. Large (greater than 10 horsepower) and critical equipment motors shall be installed above grade and above the 100 year flood plain.

3.03 INSPECTION AND TESTING

A. Where the specifications require observation of performance tests by the Construction Manager, such tests shall comply with the quality assurance paragraph in this section.

3.04 START-UP AND INSTRUCTION

A. Services Furnished Under This Contract:

1. An experienced, competent, and authorized representative of the manufacturer of each item of equipment shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation. The manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Construction Manager.

2. Each manufacturer's representative shall furnish to Owner, Construction Manager, a letter of certification stating that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for field services shall be included in the contract amount.

END OF SECTION

SECTION 15041

DISINFECTION OF POTABLE WATER PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies materials and procedures for disinfection of potable water mains. Do not use the tablet method to disinfect pipelines. Disinfect piping in accordance with AWWA Standard C651, except as modified below. Disinfection of piping shall meet the requirements of the FDEP regulations given in 62-555.340 F.A.C. Disinfection of pipelines used for reclaimed water is not required.

1.02 SCOPE OF WORK

A. The proper disinfection and bacteriological clearance of process facilities (piping, tanks, vessels, pumps, and other equipment) prior to start-up commencement is essential to preventing biological contamination that may cause or contribute to membrane fouling and other operational complications, therefore in addition to regulatory requirements for disinfection, the Contractor shall provide flushing and disinfection of all proposed process facilities in the same manner as is required for potable water system components. This requirement shall be provided regardless of the proposed service, with the exception of sanitary sewer lines, building drain lines and wastewater force mains.

1.03 JOB CONDITIONS

A. Discharge of chlorinated water into watercourses or surface waters is regulated by the National Pollutant Discharge Elimination System (NPDES). Apply to environmental regulation authority, Florida Department of Environmental Protection and obtain permit, for permission to discharge. Disposal of the chlorinated disinfection water and the flushing water is the Contractor's responsibility.

B. Schedule the rate of flow and locations of discharges in advance to permit review and coordination with Owner and regulatory authorities.

C. The Contractor shall only use potable water for flushing, disinfection, and post flushing. Potable water supply at the project site is through the City. The Contractor shall be responsible for purchasing all water used for flushing and disinfection from the City.

D. Submit requests for use of water from waterlines of Owner 48 hours in advance.

1.04 SUBMITTALS

A. Copies of all laboratory test results.

B. Copies of all FDEP correspondence.

C. Sampling location drawing.

PART 2 - MATERIALS

2.01 LIQUID CHLORINE

Inject with a solution feed chlorinator and a water booster pump. Use an experienced operator and follow the instructions of the chlorinator manufacturer.

2.02 CALCIUM HYPOCHLORITE (DRY)

Dissolve in water to a known concentration in a drum and pump into the pipeline at a metered rate.

2.03 SODIUM HYPOCHLORITE (SOLUTION)

Further dilute in water to desired concentration and pump into the pipeline at a metered rate.

2.04 CHLORINE RESIDUAL TEST KIT

For measuring chlorine concentration, supply chlorine residual testing instruments and equipment conforming to the requirements of FDEP Standard Operating Procedures for Field Activities, DEP-SOP-001/01, using DPD Colorimetric Method, Titrimetric Method, or Ion-Selective Electrode. Maintain field test kits in good working order available for immediate test of residuals at point of sampling.

PART 3 - EXECUTION

3.01 PIPELINE FLUSHING

All pipelines shall be flushed clean of deleterious material prior to disinfection.

3.02 CONTINUOUS FEED METHOD FOR PIPELINES

Introduce potable water into the pipeline at a constant measured rate. Feed the chlorine solution into the same water at a measured rate. Proportion the two rates so that the chlorine concentration in the pipeline is maintained at a minimum concentration of 50 mg/L. Check the concentration at points downstream during the filling to ascertain that sufficient chlorine is being added.

3.03 DISINFECTION OF VALVES AND APPURTENANCES

During the period that the chlorine solution is in the section of pipeline, open and close valves to obtain a chlorine residual at hydrants and other pipeline appurtenances. Valves connected to the existing water system shall be manipulated by the City.

3.04 DISINFECTION OF CONNECTIONS TO EXISTING PIPELINES

Disinfect per AWWA C651, Section 9. Flush with potable water until discolored water, mud, and debris are eliminated. Swab interior of pipe and fittings with a 1% sodium hypochlorite solution. After disinfection, flush with potable water again until water is free of chlorine odor.

3.05 CONFIRMATION OF RESIDUAL

Total residual chlorine measurements as required herein are to be performed in the field by the Contractor at the time of sample collection in accordance with FDEP-SOP-001/01. After the chlorine solution applied by the continuous feed method has been retained in the pipeline for 24 hours, confirm that a chlorine residual of 25 mg/L minimum exists along the pipeline by sampling at air valves and other points of access.

3.06 POST CHLORINATION FLUSHING

After confirming the chlorine residual, flush the excess chlorine solution from the pipeline until the total chlorine residual in the water leaving the pipe is within 0.5 mg/l of the replacement water and no more than 4.0 mg/L.

3.07 CHLORINE RESIDUAL AND BACTERIOLOGIC TESTS

1. After reducing total chlorine residual to no more than 4.0 mg/L, the Contractor will collect one sample per day at each sample point on two consecutive days, and the samples shall be analyzed for total chlorine residual and for the presence of total coliform bacteria. Total chlorine residual is to be measured in the field by the Contractor using methods approved by FDEP-SOP-001/01. The total coliform analysis is to be performed by a laboratory of the Department of Health (DOH) or a laboratory certified by the DOH to perform bacteriological analyses of drinking water.

2. Deliver to the certified laboratory within 22 hours of obtaining the samples and obtain a bacteriologic quality test to demonstrate the absence of coliform organisms in each separate section of the pipeline. For lines longer than 2 miles, obtain one additional test each mile. Test between all valves in each direction.

3.08 REPETITION OF PROCEDURE

If the initial chlorination fails to produce required residuals or bacteriologic tests reveal the presence of total coliforms, repeat the chlorination and retesting until satisfactory results are obtained. If any bacteriological sample contains more than 4.0 mg/L, the test shall be considered invalid.

3.09 TEST FACILITY REMOVAL

After satisfactory disinfection, replace air valves, restore the pipe coating, and complete the pipeline where temporary disinfection or test facilities were installed. Any test stations removed prior to receipt of acceptable lab results will be required to be replaced at the Contractor's expense should retesting be required.

3.10. PIPING TO BE DISINFECTED

Disinfect all purification process piping per AWWA.

3.11. DISINFECTION OF STRUCTURES

A. Disinfect per AWWA C652, Method 2.

B. Disinfect the following structures:

1. Clearwell

2. Ground Storage Tank

C. Remove any chlorine solution which accumulates in the bottom of the structure each day.

D. Potable water supply at the project site is through the City of Palm Bay. The Contractor shall be responsible for purchasing all water used for flushing and disinfection from the City.

END OF SECTION

SECTION 15044

PRESSURE TESTING OF PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: This section specifies the leakage testing requirements for plant piping.

B. Related Work Described Elsewhere (not applicable)

C. General Design (not applicable)

1.02 QUALITY ASSURANCE

A. Test Pressures: Test pressures for the various services and types of piping shall be as shown in the Piping Schedule in the Drawings, and at a minimum shall be 1.5 times the working pressure.

1.03 SUBMITTALS

A. Materials and Shop Drawings (Not Applicable)

B. Additional Information:

1. Testing Plan: Submit prior to testing and include at least the information that follows:

a. Testing dates.

b. Piping systems and section(s) to be tested.

c. Test type.

d. Method of isolation.

e. Calculation of maximum allowable leakage for piping section(s) to be tested.

2. Certifications of Calibration: Testing equipment.

3. Certified Test Report.

4. Testing Records:

a. Provide a record of each piping installation during the testing. These records shall include:

1) Date of test.

2) Identification of pipeline tested or retested.

3) Identification of pipeline material.

4) Identification of pipe specification.

5) Test fluid.

6) Test pressure.

7) Remarks: Leaks identified (type and location), types of repairs, or corrections made.

8) Certification by Contractor that the leakage rate measured conformed to the specifications.

9) Signature of Owner's representative witnessing pipe test.

b. Submit five (5) copies of the test records to the Engineer's representative upon completion of the testing.

PART 2 - PRODUCTS

2.01 GENERAL

A. Testing fluid shall be clean water for all piping except air service and shall be of such quality to prevent corrosion of materials in piping system for all hydrostatic tests. Air piping shall be tested using compressed air.

2.02 MATERIALS AND EQUIPMENT

A. Provide pressure gauges, necessary bracing and restraint, test plugs, pipes, bulkheads, pumps, and meters to perform the hydrostatic and pneumatic testing.

PART 3 - EXECUTION

3.01 PREPARATION

A. Pipes shall be in place and anchored before commencing pressure testing.

B. Conduct hydrostatic and pneumatic tests on exposed and aboveground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.

C. Before conducting hydrostatic tests, flush pipes with water to remove dirt and debris. For pneumatic tests, blow air through the pipes.

D. Test new pipelines which are to be connected to existing pipelines by isolating the new line from the existing line by means of pipe caps, special flanges, or blind flanges. After the new line has been successfully tested, remove caps or flanges and connect to the existing piping.

E. Conduct hydrostatic tests on buried pipe after the trench has been completely backfilled. The pipe may be partially backfilled and the joints left exposed for inspection for an initial leakage test. Perform the final test, however, after completely backfilling and compacting the trench.

F. Chlorine Piping: Test, dry, and clean in accordance with requirements of Chlorine Institute Pamphlet 6.

G. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to ENGINEER.

H. Items that do not require testing include: Piping between wet wells and wetwell isolation valves, equipment seal drains, tank overflows to atmospheric vented drains, and tank atmospheric vents.

I. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.

2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to ENGINEER.

J. Pressure Test:

1. All tests shall be made in the presence of and to the satisfaction of the Owner or Engineer and also, to the satisfaction of any local or state inspector having jurisdiction.

a. Provide not less than three (3) days notice to the Owner, Engineer, and the authority having jurisdiction when it is proposed to make the tests.

b. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Engineer shall be retested in part or in whole as directed by the Engineer.

c. The piping systems may be tested in sections as the work progresses, but no joint or portion of the system shall be left untested.

2. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.

3. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.

3.02 INSTALLATION (Not Applicable)

3.03 INSPECTION AND TESTING

A. Hydrostatic Testing of Aboveground or Exposed Piping: The maximum filling velocity shall be 0.25 feet per second, applied over full area of pipe. Open vents at high points of the piping system to purge air while the pipe is being filled. Subject the piping system to the test pressure indicated. Maintain the test pressure for a minimum of four (4) hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show no leakage or weeping. Correct leaks and retest until no leakage is obtained.

B. Hydrostatic Testing of Buried Piping:

1. Test after backfilling has been completed. Expel air from piping system during filling.

2. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after the concrete has been poured. When testing mortar-lined piping, fill the pipe to be tested with water and allow it to soak for at least 48 hours to absorb water before conducting the pressure test.

3. Apply and maintain the test pressure by means of a hydraulic force pump. Maintain the test pressure for a minimum duration of four (4) hours. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure during the four hours. This amount of water is the loss due to leakage in the piping system. The allowable leakage rate is defined by the formula.

$$L = \frac{SD(P)^{1/2}}{133{,}200}$$

in which:

L = allowable leakage (gallons/hour) during the test period.
S = length of pipe, in feet
D = diameter of the pipe (inches)
P = specified test pressure (psig)

4. Repair and retest any pipes showing leakage rates greater than that allowed.

C. Pneumatic Test for Pressure Piping:

1. Do not perform on PVC or CPVC pipe.

2. Fluid: Oil-free, dry air.

3. Procedure:

a. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections, examine for leakage.

b. Correct visible leaks and repeat preliminary test until visible leaks are corrected.

c. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.

d. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.

e. Correct visible leakage and retest as specified.

4. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

5. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

D. Hydrostatic Test for Gravity Piping:

1. Testing Equipment Accuracy: Plus or minus 1/2 gallon of water leakage under specified conditions.

2. Maximum Allowable Leakage: 0.16 gallon per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

3. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems

exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

4. Exfiltration Test:

   a. Hydrostatic Head:

      1) At least 6 feet above maximum estimated groundwater level in section being tested.

      2) No less than 6 feet above inside top of highest section of pipe in test section, including service connections.

5. Infiltration Test:

   a. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

6. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

7. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

E. Test Pressure:

1. All pipe shall be tested at pressures shown in the Piping Schedule in the Drawings, and at a minimum shall be 1.5 times the normal working pressure of the pipe.

3.04 START-UP AND INSTRUCTION (NOT APPLICABLE)

END OF SECTION

SECTION 15062

DUCTILE IRON PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: Provide and install ductile iron pipe of the sizes and in the locations shown on the Drawings conforming to the Pipe and Fitting Material Schedule shown on the Drawings and as specified herein.

B. Related Work Described Elsewhere:

1. Earthwork: Section 02200.

2. Material and Equipment: Section 01600.

3. High Performance Paints and Coatings: Section 09961.

4. Piping, Valve, and Equipment Identification System: Section 09905.

5. Pressure Testing of Piping: Section 15044.

C. General Design (Not Applicable)

1.02 QUALITY ASSURANCE

A. Standards (as applicable):

1. Cement mortar lining for water: ANSI 21.4.

2. Rubber gasket joints: ANSI 21.11.

3. Ductile iron pipe thickness: ANSI A-21.50.

4. Ductile iron pipe centrifugally cast in metal or sand lined molds: ANSI A-21.51.

5. Cast iron pipe flanges and fittings: ANSI B-16.1.

6. Threaded flanges: CIPRA standard.

7. Cast and ductile iron fittings: ANSI A-21.10.

8. Fusion-bonded polyethylene lining for water ANSI/ASTM D1248.

B. Qualifications: All ductile iron pipe and cast iron fittings shall be furnished by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the materials to be furnished. The pipe and fittings shall be designed, constructed, installed in accordance with the best practices and methods and shall comply with these Specifications as applicable.

C. Manufacturer: Pipe shall be as manufactured by the American Cast Iron Pipe Company, U.S. Pipe and Foundry Company, or equal.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Shop Drawings, including layouts within, and under buildings and structures shall be submitted to the Engineer for approval in accordance with General Conditions and Section 01340: Shop Drawings, Working Drawings and Samples and the following. Shop Drawings shall be prepared by the pipe manufacturer.

B. Additional Information:

1. Tabulated layout schedule including:

a. Order of installation and closures.

b. Pipe invert elevation and station at each change of grade and alignment.

c. Elements of curves and bends, both in horizontal and vertical alignment, including elements of the resultant true angular deflections in cases of combined curvature.

d. The limits of each reach of pipe thickness class and of restrained joints.

e. The limits of each reach of concrete encasement or encasement in casing.

f. Locations of closures for length adjustment and for construction convenience.

g. Locations of manholes and other points of access for placement of mortar lining a field joints and removal of test bulkheads.

h. Locations of valves and other mechanical equipment.

i. Methods and locations of supports.

2. Details of special elbows and fittings.

3. Calculations and test data demonstrating that the proposed retrained joint arrangement can transmit the required forces.

4. Copy of the manufacturer's quality control check of pipe material and production.

5. Provide an affidavit of compliance with AWWA standards referenced in this specification.

C. Operating Instructions (Not Applicable)

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All pipe shall be shipped and stored at the jobsite with wood lagging between pipes such that pipes do not make contact with one another.

B. Exercise extra care when handling epoxy, cement, and polyethylene lined pipe and fittings. Damage to the lining will render it unfit for use.

1.05 WARRANTY AND GUARANTEES

A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for 1 year after the time of completion and acceptance.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials that come into contact with potable water, the water being treated, or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555 FAC.

B. All joints in pressurized piping systems for the plant yard piping shall be restrained. The use of thrust blocks for achieving thrust restraint shall not be allowed.

2.02 MATERIALS AND EQUIPMENT

A. Pipe - Ductile Iron Pipe Conforming to ANSI A21.51 and AWWA C151:

1. Unless otherwise shown on the Drawings, the minimum thickness of ductile iron pipe shall be:

    a. For buried pipe:

        1) Pipe shall be the following minimum Thickness Class unless otherwise noted or specified:

            i. 3-inch diameter: Minimum wall thickness 0.25 inch

            ii. 4-inch diameter: Thickness Class 51.

            iii. 6-inch and larger diameter: Thickness Class 50.

    b. For pipe with flanges (all above ground or exposed piping): Thickness Class 53.

2. Pipe for use with sleeve type couplings or mechanical parts shall have plain ends (without bells or beads) cast or machined at right angles to the axis.

3. Pipe for use with split type couplings shall have ends with cast or machined shoulders or grooves that meet the requirements of the coupling manufacturer.

4. Pipe shall be supplied in lengths not in excess of 20 feet having rubber-ring type push-on joints, standard mechanical joints or restrained joints where required for underground piping and flanged joint piping, for all above ground piping as shown on the Drawings.

5. Coatings and Linings:

    a. Wastewater Service Interior Lining: All ductile iron pipe, fittings, and specials for force mains shall be lined with Protecto 401 Ceramic Epoxy Pipe Coating with a minimum dry film thickness of 40 mils applied by the pipe manufacturer. Storage, surface preparation, application, and safety precautions shall strictly follow manufacturer's instructions.

    b. Potable and Reuse Service Lining: All ductile iron pipe, fittings, and specials for water and reuse mains shall have an interior protective lining of cement-mortar with a seal coat of asphaltic material in accordance with ANSI/AWWA A21.4/C104.

    c. Exterior Coatings for Buried Pipe (wastewater, potable, and reuse service): Ductile iron pipe, fittings, and specials to be installed underground shall be coated on the exterior at the factory with an asphaltic coating approximately 1 mil thick as specified in AWWA C151.

6. Color Identification:

a. Ductile iron pipe used for potable water service shall have blue colored stripes added to pipe exterior to identify pipe service as specified in the Piping Schedule and in accordance with F.A.C 62-555.320(21)(b)(3).

B. Fittings: All ductile iron pipe fittings shall be ductile iron with a minimum pressure rating as follows:

1. Fittings shall be either mechanical joint or push-on restrained joint as indicated on the Drawings and shall have a minimum working pressure of 250 psi. Fittings shall be ductile iron and shall conform to ANSI/AWWA C110/A21.10, ANSI/AWWA C111/A21.11 and ANSI/AWWA C153/A21.53, latest revisions for mechanical joint pipe. Fittings shall be coated and lined in the manner specified above for ductile iron pipe. The rubber gaskets for mechanical and push-on joints shall be as described below. All fittings shall be restrained.

C. Joints (as shown on the Drawings and as specified):

1. General: Joints in "runs" of aboveground piping or piping located in vaults and structures shall be flanged. Joints in "runs" of buried piping shall be of the push-on or mechanical joint type per AWWA C-111 except where flanged joints are required to connect to valves, meters, and other equipment. All joints shall be restrained.

2. Flanges:

a. Flanges shall be Class 125 per ANSI B-16.1 unless otherwise specifically noted.

b. Gaskets: Fullface, 1/8 inch thick, cloth-inserted rubber:

1) Potable Water: Gaskets to be furnished in EPDM rubber suitable for potable water service, suitable for use with chloramines, and Certified to NSF Standard 61.

2) Air Service: Gaskets to be furnished in EPDM rubber suitable for high temperature service.

3) All Other: gaskets to be furnished in Buna-N rubber suitable for sewage and water service.

c. Bolts and Nuts for Flanges:

1) Bolts and nuts for flanges located in enclosed vaults and within structures, basins, or wetwells, buried and submerged and shall be Type 316 stainless steel conforming to ASTM A-193, Grade

B8M for bolts, and ASTM A-194, Grade 8M for nuts. Bolts and nuts located outdoors above ground shall be hot dipped galvanized steel, hex heavy.

2) Provide washers for each nut. Washers shall be of the same material as the nuts.

d. Provide specially drilled flanges when required for connection to existing piping or special equipment.

e. Flanges shall be long-hub type screwed tightly on pipe by machine at the foundry prior to facing and drilling. Flange faces shall be coated with a rust inhibitor immediately after facing and drilling. Field assembled screwed on flanges are prohibited.

3. Mechanical Joints:

a. Jointing materials for mechanical joints shall be provided by the pipe and fitting manufacturer. Materials assembly and bolting shall be in strict accordance with ANSI/AWWA C111/A21.11 and ANSI/AWWA C153/A21.53, latest revisions. Tee head bolts and nuts for mechanical joints shall be manufactured of high strength, low alloy steel in accordance with ANSI/AWWA C111/A21.11. The plain ends of push-on pipe shall be factory, machined to a true circle and chamfered to facilitate fitting the gasket.

b. Each joint shall be complete with rubber gasket, cast iron gland and all required bolts and nuts.

c. Gaskets:

1) Potable Water: Gaskets to be furnished in EPDM rubber suitable for potable water service, suitable for exposure to chloramines, and NSF 61 certified.

2) All Other: Gaskets to be furnished in Buna-N rubber suitable for sewage and water service.

D. Restrained Joints: Restrained joints on pipe and fittings shall be provided for all buried piping systems as indicated on the Drawings to restrain system thrust. Pipe joints and fittings shall be restrained as specified below. It is intended that all buried joints be restrained.

1. Manufactured Restrained Joints: Manufactured restrained joints shall be Flex-Ring, Lok-Ring or Lok-Fast manufactured by the American Cast Iron Pipe Company, Lok-Tyte or Tr-Flex Type manufactured by the United States Pipe Company or an equal approved by the Engineer. Joints shall be manufacturer's

standard specifically modified push-on type joints with joint restraint provided by ductile iron retainer rings joined together by corrosion resistant, high strength steel tee head bolts and nuts or with joint restraint provided by a welded-on retainer ring and a split flexible ring assembled behind the retainer ring.

2. Restrained joint pipe and fittings shall be ductile iron only and shall comply with applicable portions of this specification. Manufactured restrained joints shall be capable of deflection during assembly. Deflection shall not exceed 80 percent of the manufacturer's recommendations.

3. Tee head bolts and nuts for restrained joints shall be manufactured of CORTEN, high strength, low alloy, corrosion resistant steel as manufactured by NSS Industries, Plymouth, Michigan, or an equal approved by the Engineer.

E. Alternate Restrained Joints: When prior approval is obtained from the Engineer, ductile iron pipe and fittings with mechanical joints may be restrained using a follower gland, which includes a restraining mechanism. When actuated during installation, the restraining device shall impart multiple wedging action against the pipe wall, which increases resistance as internal pressure in the pipeline increases.

1. The joint shall maintain flexibility after installation. Glands shall be manufactured of ductile iron conforming to ASTM A536 and restraining devices shall be of heat treated ductile iron with a minimum hardness of 370 BHN. The gland shall have standard dimension and bolting patterns for mechanical joints conforming to ANSI/AWWA C111 and C153, latest revisions.

2. Tee head bolts and nuts shall be manufactured of corrosion resistant, high strength, low alloy CORTEN steel in accordance with ASTM A242.

3. The restraining wedges shall have twist-off nuts to insure proper torquing. The mechanical joint restraint device shall have a minimum working pressure rating of 250 psi with a minimum safety factor of 2 to 1 and shall be MEGALUG^{R} as manufactured by EBBA Iron, Inc. No other retainer gland type device will be acceptable. After installation prior to backfilling, all parts of the joint restraint system shall be coated with coal tar epoxy equal to Kop-Coat Bitumastic No. 300-M."

2.03 ACCESSORIES

A. Outlets:

1. For outlets larger than 2 inches, provide a tee with a flanged outlet.

2. Provide outlets 2 inches and smaller by tapping and attaching a service clamp.

PART 3 - EXECUTION

3.01 PREPARATION (NOT APPLICABLE)

3.02 INSTALLATION

A. Assembling joints:

1. Push-on joints:

a. Insert the gasket into the groove of the ball.

b. Uniformly apply a thin film of special lubricant over the inner surface of the gasket that will contact the spigot end of the pipe.

c. Insert the chamfered end of the plain pipe into the gasket and push until it seats against the bottom of the socket.

2. Bolted joints:

a. Remove rust preventative coatings from machined surfaces prior to assembly.

b. Thoroughly clean and carefully smooth all burrs and other defects from pipe ends, sockets, sleeves, housings and gaskets.

3. Grooved end joints:

a. Install grooved end pipe and fittings in accordance with the coupling manufacturer's recommendations and the following.

b. Clean loose scale, rust, oil, grease, and dirt from the pipe or fitting groove before installing coupling. Apply the coupling manufacturer's gasket lubricant to the gasket exterior, including lips, pipe ends, and housing interiors.

c. Fasten coupling alternately and evenly until coupling halves are seated. Use torques as recommended by the coupling manufacturer.

4. Flanged joints:

a. Bolt holes of flanges shall straddle the horizontal and vertical centerlines of the pipe. Clean flanges by wire brushing before installing flanged fittings. Clean flange bolts and nuts by wire brushing, lubricate bolts with oil and graphite.

b. Insert the nuts and bolts (or studs) finger tighten, and progressively tighten diametrically opposite bolts uniformly around the flange to the proper tension.

c. Execute care when tightening joints to prevent undue strain upon valves, pumps and other equipment.

d. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reset or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

5. Mechanical joints:

a. Thoroughly clean, with a wire brush, surfaces that will be in contact with the gaskets.

b. Lubricate the gasket, bell and spigot by washing with soapy water.

c. Slip the gland and gasket, in that order, over the spigot and insert the spigot into the bell until properly sealed.

d. Evenly seat the gasket in the bell at all points, center the spigot, and firmly press the gland against the gasket.

e. Insert the bolts, install the nuts finger tight, and progressively tighten diametrically opposite nuts uniformly around the joints to the proper tension with a torque wrench.

B. Fabrication:

1. Tapped connections:

a. Make all tapped connections as shown on the Drawings or as directed by the Engineer.

b. Make all connections watertight and of adequate strength to prevent pullout.

c. Drill and tap normal to the longitudinal axis of the pipe.

2. Cutting:

a. Perform all cutting with machines having rolling wheel cutters or knives designed to cut ductile iron. The use of a hammer and chisel to cut pipe is prohibited.

b. After cutting, examine all cut ends for possible cracks.

c. Carefully chamfer all cut ends to be used with push-on joints to prevent damage to gaskets when pipe is installed.

C. Installing Buried Piping:

1. Inspect each pipe and fitting before lowering the buried pipe or fitting into the trench. Inspect the interior and exterior protective coatings. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.

2. Handle pipe in a manner to avoid any damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

3. When installing piping in trenches, do not deviate more than 1-inch from line or 1/4 inch from grade. Measure for grade at the pipe invert.

4. Grade the bottom of the trench by hand to the line and grade to which the pipe is to be laid, with allowance for pipe thickness. Remove hard spots that would prevent a uniform thickness of bedding. Before laying each section of the pipe, check the grade with a straightedge and correct any irregularities found. The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between bell holes, except that the grade may be disturbed for the removal of lifting tackle.

5. At the location of each joint, dig bell (joint) holes of dimensions in the bottom of the trench and at the sides to permit visual inspection of the entire project.

6. Keep the trench in a dewatered condition during pipelaying in accordance with Section 02200: Earthwork.

7. When the pipelaying is not in progress, close the open ends of pipe. Do not permit trench water, animals, or foreign material to enter the pipe.

D. Pipe deflection:

1. Push-on and mechanical joints:

a. The maximum permissible deflection of alignment at joints shall not exceed 75% of the manufacturer's recommended deflection.

E. Hydrostatic Testing: Test in accordance with Section 15044: Pressure Testing of Piping. Test pressures are shown in the Piping Pressure Test Schedule, Table 15044-A of Section 15044.

3.03 INSPECTION AND TESTING

A. All pipe shall be inspected and tested at the foundry.

B. The Owner shall have the right to have any or all piping, fittings or special castings inspected and tested by an independent testing agency at the foundry or elsewhere. Such inspection and testing will be at the Owner's expense.

C. Mark as rejected and immediately remove from the job site, all pipe lengths showing a crack, damaged lining, or receiving a severe blow that may cause an incipient fracture, even though no such fractures can be seen.

D. Removal of cracked portions:

1. Any pipe showing a distinct crack, but no incipient fracture beyond the limits of the visible crack, may be cut off and the sound portion installed. Cut the pipe at least 12 inches from the visible limits of the crack. Cutting of pipe shall be done by skilled workmen, and in such a manner as to not damage the pipe. Every cut shall be square and smooth, with no damage to the pipe lining. Cut surfaces, shall be recoated as specified for the pipe.

2. Cutting and installing cracked pipe shall only be performed when approved by the Engineer, and shall be at the expense of the Contractor.

E. Carefully inspect and hammer test all pipe and fittings prior to installation.

3.04 DISINFECTION

A. All ductile iron piped used for potable water service is to be disinfected in accordance with Section 15041.

END OF SECTION

SECTION 15064

POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment and incidentals required, and install and test in the locations as shown on the Drawings, the polyvinyl chloride piping, fittings and appurtenances as specified herein.

B. Related Work Described Elsewhere:

1. Valves and appurtenances are included in Section 15100.

2. Pipe hangers and supports are included in Section 15126.

3. Couplings and connectors are included in Section 15129.

4. Schedule 80 PVC pipe is included in Section 15070.

C General Design: PVC Piping shall be installed in the locations as shown on the Drawings.

1.02 QUALITY ASSURANCE

A. All plastic pipe, fittings and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Shop drawings shall be submitted to the Engineer for approval in accordance with the General Conditions and Section 01340 and shall include dimensioning and the technical specification for all piping to be furnished.

B. Additional Information:

1. Submit to the Engineer, for approval, samples of all materials specified herein, along with the manufacturer's Certificates of Inspection, descriptive literature, illustrations, specifications, installation instructions and related information.

C. Operating Instructions (Not Applicable)

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. PVC pipe shall be delivered to the site in unbroken bundles packaged in such manner as to provide protection against damage. When possible pipe should be stored at the job site in the unit packages until ready for use. Packaged units shall be handled using a fork lift or a spreader bar with fabric straps. Packaged units shall not be stacked at the job site higher than two units high.

B. When it is necessary to store PVC pipe for more than 30 days, exposure to direct sunlight shall be prevented by covering the pipe with an opaque material. Adequate air circulation above and around the pipe shall be provided as required to prevent excessive heat accumulation. PVC pipe shall not be stored close to heat sources or hot objects such as heaters, fires, boilers or engine exhaust. Pipe gaskets shall be protected from excessive exposure to heat, direct sunlight, ozone, oil and grease. The interior and all sealing surfaces of pipe, fittings and other appurtenances shall be kept clean and free of dirt and foreign matter.

C. Care shall be taken in handling and laying pipe and fittings to avoid severe impact blows, crushing, abrasion damage, gouging or cutting. Pipe shall be lowered, not dropped, from trucks or into trenches. All cracked, damaged or defective pipe and fittings, or any length of pipe having a gouge, scratch or other permanent indentation of more than 10 percent of the wall thickness in depth, shall be rejected and removed at once from the work and replaced with new acceptable pipe at no additional cost to the Owner.

1.05 WARRANTY AND GUARANTEES

A. The manufacturer's written warranty shall be submitted, as specified in Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for 1 year after the time of completion and acceptance.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555.320(3) Florida Administrative Code.

2.02 MATERIALS AND EQUIPMENT

A. Buried PVC Pressure Piping 4” and Larger:

1. Polyvinyl chloride pipe for all services in nominal diameters of 4 to 12 inches in size shall conform to the requirements of AWWA C900 with a dimension ratio of DR 18, pressure rating 235 psi, and gasketed integral bell ends. Pipe shall be designed for maximum working pressure of not less than 235 psi and with not less than a 2.5 to 1 sustained hydrostatic pressure safety factor.

2. Polyvinyl chloride pipe for all services in nominal diameters of 14 to 30 inches in size shall conform to the requirements of AWWA C900 with a dimension ratio of DR 18, pressure rating 235 psi, and gasketed integral bell ends. Pipe shall be designed for maximum working pressure of not less than 235 psi and with not less than a 2 to 1 sustained hydrostatic pressure safety factor.

3. Color identification by use of pigmentation of the PVC and/or the use of stripes on the pipe to identify pipe service as listed in the Piping Schedule in the Drawings shall be required. PVC pipe and fittings shall be pigmented where specified in the Piping Schedule and be pigmented blue for potable water, purple for reclaimed water, and green for wastewater service. Process piping shall have colored stripes added to pipe exterior to identify pipe service where specified in the Piping Schedule. Tracing wire of the same coloration as the stripe if stripes are used, otherwise the same color as the pipe, shall be placed parallel and above, and shall be 10 AWG or engineer approved equal. Marking tape of the same coloration as the locating wire shall be approved by the Engineer and placed 18 inches above the crown of pipe.

B. Joints:

1. Bell and Spigot: Pipe joints shall be made with integral bell and spigot pipe ends. The bell shall consist of an integral thickened wall section designed to be at least as strong as the pipe wall. The bell shall be supplied with a factory glued rubber ring gasket which conforms to the manufacturer's standard dimensions and tolerances. The gasket shall meet the requirements of ASTM F 477 "Elastomeric Seals (Gaskets) for Joining Plastic Pipe". PVC joints shall be "Ring-Tite" as manufactured by Johns-Manville or an equal approved by the Engineer.

2. Restrained Joints: Where indicated on drawings, to prevent pipe joints and fittings from separating under pressure, pipe joints and fittings shall be restrained as follows:

   a. PVC pipe bell and spigot joints shall be restrained with the Uni-Flange Corp. Series 1350 Restrainer, EBAA Iron Inc. Restraint Harness Series 1900, 2800, 1600, and 2500, or an equal approved by the Engineer. The restraining device and Tee head bolts shall be manufactured of high strength ductile iron meeting ASTM A 536, Grade 65-45-12. Clamping bolts and nuts shall be manufactured of corrosion resistant high

strength, low alloy COR-TEN steel meeting the requirements of ASTM A242.

b. Cast iron mechanical joint connections used with PVC pipe shall be restrained with the Uni-Flange Corp. Series 1300 Restrainer, EBAA Iron Inc. Mechanical Joint Restraint Series 2000PV or 19MJ00, or an equal approved by the Engineer. The restraining device and Tee head bolts shall be manufactured of high strength ductile iron meeting ASTM A536, Grade 65-45-12. Clamping bolts and nuts shall be manufactured of corrosion resistant high strength, low alloy COR-TEN steel meeting the requirements of ASTM A242.

C. Fittings:

1. All fittings for use with PVC pipe for potable water service four (4) inches and larger in size shall be ductile iron with a minimum working pressure of 250 psi and shall conform to ANSI/AWWA A21.10/C110, latest revision. Fittings shall have mechanical joint bell ends manufactured in accordance with ANSI/AWWA A21.11/C111, latest revision. Jointing materials for mechanical joints shall be provided by the fitting manufacturer. Materials, assembly and bolting shall be in accordance with ANSI/AWWA A21.11/C111, latest revision. Tee head nuts and bolts for mechanical joints shall be manufactured of corrosion resistant high strength, low alloy COR-TEN steel meeting the requirements of ASTM A242.

2. Fittings for use in raw water, permeate, and concentrate service as noted on the yard piping schedule, shall be constructed of PVC with a minimum dimension ratio of DR18 and meet the same pressure rating as the pipe. PVC pipe fittings shall be restrained with uniflange corporation stops 1360 restraint service or an equal approved by the Engineer. The restraining device and Tee head bolts shall be manufactured of high strength ductile iron meeting ASTM A536, Grade 65-45-12. Clamping bolts and nuts shall be manufactured of corrosion resistant high strength, low alloy COR-TEN steel meeting the requirements of ASTM A242.

3. All cast iron and ductile iron fittings for use with PVC pipe in potable water service shall be asphalt coated and cement mortar lined as specified for ductile iron pipe in Section 15062 intended for similar service. All ductile iron fittings for use with PVC pipe in wastewater force main service shall be asphalt exterior coated and interior lined with 40 mils of Protecto 401 by the fitting manufacturer.

D. Small Gravity Drainage Piping: PVC pipe smaller than 4 inches nominal diameter used for gravity drainage piping shall be schedule 40 pipe in accordance with ASTM D1785. Schedule 40 PVC pipe shall have solvent welded joints as specified for schedule 80 PVC pipe.

E. Gravity Sewer Piping

1. Polyvinyl Chloride (PVC) gravity sewer pipe and fittings 4-inches through 15-inches in size shall conform to ASTM D-3034, "Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings," SDR 26. Uniform minimum "pipe stiffness" at five (5) percent deflection shall be 46 psi.

2. The supplier shall be responsible for the performance of all inspection and testing requirements specified in ASTM D-3034. Complete records of inspections, examinations and tests shall be kept and submitted to the Engineer. The Owner reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that materials and services conform to the prescribed requirements.

3. Pipe shall be joined with integral bell and spigot type rubber gasketed joints in accordance with ASTM D-3212. Each integral bell joint shall consist of a formed bell with a rubber gasket. Gaskets shall conform to ASTM F-477. Joints shall permit contraction, expansion and settlement, and yet maintain a watertight connection.

4. Pipe shall be furnished in standard laying lengths not exceeding twenty (20) feet. Minimum standard length of pipe shall be thirteen (13) feet.

5. All fittings and accessories shall be furnished by the pipe supplier and shall have bell and/or spigot configurations compatible with the pipe.

6. All gaskets shall be factory installed.

7. All PVC pipe for gravity sewers shall be pigmented green in color.

F. Schedule 80 PVC Piping: Buried pressurized PVC piping smaller than 4” minimal diameter where indicated in the Piping Schedule and the Drawings shall be schedule 80 PVC in accordance with Section 15070. PVC pipe and fittings shall be pigmented where specified in the Piping Schedule and be pigmented blue for potable water, purple for reclaimed water, and green for wastewater service. Tracing wire of the same coloration as the stripe if stripes are used, otherwise the same color as the pipe, shall be placed parallel and above, and shall be 10 AWG or engineer approved equal. Marking tape of the same coloration as the locating wire shall be approved by the Engineer and placed 18 inches above the crown of pipe.

2.03 SPARE PARTS

A. Special tools, solvents, lubricants, and caulking compounds required for normal installation shall be furnished with the pipe.

2.04 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifies as required for project.

PART 3 - EXECUTION

3.01 PREPARATION (NOT APPLICABLE)

3.02 INSTALLATION

A. Excavating, trenching, and backfilling shall be performed in accordance with the requirements of Section 02200, Earthwork. Bedding for PVC pipe shall be Class B using granular pipe bedding material as specified in ASCE Manual No. 37 and as shown on the standard details.

B. All PVC pipe and fittings and cast or ductile iron fittings shall be laid in accordance with the pipe manufacturers published installation guide, the AWWA Manual of Practice No. M23 "PVC Pipe - Design and Installation" and the Uni-Bell Plastic Pipe Association installation recommendations.

C. In preparation of pipe installation, placement (stringing) of pipe should be as close to the trench as practical on the opposite side of the trench from the excavated material. The bell ends of the pipe should point in the direction of the work progress.

D. Pipe and fittings shall be laid accurately to the lines and grades indicated on drawings or required. Care shall be taken to insure a good alignment both horizontally and vertically and to give the pipe a firm bearing along its entire length. Any pipe which has its grade or joint disturbed after laying shall be taken up and re-laid.

E. All pipe and fittings shall be cleared of sand, dirt and debris before laying. All precautions shall be taken to prevent sand, dirt or other foreign material from entering the pipe during installation. If necessary, a heavy, tightly woven canvas bag of suitable size shall be placed over each end of the pipe before lowering into the trench and left there until the connection is made to the adjacent pipe. Any sand, dirt or other foreign material that enters the pipe shall be removed from the pipe immediately. Interior of all pipe and fittings shall be kept clean after installation until accepted in the complete work.

F. Any time that pipe installation is not in progress, the open ends of pipe shall be closed by a watertight plug or other method approved by the Engineer. Plugs shall remain in pipe ends until all water is removed from the trench. No pipe shall be installed when trench conditions are unsuitable for such work, including standing water, excess mud, rain or snow.

G. Pipe Joint Assembly:

1. The PVC bell and spigot joint shall be assembled in accordance with the pipe manufacturer's installation instructions. Clean the interior of the bell, the gasket, and the spigot of the pipe to be jointed with a rag to remove any dirt or foreign material before assembling. Inspect the gasket, pipe spigot bevel, gasket groove and sealing surfaces for damage or deformation.

2. Lubricate the spigot end of the pipe with a lubricant supplied or specified by the pipe manufacturer for use with gasketed PVC pipe in potable water system. The lubricant should be applied as specified by the pipe manufacturer. After the spigot end is lubricated it must be kept clean and free of dirt and sand. If dirt and sand adhere to the lubricated end, the spigot must be wiped clean and relubricated.

3. Insert the spigot into the bell so that it contacts the gasket uniformly. Align the pipe sections and push the spigot end into the bell until the manufacturer's reference mark on the spigot is flush with the end of the bell. The pipe should be pushed into the bell using a bar and block. The joint shall not be assembled by "stabbing" or swinging the pipe into the bell, nor shall construction machinery be used to push the pipe into the bell.

4. If undue resistance to insertion of the spigot end is encountered or if the reference mark does not reach the flush position, disassemble the joint and check the position of the gasket. If the gasket is twisted or pushed out of its seat, inspect the components, repair or replace damaged items, clean the components and repeat the assembly steps. Be sure the pipe is in proper alignment during assembly. If the gasket was not out of position, check the distance between the spigot end and the reference mark and relocate the mark if it is out of position.

5. The weight of valves and cast iron fittings shall not be carried by PVC pipe. The valve or fittings shall be supported by a concrete cradle as shown on the standard details. Concrete for the cradle shall be poured against undisturbed soil.

H. Field Cutting Pipe:

1. Field cutting of pipe shall be done in a neat workmanlike manner without creating damage to the pipe. The pipe shall be cut square with a fine toothed hand or power saw or other cutter or knife designed for the use with plastic

pipe. Prior to cutting, the pipe shall be marked around its entire circumference or a square-in vise shall be used to ensure the pipe end is cut square. Remove burrs by smoothing edges with a knife, file or sandpaper. Bevel the cut end of the pipe using a pipe beveling tool, wood rasp, or portable sander to prevent damage to the gasket during joint assembly.

A factory finished beveled end should be used as a guide to ensure proper beveling angle and correct depth of bevel. Round off any sharp edges on the leading edge of the bevel with a knife or file.

I. Field Painting:

1. Pipe normally exposed to view shall be painted and marked as specified in the High Performance Paints and Coatings Section 09961. The engineer will assist in identifying pipe contents, direction of flow and all else required for proper marking of pipe.

3.03 INSPECTION AND TESTING

A. All PVC mains, and system piping shall be hydrostatically pressure tested and flushed in accordance with Section 15044.

3.04 START-UP AND INSTRUCTION (NOT APPLICABLE)

3.05 DISINFECTION

A. All PVC piping used for potable water service is to be disinfected in accordance with Section 15041.

END OF SECTION

SECTION 15066

TYPE 316 STAINLESS STEEL PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: Furnish all labor, materials, equipment and incidentals required to supply, store, install, clean, and test all type 316 stainless steel pipe and fittings where shown on the Drawings and as specified herein.

B. Related Work Described Elsewhere:

1. Reverse Osmosis Treatment Units: Section 11250.

2. Pressure Testing of Piping: Section 15044.

3. Valves and Appurtenances: Section 15100.

4. Pipe Hangers and Supports for Process Piping: Section 15126.

5. Couplings and Connectors: Section 15129.

C. General Design (Not Applicable)

1.02 QUALITY ASSURANCE

A. All stainless steel pipe, fittings and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The manufacturer shall be qualified to perform work in accordance with the ASME Code Standards and shall hold one or all of the following ASME accredited code stamps (“U”, “S”, “PP”). The stainless steel pipe, fittings and appurtenances shall be fabricated and installed in accordance with the best practices and methods and shall comply with these Specifications.

B. Stainless steel pipe and fittings shall be supplied by Aerex Industries, Inc., Ft. Pierce, Florida, Felker Brothers Corporation, Marshfield, Wisconsin, or Douglas Brothers, Portland, Maine. Stainless steel fabricators shall provide a list of municipal references to include at least three (3) reverse osmosis water treatment facilities with an individual skid capacity of 2.0 MGD or greater and a total plant capacity of 4.0 MGD or greater. Qualifying reference projects shall have a final shipping date within the last five (5) years.

C. Welder Qualifications: All welding shall be done by welders, welding operators, and tackers fully qualified in accordance with ASME Sect. IX and have adequate experience in the methods and materials to be used. All field welding shall be per the pipe

manufacturer's written instructions and procedures unless otherwise approved by the Engineer.

1.03 SUBMITTALS

A. Materials and Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with Section 01340 and the following supplemental requirements as applicable.

1. Certified dimensional drawings of all valves, fittings, and appurtenances.

2. Joint and pipe/fitting wall construction details which indicate the type and thickness of pipe, manufacturing tolerances, and all other pertinent information required for the manufacture of the product.

3. Fittings and specials details such as elbows, wyes, tees, outlets, connections, test bulkheads, and nozzles or other specials where shown on the drawings which indicate amount and position of all reinforcement. All fittings and specials shall be properly reinforced utilizing wall thickness to withstand the internal pressure, both circumferential and longitudinal. Calculations shall be submitted proving complete compliance with ASME B31.3 for all extruded reducing outlet tees.

4. Process piping layout and marking diagrams which indicate the specific number of each pipe and fitting and the location of each pipe and the direction of each fitting in the completed line.

5. Full and complete information regarding location, type, size, and extent of all welds shall be shown on the shop drawings. The shop drawings shall distinguish between shop and field welds. Shop drawings shall indicate by welding symbols or sketches the details of the welded joints and include the applicable WPS and PQR. Submit Weld Procedure Specifications (WPS) along with applicable supporting Procedure Qualification Records (PQR) and Welder Qualification Records.

6. Complete piping design pressure calculations shall be submitted to the Engineer. The calculations shall be in conformance with the ASME B31.3 standards and the requirements specified herein.

B. Additional Information:

1. Submit materials list showing material of pipe and fittings with ASTM reference and grade.

C. Operating Instructions (Not Applicable)

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The equipment provided under this section shall be shipped, handled and stored in accordance with the manufacturer's written instructions, and in accordance with Section 01600 - Material and Equipment.

1.05 WARRANTY AND GUARANTEES

A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for one (1) year, commencing at the time of final acceptance by the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water.

B. Stainless steel piping shall be pickled and passivated following all final fabrication work and properly protected from damage or contamination during shipping or storage.

C. Stainless steel piping on the RO skids shall be furnished by the membrane OEM in accordance with Section 11250.

2.02 MATERIALS AND EQUIPMENT

A. Materials:

1. Type 316 Stainless Steel Pipe and Fittings (0-300 psi working pressure as listed on the Piping Schedule at 120°F maximum).

a. All stainless steel pipe and fittings shall be fabricated from Type 316L extra low carbon grade austenitic stainless steel sheet and plate.

i. Pipe shall conform to ASTM A-312 and be die-formed or rolled true to dimension and round within the applicable ANSI Standard. The two edges of sheet shall be brought to line so as not to leave a shoulder on the inside of the pipe.

ii. Pipes shall be straight within the applicable ANSI Standard for ASTM-A-312 welded pipe.

iii. Ends of pipe and fittings shall be true and perpendicular to the longitudinal axis with the edges deburred.

iv. Fittings shall conform to ASTM A-403-WP in accordance with B16.9.

v. Longitudinal seams on pipe and fittings shall be welded by the GTAW, PAW, FCAW, SAW, or the SMAW methods. Filler metal, if utilized, shall be of same composition or superior to the pipe and fittings material.

vi. Weld deposit at the seams shall have a slight crown on both sides of the weld and no cracks or crevices shall be allowed. Excessive weld deposits, slag, weld spatter and projections into interior of pipe shall be removed by grinding. The interior welds shall be smooth, even and shall not have an internal bead higher than 1/16 inch.

vii. All pieces shall be marked indicating wall thickness/schedule, grade of stainless steel, and ASTM Standard.

b. The stainless steel piping wall dimensions shall be at a minimum as listed in the Piping Schedule and in all cases shall be a minimum Schedule 10S. The required Schedule Gauge or Plate and Wall Thickness are to be indicated in the manufacturer's shop drawings and verified by ASME B31.3 calculations. Piping wall thickness shall at a minimum be designed for the hydrostatic test pressure as required in the Piping Schedule. Calculations for wall thickness shall be based on the minimum wall thickness due to manufacturing tolerances, joint efficiencies, and a safety factors as permitted by ASME B31.3.

c. Fittings: Fittings shall be butt weld type per ASTM-A-403WP and manufactured in accordance with ANSI B16.9. All fittings shall be of the same pressure rating and grade material as the pipe. Elbows shall be long radius; i.e., centerline to end of elbow equals 1.5 times the nominal pipe size, unless otherwise approved by the Engineer. All elbows up to 24-inch diameter shall be smooth flow. All short radius, special radius, and reducing elbows and long radius elbows greater than 24-inch diameter shall be of mitered construction with at least (5) miter sections for 90 degree bends, (3) mitered sections for 45 and 60 degree bends, and (2) mitered sections for 30 degree and smaller bends. Reducers shall be straight tapered, cone type.

i. Fittings three inches and smaller shall be threaded conforming to ASTM-A-182 forged, Class 3000# and manufactured to ANSI B16.11.

ii. Fittings for buried or submerged pipe larger than three inches shall be butt-welded, conforming to ASTM-A-403WP, same pressure rating and material as the pipe and manufactured to ANSI B16.9.

iii. Fittings for above ground or exposed pipe larger than three inches shall be butt-welded except when flanged or coupled, as shown on the drawings, conforming to ASTM A 403 WP, same pressure rating and grade material as the pipe and manufactured to ANSI B16.9. Tees shall have no welds in the throat area and the crotch shall be reinforced with long radius design to eliminate sharp corners. Extruded branch outlets may be used in place of reducing outlet tees when properly designed and manufactured per ASME B31.3 to meet the applicable operating, design, and test pressures as specified herein.

iv. Drain & Instrumentation Branches:

(1) Outlets of size three inches and smaller in piping 4 inches and larger shall be of the Thredolet type, per AWWA Manual M11 (1964 edition), Figure 19.24. Outlets shall be 3,000 pound WOG stainless steel per ASTM A 182, or ASTM A 403. Threads shall comply with ANSI B2.01. Outlets shall be Bonny Forge Co. "Thredolet," Allied Piping Products Co. "Brachlet," or equal.

(2) For outlets three inches and smaller in piping smaller than four inches, use a threaded tee in accordance with c.i. above.

(3) For outlets larger than three inches, use a tee conforming to ASTM-A-403WP, in accordance with c.iii. above and with a flanged outlet or as shown on the Drawings.

v. Process Piping Branches

(1) Reducing outlets of size 8 inches to 1-1/4 inches for skid process piping headers shall be fabricated of 316L stainless steel, ASTM SA-312, to match the material and construction of the header pipe. Fabricated outlets shall be extruded with a single butt weld in accordance to ASME B31.3 to connect the outlet branch to the header pipe.

d. Joints:

i. Joints for pipes three inches and smaller shall be threaded or socket welded, same material as the pipe, 3,000 pound WOG, conforming to ANSI B16.11.

ii. Joints for buried or submerged pipe larger than three inches shall be butt-welded.

iii. Joints for aboveground or exposed pipe larger than three inches shall be butt-welded except where flanges or grooved end joints are shown on the Drawings.

e. Flanges:

i. Provide weld-neck flanges conforming to ANSI B16.5 for piping three inches and smaller to connect to flanged valves, fittings, or equipment. Provide slip-on flanges for piping larger than three inches. Provide blind flanges at dead end connections and where shown on the Drawings. Flanges shall be Class 150 per ANSI B16.5 unless a higher pressure rating is required. Flanges shall be Class 300 for the reverse osmosis feed water piping. Material for weld-neck, slip-on, and blind flanges shall conform to ASTM-A-182, Grade F316L. Flanges and blind flanges shall match the connecting flanges on the adjacent fitting, valve or piece of equipment.

ii. Determine the pressure class of flange and blind flanges based on the test pressure specified in the Piping Schedule in the Drawings.

iii. Where a raised face steel flange connects to a flat face flange, remove the raised face on the steel flange.

f. Field welding of stainless steel piping is not permitted within and around the administration and RO process building. Proposed field welded joints in all other areas of the project must be submitted to the Engineer for approval in advance of such work. All field welding shall be performed by welders certified in accordance to ASME Section IX. Welding processes utilized shall be as specified herein.

g. Pipe ends shall be prepared for either mechanical or flexible couplings where shown on the Drawings.

h. Pipe and fittings shall be cleaned acid pickled after manufacture in accordance with 3.01 of this specification.

i. Dead Ends of pipe runs shall have butt-welded ASME Code dished heads designed to meet the test pressures specified in Section 15044.

j. Mechanical couplings at equipment connections shall be in accordance with the requirements of Section 15000, "Mechanical - General Requirements" as modified by this Section. Gaskets shall be suitable for the service conditions. The pipe ends shall be roll grooved to the coupling manufacturer's specifications for piping size 6-inches and under. Where roll grooving is not sufficient for the specified pressure, the pipe shall have heavy wall machine grooved pipe nipples or machined ring collars fully welded to the pipe or fitting. Nipples shall be taper bored to the I.D. of the adjoining pipe to allow full weld penetration. Collars shall be welded on both sides to the piping. Nipples and collars shall be of the same alloy as the piping.

2. Stainless Steel Tubing and Fittings

a. Pipe and fittings to sample panels, 1-inch and smaller, shall incorporate seamless passivated 316 stainless steel tubing and shall maximize the use of non-threaded fittings where possible. Tubing systems shall be pressure rated for a minimum of 1,000 psi and shall conform to ASTM A276.

i. Approved fittings include Swagelok VCR or VCO series, Ham-Let Let-Lok series, or Engineer approved equal. Gaskets shall be made of stainless steel or Buna N. All pressure ratings shall comply with calculations in accordance with ASME Code for Pressure Piping B31.3, Process Piping, and ASME B31.1, Power Piping. For 316 SS fittings and gaskets, temperature rating shall be 1000^{o}F (537^{o}C).

ii. Pressure relief valves shall be constructed of 316 SS with screw type adjustment and shall have an operating range of 30-150 psi. Pressure relief valves shall be manufactured by Jesco or approved equal.

iii. Ball valves shall be two-way vented with quarter turn actuation, pressure rated for a minimum of 1,000 psi. Models include Swagelok 60 series, Hamlet 700 series, or approved equal.

iv. When threaded fittings are used, unions shall be provided within 2 feet on each threaded end unless there are other connections which permit easy removal of the fitting.

v. Pipe and fittings larger than 1-inch shall be threaded stainless steel piping and fittings as specified herein.

2.03 ACCESSORIES

A. Bolts and Nuts for Flanges:

1. Bolts and nuts for flanges shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M, for bolts and ASTM A 194, Grade 8M, for nuts. Both bolts and nuts shall be bright polished.

2. Provide washer for each nut. Washers shall be of the same material as the nuts.

B. Gaskets for Flanges:

1. Provide full-face gaskets for flat faced flanges. Provide ring gaskets for raised face flanges.

2. Air Service (High Temperature): Gaskets shall be composed of asbestos with rubber binder, 1/8-inch thick, Johns-Manville No. 60, John Crane Co. "Granite", or Engineer approved equal.

3. Water Service

a. Gaskets for water service shall be tested and certified by NSF 61.

b. High Pressure Service (150-450 psi at 120-Degrees F): Gaskets for high pressure service shall be Garlok Style 3505 (Gylon) high performance restructured PTFE material with glass microspheres.

c. Low Pressure Service (0-150 psi at 120-Degrees F): Gaskets for low pressure service shall be Garlok Style 3760-U synthetic fiber sheet with a proprietary rubber binder for raised face flanges and Garlok Style 98206 EPDM sheet gasket material with Sulfur Cure (85 durometer) for flat face flanges.

2.04 SPARE PARTS (NOT APPLICABLE)

2.05 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.

B. Piping subcontractor shall submit a list of welders who will work on this project along with a welder’s current certification (less than one year old) and two sample weld coupons. Only approved welders will be allowed to work on this project.

C. The weld should be made as rapidly as possible, with the least amount of generated heat.

D. At random, Contractor shall visually examine via x-ray approximately 10 percent of all welds. Engineer may require additional testing at the Contractor's expense if random visual inspection or X-rays reveal unsatisfactory weld joints.

E. All shop welds shall be visually inspected by the fabricator's quality control division. Each weld shall be marked with an inspection stamp, certifying that the weld is acceptable.

PART 3 - EXECUTION

3.01 PREPARATION

A. Descaling, Cleaning, and Passivation:

1. Following final fabrication, all stainless steel pipe spools and fittings shall be cleaned and descaled in accordance with the requirements of ASTM A380. Descaling shall include immersion in an appropriate pickling solution for the type and grade of material being treated. Caution shall be taken to avoid over-pickling. The type of acid used, acid concentration, solution temperature, and contact time shall be consistent with industry standards for such work. In addition to pickling, piping and fittings shall be scrubbed and washed until discoloration and possible iron, picked up from manufacturing process, is removed. Pickling and passivation of individual pipe lengths and fittings will not be considered equal to pickling and passivation of the finished product(s) following fabrication.

2. After chemical descaling, surfaces shall be thoroughly rinsed to remove residual chemicals. Surfaces shall not be permitted to dry between successive steps of the acid descaling and rinsing procedure. Following the final rinse, thorough air drying shall be performed.

B. Electropolishing (Where Required)

1. Electropolish stainless steel pipe inside and out in conformance with ASME B912. The electropolish process shall not remove more than 5 µm from the surface.

2. Following shop fabrication of pipe sections, straight spools, fittings and other components, prepare surface using preparatory and cleaning procedures defined in ASTM A 380. Wipe all items with appropriate solvent to remove any marks, sugar, markers, or crayon.

3. A post dip in room temperature 10 to 30% nitric acid solution is required to remove residuals from the electropolishing process and to provide a shine to the metal surface. Final rinsing with water shall follow the post dip procedure to remove residual acid or any other materials that may affect the appearance or performance of the passivated part.

4. Finished surfaces shall be free of imperfections such as pitting, etches, burn marks or stains, as in Electropolish Finish Standards (EFS) 3.

C. Handling and Storage

1. Extreme care shall be used to avoid the contact of any ferrous materials with the stainless steel piping. All saws, drills, files, wire brushes, etc. shall be used for stainless steel piping only. Pipe storage and fabrication racks shall be non-ferrous or stainless steel or rubber lined. Nylon slings or straps shall be used for handling stainless steel piping. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls. After installation, the Contractor shall wash and rinse all foreign matter from the piping surface. If rusting of embedded iron occurs, the Contractor shall pickle the affected surface with Oakite Deoxidizer SS or equal, scrub with stainless steel brushes and rinse clean.

2. The use of chains, hooks, or other equipment which might injure the pipe will not be permitted. All other pipe handling equipment and methods shall be acceptable to the Engineer.

3. All fabricated piping shall have openings plugged and flanges screened for storage and/or transport after fabrication.

4. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged, including any cosmetic damage to electropolished piping.

3.02 INSTALLATION

A. Stainless steel piping shall be installed true to alignment and rigidly supported.

B. After installation, completed pipelines shall be washed clean with steam or hot water to remove any foreign material picked up during transportation.

C. Field Welded Piping: Field welding is not permitted for RO process piping located within the process building. The Contractor shall use flange joints or couplings at assembly joints as approved by the Engineer. At other locations where permitted, field joint welding shall be in accordance with the ASME B31.3 standards. The strength of the weld shall develop the strength of the pipe. All field welds shall be descaled and passivated with pickling paste, scrubbed with stainless wire brushes and rinsed until clean.

D. Installation Threaded Piping: Ream, clean and remove burrs from threaded straddling the pipe's horizontal and vertical centerline. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.

E. Fabrication, Assembly and Erection of Welded Piping:

1. Beveled ends for butt-welding shall conform to ANSI B16.25. Remove slag by chipping or grinding. Surfaces shall be clean of paint, oil, rust, scale, slag, and other material detrimental to welding.

2. Fabrication shall comply with ANSI B31.3, Chapter V.

3. Use the GTAW process only for all stainless steel field welded butt joints in accordance with the specifications.

4. Welding preparation shall comply with ANSI B31.3, paragraph 327.3. Limitations on imperfections in welds shall conform to the requirements in ANSI B31.3, Tables 327.4.1A and 327.4.1a, and paragraph 327.4 for visual examination. Identify welds in accordance with ANSI B31.3, paragraph 327.4.

5. Clean each layer of deposited weld metal prior to depositing the next layer of weld metal, including the final pass, by a power-driven wire brush on the same material.

6. Welding electrodes shall comply with AWS A5.4. Bare wire shall comply with AWS AS.9.

7. Where field welds are permitted, the Contractor shall install the stainless steel piping system with minimal field welds in conformance with procedures detailed in the mechanical specifications. All installed stainless steel pipe shall be closed to the atmosphere after connections of pipe, valves or equipment with a nitrogen purge and bagged ends. Provide temporary enclosures as required to complete the piping installation in a clean environment. This area shall remain clean and dust free. If the area is not maintained adequately, the fabrication and welding work will not be accepted.

8. Mark each weld (field and manufacturing facility) with symbol identifying welder and date of weld.

F. Painting:

1. Stainless steel piping is not required to be painted.

2. Fitting flanges and other non-stainless steel appurtenances shall be final painted as specified in Section 09961: High Performance Paints and Coatings.

3.03 INSPECTION AND TESTING

A. All stainless steel pipe shall be pressure tested in accordance with Section 15044: Pressure Testing of Piping.

END OF SECTION

SECTION 15070

SCHEDULE 80 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment and incidentals required, and install and test in the locations as shown on the Drawings, the Schedule 80 polyvinyl chloride piping, fittings and appurtenances specified herein.

2. Schedule 80 PVC piping shall be used on all small diameter PVC piping systems (3 inches and smaller in diameter) which includes, but are not limited to, non-potable water, potable water, and chemical feeds.

3. Schedule 80 PVC shall be used for treatment process piping including the membrane cleaning system piping, RO permeate to waste piping, portions of the low pressure RO concentrate piping, equipment drains and in all other locations as shown on the Drawings.

4. All plastic pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the contractor.

B. Related Work Described Elsewhere:

1. Piping, Valve and Equipment Identification System: Section 09905.

2. High Performance Paints and Coatings: Section 09961.

3. Mechanical – General Requirements: Section 15000.

4. Pressure Testing of Piping: Section 15044.

5. Chemical Feed System Piping: Section 15090.

6. Valves and Appurtenances: Section 15100.

7. Pipe Hangers and Supports: Section 15126.

8. Couplings and Connectors: Section 15129.

C. General Design:

1. Schedule 80 PVC piping shall be installed in the locations as shown on the Drawings. All plastic pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the Contractor.

2. All small diameter pipe, 3-inch diameter and smaller, shall be made of polyvinyl chloride unless specifically noted otherwise on the Drawings or in other sections of the specifications.

1.02 QUALITY ASSURANCE

A. All plastic pipe, fittings and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications. The equipment shall be manufactured by Spears, IPEX, or an Engineer approved equal.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Shop drawings shall be submitted to the Engineer for approval in accordance with the General Conditions and Section 01340. All products within this specification shall be combined into a single submittal which shall include at least the following:

a. Dimensioning and the technical specification for all piping, fittings, and appurtenances to be furnished.

b. Letter of Certification from the National Sanitation Foundation International (NSF) stating compliance with Standard 14 and Standard 61.

c. Letter from the Manufacturer verifying chemical compatibility of all products to be used in chemical feed systems.

B. Additional Information:

1. Submit to the Engineer, for approval, samples of all materials specified herein, along with the manufacturer's Certificates of Inspection, descriptive literature, illustrations, specifications, installation instructions and related information.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. PVC pipe shall be delivered to the site in unbroken bundles packaged in such manner as to provide protection against damage. When possible pipe should be stored at the job site in the unit packages until ready for use. Packaged units shall be handled using a forklift or a spreader bar with fabric straps. Packaged units shall not be stacked at the job site higher than two units high.

B. When it is necessary to store PVC pipe for more than 30 days, exposure to direct sunlight shall be prevented by covering the pipe with an opaque material. Adequate air circulation above and around the pipe shall be provided as required to prevent excessive heat accumulation. PVC pipe shall not be stored close to heat sources or hot objects such as heaters, fires, boilers or engine exhaust. Pipe gaskets shall be protected from excessive exposure to heat, direct sunlight, ozone, oil and grease. The interior and all sealing surfaces of pipe, fittings and other appurtenances shall be kept clean and free of dirt and foreign matter.

C. Care shall be taken in handling and laying pipe and fittings to avoid severe impact blows, crushing, abrasion damage, gouging or cutting. Pipe shall be lowered, not dropped, from trucks or into trenches. All cracked, damaged or defective pipe and fittings, or any length of pipe having a gouge, scratch or other permanent indentation of more than 10 percent of the wall thickness in depth, shall be rejected and removed at once from the work and replaced with new acceptable pipe at no additional cost to the Owner.

1.05 WARRANTY AND GUARANTEES

A. Provide equipment warranty in accordance with Section 01740: Warranties and Bonds.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555.320(3) Florida Administrative Code.

2.02 MATERIALS AND EQUIPMENT

A. PVC Pipe:

1. Pipe shall be made of polyvinyl chloride, Schedule 80 pipe, conforming to ASTM D1785. Schedule 80 pipe shall have solvent welded joints.

Threaded connections are permissible when connecting to valves or other equipment where solvent weld connections are not an option. In no cases is connection of PVC female threads to metal male threads allowable.

B. Fittings:

1. Fittings for Schedule 80 pipe 4 inches and smaller in diameter shall be socket type, solvent welded in conformance with ASTM D 2467. When permitted, threaded joints shall be in conformance with ASTM D 2464. Solvent welded and threaded joints shall be watertight. Chlorine gas vacuum feed lines and chlorine solution lines shall have solvent welded fittings.

2. Fittings for Schedule 80 pipe greater than 4 inches in diameter shall be socket type, solvent welded in conformance with ASTM D 2467. Fittings shall be a 1-piece injection molded design. Use of low pressure fabricated PVC fittings will not be permitted.

C. Solvent Cement:

1. PVC solvent cement shall be in compliance with ASTM D 2564.

2. Solvent cement shall be specified by compatibility based on pipe service and size. Large diameter joints shall be solvent welded with slow setting solvent cement.

3. Manufacturer to provide certification with submittal.

4. All PVC chemical feed piping joints are to be solvent welded using CPVC solvent cement.

D. Flanges:

1. Slip-on flanges shall be provided to connect to flanged valves, fittings, or equipment. Flanges shall match the connecting flanges on the adjacent fitting, valve or piece of equipment and must meet the test pressure of the piping system as specified in Section 15044.

2. Flange hardware (bolts, nuts, and washers) for PVC flanges shall be Type 316 stainless steel in accordance with ASTM F593 and F594, respectively. Flange hardware for PVC flanges on Sulfuric Acid piping shall be Hastelloy C-276. The length such that, after installation, bolts will project 1/8 to 3/8 inch beyond the outer face of the nut. Flat Washers shall be of the same material as the bolts.

3. Flange gaskets shall be EPDM for water service. For chemical feed piping systems, the gasket material shall be selected by the gasket manufacturer

based on the chemical concentrations as specified in Section 15090: Chemical Feed System Piping.

2.03 ACCESSORIES (NOT APPLICABLE)

2.04 SPARE PARTS

A. All special tools, solvents, lubricants, and cements required for normal installation shall be furnished with the pipe.

2.05 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.

PART 3 - EXECUTION

3.01 PREPARATION (NOT APPLICABLE)

3.02 INSTALLATION

A. Install PVC pipe where shown on the Drawings and in strict accordance with the manufacturer's technical data and printed instructions.

B. Joints for Schedule 80 PVC pipe and fittings shall be solvent welded, flanged, or threaded. All joints shall be made watertight. All pipe cutting, threading and jointing procedures for solvent welded and threaded PVC pipe joints shall be in strict accordance with the pipe and fittings manufacturer's printed installation instructions. Thread lubricant for threaded joints shall be Teflon tape only. In making solvent welded connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth, if necessary and apply solvent cement of proper grade.

C. Installation of valves and fittings shall be strictly in accordance with the manufacturer's instructions. Particular care shall be taken not to over-stress threaded connections at sleeves. In making solvent weld connections the solvent shall not be spilled on valves or allowed to run from joints.

D. All piping shall have sufficient number of unions to allow convenient removal and shall be as approved by the Engineer.

E. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and the Contractor shall verify their locations from approved piping layout Drawings and the structural Drawings. Pipe hangers and supports are specified in Section 15126.

F. Field Painting:

1. Pipe normally exposed to view shall be painted in accordance with Section 09961 and marked as specified in Section 09905.

G. Jointing:

1. Clean each pipe length, coupling and fitting of all debris and dirt before installation.

2. Do not use pipe length if there are any cuts, abrasions, or defects on the surface of the pipe.

3. Provide and use coupling pullers for joining the pipe when required.

4. Shove home each length of pipe against the pipe previously laid and hold securely in position.

5. Do not pull or cramp joints.

H. Fabrication:

1. Cutting:

a. Use a hand saw or pipe cutter with blades (not rollers).

b. Examine all cut ends for possible cracks caused by cutting.

2. Connecting:

a. Solvent weld connections are recommended by the manufacturer.

b. Connect pipe and fittings only when temperature is above the minimum recommended by the manufacturer.

c. Threaded adapters shall be connected only with plastic male into metal female.

3.03 INSPECTION AND TESTING

A. All PVC piping shall be hydrostatically pressure tested and flushed in accordance with the requirements in Section 15044: Pressure Testing of Piping.

END OF SECTION

SECTION 15072

CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

PART 1- GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment and incidentals required, and install and test in the locations and of the size as shown on the Drawings and specified herein Schedule 80 Chlorinated Polyvinyl Chloride (CPVC) piping, fittings and appurtenances specified herein.

B. Related Work Described Elsewhere:

1. High Performance Paints and Coatings: Section 09961.

2. Piping, Valve, and Equipment Identification System: Section 09905.

3. Mechanical – General Requirements: Section 15000.

4. Pressure Testing of Piping: Section 15044.

5. Chemical Feed System Piping: Section 15090.

6. Valves and Appurtences: Section 15100.

7. Pipe Hangers and Supports: Section 15126.

8. Couplings and Connectors: Section 15129.

C. General Design

1. Schedule 80 CPVC piping shall be installed in the locations as shown on the Drawings. All plastic pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the Contractor.

1.02 QUALITY ASSURANCE

A. All plastic pipe, fittings and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications. The equipment shall be manufactured by Spears, IPEX, or an Engineer approved equal.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Shop drawings shall be submitted to the Engineer for approval in accordance with the General Conditions and Section 01340. All products within this specification shall be combined into a single submittal which shall include at least the following:

a. Dimensioning and the technical specification for all piping, fittings, and appurtenances to be furnished.

b. Letter of Certification from the National Sanitation Foundation International (NSF) stating compliance with Standard 14 and Standard 61.

c. Letter from the Manufacturer verifying chemical compatibility of all products to be used in chemical feed systems.

B. Additional Information:

1. Submit to the Engineer, for approval, samples of all materials specified herein, along with the manufacturer's Certificates of Inspection, descriptive literature, illustrations, specifications, installation instructions and related information.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. CPVC pipe shall be delivered to the site in unbroken bundles packaged in such manner as to provide protection against damage. When possible pipe should be stored at the job site in the unit packages until ready for use. Packaged units shall be handled using a forklift or a spreader bar with fabric straps. Packaged units shall not be stacked at the job site higher than two units high.

B. When it is necessary to store CPVC pipe for more than 30 days, exposure to direct sunlight shall be prevented by covering the pipe with an opaque material. Adequate air circulation above and around the pipe shall be provided as required to prevent excessive heat accumulation. CPVC pipe shall not be stored close to heat sources or hot objects such as heaters, fires, boilers or engine exhaust. Pipe gaskets shall be protected from excessive exposure to heat, direct sunlight, ozone, oil and grease. The interior and all sealing surfaces of pipe, fittings and other appurtenances shall be kept clean and free of dirt and foreign matter.

C. Care shall be taken in handling and laying pipe and fittings to avoid severe impact blows, crushing, abrasion damage, gouging or cutting. Pipe shall be lowered, not dropped, from trucks or into trenches.

D. All cracked, damaged or defective pipe and fittings, or any length of pipe having a gouge, scratch or other permanent indentation of more than 10 percent of the wall thickness in depth, shall be rejected and removed at once from the work and replaced with new acceptable pipe at no additional cost to the Owner.

1.05 WARRANTY AND GUARANTEES

A. Provide equipment warranty in accordance with Section 01740: Warranties and Bonds.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555.320(3) Florida Administrative Code.

2.02 MATERIALS AND EQUIPMENT

A. CPVC Pipe:

Pipe shall be made of chlorinated polyvinyl chloride, Schedule 80 pipe, conforming to ASTM D1784 and ASTM F441, Type IV, Grade I, Cell Classification 23447-A. All chemical piping using Schedule 80 CPVC shall be solvent welded.

B. Fittings:

1. Fittings for Schedule 80 CPVC pipe 4 inches and smaller in diameter shall be socket type, solvent welded in conformance with ASTM D 2467 (Cell Classification 23447-A). When permitted, threaded joints shall be in conformance with ASTM D 2464 (Cell Classification 23447-A). Solvent welded and threaded joints shall be watertight.

2. Fittings for Schedule 80 CPVC pipe greater than 4 inches in diameter shall be socket type, solvent welded in conformance with ASTM D 2467 (Cell Classification 23447-A). Fittings shall be a 1-piece injection molded design. Use of low pressure fabricated CPVC fittings will not be permitted.

C. Solvent Cement:

1. CPVC solvent cement shall be in compliance with ASTM D 2564.

2. Solvent cement shall be specified by compatibility based on pipe service and size. Large diameter joints shall be solvent welded with slow setting solvent cement.

3. Manufacturer to provide certification with submittal.

4. All CPVC chemical feed piping joints are to be solvent welded using CPVC solvent cement.

D. Flanges:

1. Slip-on flanges shall be provided to connect to flanged valves, fittings, or equipment. Flanges shall match the connecting flanges on the adjacent fitting, valve or piece of equipment and must meet the test pressure of the piping system as specified in Section 15044. Diameter and drilling shall conform to ANSI B16.5, Class 150.

2. Flange hardware (bolts, nuts, and washers) for CPVC flanges shall be Type 316 stainless steel in accordance with ASTM F593 and F594, respectively. Flange hardware for PVC flanges on Sulfuric Acid piping shall be Hastelloy C-276. The length such that, after installation, bolts will project 1/8 to 3/8 inch beyond the outer face of the nut. Flat Washers shall be of the same material as the bolts.

3. Flange gasket shall be full face, 1/8 inch thick, chemical-resistant elastometric material suitable for the specified service. For chemical feed piping systems, the gasket material shall be selected by the gasket manufacturer based on the chemical concentrations as specified in Section 15090: Chemical Feed System Piping.

E. Expansion Joints:

1. Expansion joins shall be Edlon "Thermo-molded TFE", Resistoflex "Style R6905", or equal molded expansion joint.

2.03 SPARE PARTS

A. All special tools, solvents, lubricants, and cements required for normal installation shall be furnished with the pipe.

2.04 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION (NOT APPLICABLE)

3.02 INSTALLATION

A. Install CPVC pipe where shown on the Drawings and in strict accordance with the manufacturer's technical data and printed instructions.

B. Joints for Schedule 80 CPVC pipe and fittings shall be solvent welded or threaded. All joints shall be made watertight. All pipe cutting, threading and jointing procedures for solvent welded and threaded CPVC pipe joints shall be in strict accordance with the pipe and fitting manufacturer's printed installation instructions. Thread lubricant for threaded joints shall be Teflon tape only. In making solvent welded connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth, if necessary and apply solvent cement of proper grade.

C. Installation of valves and fittings shall be strictly in accordance with the manufacturer's instructions. Particular care shall be taken not to over-stress threaded connections at sleeves. In making solvent weld connections the solvent shall not be spilled on valves or allowed to run from joints.

D. All piping shall have sufficient number of unions to allow convenient removal and shall be as approved by the Engineer.

E. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and the Contractor shall verify their locations from approved piping layout Drawings and the structural Drawings. Pipe hangers and supports are specified in Section 15126.

F. Field Painting:

1. Pipe normally exposed to view shall be painted in accordance with Section 09961 and marked as specified in Section 09905.

G. Jointing:

1. Clean each pipe length, coupling and fitting of all debris and dirt before installation.

2. Do not use pipe length if there are any cuts, abrasions, or defects on the surface of the pipe.

3. Provide and use coupling pullers for joining the pipe when required.

4. Shove home each length of pipe against the pipe previously laid and hold securely in position.

5. Do not pull or cramp joints.

H. Fabrication:

1. Cutting:

a. Use a hand saw or pipe cutter with blades (not rollers).

b. Examine all cut ends for possible cracks caused by cutting.

2. Connecting:

a. Solvent weld connections are recommended by the manufacturer.

b. Connect pipe and fittings only when temperature is above the minimum recommended by the manufacturer.

c. Threaded adapters shall be connected only with plastic male into metal female.

3.03 INSPECTION AND TESTING

A. All CPVC pipe shall be pressure tested in accordance with Section 15044 - Pressure Testing of Piping.

END OF SECTION

SECTION 15074

POLYVINYLIDENE FLUORIDE (PVDF) PIPE AND FITTINGS

PART 1- GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment and incidentals required, and install and test in the locations and of the size as shown on the Drawings and specified herein Schedule 80 Polyvinylidene Fluoride (PVDF) piping, fittings and appurtenances specified herein.

B. Related Work Described Elsewhere:

1. High Performance Paints and Coatings: Section 09961.

2. Piping, Valve, and Equipment Identification System: Section 09905.

3. Mechanical – General Requirements: Section 15000.

4. Pressure Testing of Piping: Section 15044.

5. Chemical Feed System Piping: Section 15090.

6. Valves and Appurtences: Section 15100.

7. Pipe Hangers and Supports: Section 15126.

8. Couplings and Connectors: Section 15129.

C. General Design

1. PVDF piping shall be installed in the locations as shown on the Drawings. All pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the Contractor. Materials shall be rated for 93% Sulfuric Acid solution.

1.02 QUALITY ASSURANCE

A. All pipe, fittings and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications. The

pipe, fittings and appurtenances shall be manufactured by Asahi/America or an Engineer approved equal.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Shop drawings shall be submitted to the Engineer for approval in accordance with the General Conditions and Section 01340. All products within this specification shall be combined into a single submittal which shall include at least the following:

a. Dimensioning and the technical specification for all piping, fittings, and appurtenances to be furnished.

b. Letter of Certification from the National Sanitation Foundation International (NSF) stating compliance with Standard 14 and Standard 61.

c. Letter from the Manufacturer verifying chemical compatibility of all products to be used in chemical feed systems.

d. Submit materials list for review. Submit manufacturer's recommended method for making fusion joints.

B. Additional Information:

1. Submit to the Engineer, for approval, samples of all materials specified herein, along with the manufacturer's Certificates of Inspection, descriptive literature, illustrations, specifications, installation instructions and related information.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. PVDF pipe shall be delivered to the site in unbroken bundles packaged in such manner as to provide protection against damage. When possible pipe should be stored at the job site in the unit packages until ready for use. Packaged units shall be handled using a forklift or a spreader bar with fabric straps. Packaged units shall not be stacked at the job site higher than two units high.

B. When it is necessary to store PVDF pipe for more than 30 days, exposure to direct sunlight shall be prevented by covering the pipe with an opaque material. Adequate air circulation above and around the pipe shall be provided as required to prevent excessive heat accumulation. PVDF pipe shall not be stored close to heat sources or hot objects such as heaters, fires, boilers or engine exhaust. Pipe gaskets shall be protected from excessive exposure to heat, direct sunlight, ozone, oil and grease. The interior and all sealing surfaces of pipe, fittings and other appurtenances shall be kept clean and free of dirt and foreign matter.

C. Care shall be taken in handling and laying pipe and fittings to avoid severe impact blows, crushing, abrasion damage, gouging or cutting. Pipe shall be lowered, not dropped, from trucks or into trenches.

D. All cracked, damaged or defective pipe and fittings, or any length of pipe having a gouge, scratch or other permanent indentation of more than 10 percent of the wall thickness in depth, shall be rejected and removed at once from the work and replaced with new acceptable pipe at no additional cost to the Owner.

1.05 WARRANTY AND GUARANTEES

A. Provide equipment warranty in accordance with Section 01740: Warranties and Bonds.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555.320(3) Florida Administrative Code.

2.02 MATERIALS AND EQUIPMENT

A. PVDF Material:

PVDF pipe and fittings shall be translucent, conforming to ASTM D3222.

B. Pipe:

Pipe shall be made of polyvinylidene fluoride, Schedule 80 pipe, conforming to ASTM ASTM D3222. Pipe shall be manufactured to the same tolerances for outside diameter and wall thickness as outlined in ASTM D1785 for Schedule 80 pipe. All chemical piping using Schedule 80 PVDF shall be fusion welded. Threaded joints are not allowed.

C. Fittings:

1. Fittings for Schedule 80 PVDF shall be socket-type suitable for heat-fusion welding with dimensions conforming to ASTM D2467. Fusion welded joints shall be watertight. Threaded joints are not allowed.

D. Flanges:

1. PVDF flanges shall be made of the same material as the pipe. Diameter and drilling shall conform to ANSI B16.5, Class 150. Flanges shall be provided to connect to flanged valves, fittings, or equipment. Flanges shall match the connecting flanges on the adjacent fitting, valve or piece of equipment and must meet the test pressure of the piping system as specified in Section 15044.

2. Flange hardware (bolts, nuts, and washers) for PVDF flanges shall be Type 316 stainless steel in accordance with ASTM F593 and F594, respectively. The length such that, after installation, bolts will project 1/8 to 3/8 inch beyond the outer face of the nut. Flat Washers shall be of the same material as the bolts.

3. Flange gasket shall be full face, 1/8 inch thick, chemical-resistant elastometric material suitable for the specified service. For chemical feed piping systems, the gasket material shall be selected by the gasket manufacturer based on the chemical concentrations as specified.

E. Unions:

1. Unions shall have socket-type ends, Viton O-rings, and shall be Schedule 80.

F. Joints:

1. Pipe and fitting joints shall be heat-fusion welded except where flanged joints are required to connect to valves and equipment.

2.03 SPARE PARTS

A. All special tools, solvents, lubricants, and cements required for normal installation shall be furnished with the pipe.

2.04 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 GENERAL

A. Do not install PVDF pipe when the temperature is below 40°F. Store loose pipes on racks with a maximum support spacing of 3 feet. Provide shades for pipe stored or installed outdoors until the pipe is filled with water. Store fittings indoors in their original cartons.

3.02 INSTALLATION

A. Install PVDF pipe where shown on the Drawings and in strict accordance with the manufacturer's technical data and printed instructions. Specialized joining equipment shall be as recommended by manufacturer.

B. Do not drag PVDF pipe over the ground, drop it onto the ground, or drop objects on it. Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings. Bevel fusion welded pipe ends as recommended by the pipe manufacturer.

C. Installation of valves and fittings shall be strictly in accordance with the manufacturer's instructions.

D. All piping shall have sufficient number of unions to allow convenient removal and shall be as approved by the Engineer.

E. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and the Contractor shall verify their locations from approved piping layout Drawings and the structural Drawings. Pipe hangers and supports are specified in Section 15126.

F. Fabrication:

1. Cutting:

a. Use a hand saw or pipe cutter with blades (not rollers).

b. Examine all cut ends for possible cracks caused by cutting.

2. Connecting:

a. Heat-fusion weld connections as recommended by the manufacturer.

b. Connect pipe and fittings only when temperature is above the minimum recommended by the manufacturer.

G. Fusion Welded Joints:

1. Prior to fusion welding, remove fittings and couplings from their cartons and expose them to the air at the same temperature conditions as the pipe for at least one hour.

2. Wipe away loose dirt and moisture from the inside and outside diameters of the pipe end and the inside diameter of the fitting before commencing fusion welding. Do not fusion weld wet surfaces.

3. Make fusion joints per ASTM D2657.

4. Allow at least eight hours before moving fusion welded joints or subjecting the joints to any internal or external loads or pressures.

H. Flanged Joints:

1. Lubricate bolt threads before installation. Tighten bolts on PVDF flanges by tightening the nuts diametrically opposite each other using a torque wrench. Final torque values per manufacturer's recommendations.

I. Field Painting:

1. Pipe normally exposed to view shall be painted in accordance with Section 09961 and marked as specified in Section 09905.

3.03 INSPECTION AND TESTING

A. All PVDF pipe shall be pressure tested in accordance with Section 15044 - Pressure Testing of Piping.

END OF SECTION

SECTION 15090

CHEMICAL FEED SYSTEM PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope or Work:

1. This section covers furnishing and installation of piping and piping accessories and chemical feed piping including secondary containment casing piping, primary carrier piping/tubing, fittings, and appurtenances as specified herein.

2. Piping shall be furnished and installed complete with all fittings, jointing materials, hangers, supports, anchors, and other necessary appurtenances.

3. Chemical containment piping systems consisting of an inner primary carrier pipe/tubing, contained within a secondary outer containment casing pipe, are required for all chemical feed lines, unless otherwise shown in the Drawings.

B. Related Work Described Elsewhere: Other sections directly related to work covered in this section include the following:

1. Piping, Valve, and Equipment Identification System: Section 09905.

2. High Performance Paints and Coatings: Section 09961.

3. Division 15.

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers:

1. Polyvinyl Chloride (PVC) Pipe: As specified in Section 15070.

2. Chlorinated Polyvinyl Chloride (CPVC) Pipe: As specified in Section 15072.

3. Polyvinylidene Fluoride (PVDF) Pipe: As specified in Section 15074.

4. Stainless Steel Pipe: As specified in Section 15066.

B. Solvent welder shall be qualified in accordance with Chapter VII of the ASME B31.3-93 Code, Part 9, Paragraph A328.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Shop drawings shall be submitted to the Engineer for approval in accordance with the General Conditions and Section 01340. All products within this specification shall be combined into a single submittal which shall include at least the following:

a. Dimensioning, complete technical specifications, data, and catalog cuts or drawings for all PVC chemical feed piping and fittings including flexible carrier tubing, containment casing pipe, and appurtenances including, but not limited to, expansion joints for PVC pipe, flange gaskets, pipe sleeves, and pipe supports to be furnished.

b. Letter from the Manufacturer verifying chemical compatibility of all products to be used in chemical feed systems.

B. Additional Information:

1. Submit to the Engineer, for approval, samples of all materials specified herein, along with the manufacturer's Certificates of Inspection, descriptive literature, illustrations, specifications, installation instructions and related information.

1.04 OPERATIONS AND MAINTENANCE DATA

A. Operating and Maintenance Manual: Furnish Operation and Maintenance Manuals in accordance with Section 01730: Operating and Maintenance Data.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Pipe and fittings shall be handled and stored in a manner which will ensure installation in sound, undamaged condition. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide padded skids. Whenever the storage period on the job exceeds 30 days, plastic pipe shall be covered or otherwise protected from exposure to sunlight.

B. Chemical feed system pipe shall be delivered to the site in unbroken bundles packaged in such manner as to provide protection against damage. When possible, pipe should be stored at the job site in the unit packages until ready for use. Packaged units shall be handled using a fork lift or a spreader bar with fabric straps. Packaged units shall not be stacked at the job site higher than two units high.

C. Should chemical feed system pipe or tubing be stored for more than 30 days, exposure to direct sunlight shall be prevented by covering the pipe with an opaque material. Adequate air circulation above and around the pipe shall be provided as required to

prevent excessive heat accumulation. Any double wall containment pipe shall not be stored close to heat sources or hot objects such as heaters, fires, boilers or engine exhaust. Pipe gaskets shall be protected from excessive exposure to heat, direct sunlight, ozone, oil and grease. The interior and all sealing surfaces of pipe, fittings and other appurtenances shall be kept clean and free of dirt and foreign matter.

D. Care shall be taken in handling and laying pipe and fittings to avoid severe impact blows, crushing, abrasion damage, gouging, or cutting. Pipe shall be lowered, not dropped, from trucks or into trenches. All cracked, damaged or defective pipe and fittings, or any length of pipe having a gouge, scratch or other permanent indentation of more than 10 percent of the wall thickness in depth, shall be rejected and removed at once from the work and replaced with new acceptable pipe.

1.06 WARRANTY AND GUARANTEES

A. Provide equipment warranty in accordance with Section 01740 - Warranties and Bonds.

PART 2 - PRODUCTS

2.01 GENERAL

A. Chemical feed system pipe shall be installed in the locations as shown on the Drawings. All semi-rigid tubing, plastic pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the Contractor.

2.02 MATERIALS AND EQUIPMENT

A. Rigid PVC Pipe and Fittings:

1. Materials for Schedule 80 PVC pipe and fittings shall be as specified in Section 15070: Schedule 80 Polyvinyl Chloride (PVC) Pipe and Fittings.

2. Joints and jointings shall be as specified in Section 15070: Schedule 80 Polyvinyl Chloride (PVC) Pipe and Fittings.

B. Rigid CPVC Pipe and Fittings:

1. Materials for CPVC pipe and fittings shall be as specified in Section 15072: Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings.

2. Joints and jointings shall be as specified in Section 15072: Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings.

C. Stainless Steel Pipe, Tubing and Fittings:

1. Materials for stainless steel pipe, tubing and fittings shall be as specified in Section 15066: Type 316 Stainless Steel Pipe and Fittings.

2. Joints and jointings shall be as specified in Section 15066: Type Stainless Steel Pipe and Fittings.

D. Containment Casing Pipe for Buried Chemical Feed Lines

1. Sizing: Each containment casing pipe shall be sized to allow installation of carrier tubing.

2. Unless noted otherwise, containment casing piping shall be Schedule 80 PVC conforming to ASTM D1785.

3. Use only long sweep elbows for bends greater than 45-degrees, or a combination of two (2) 45-degree fittings to provide a bend radius that is double the minimum allowable carrier tubing bend radius. Fittings for Schedule 80 pipe shall be socket type, solvent welded in conformance with ASTM D2855. Solvent welded joints shall be watertight.

4. Pull boxes: Provide chemical pull boxes at each pull station for buried piping as detailed in the Drawings.

E. Semi-rigid Carrier Tubing:

1. Unless specified otherwise, tubing for buried chemical feed lines shall be Chemline Plastics ChemFlare PFA tubing meeting the requirements of ASTM D6867-03 and having the properties below:

Outside Diameter (inches)	Approximate Min. Bend Radius (inches)	Maximum Working Pressure (psi) 72° F
3/8	1	310
1/2	2	232
3/4	6	155
1	22	116

F. Piping Schedule:

1. Refer to Piping Schedule in the Drawings for the materials to be used on each piping system, the conditions of service and hydrostatic testing requirements.

G. Fabrication and Manufacture:

1. A union shall be provided within 2 feet of each threaded end valve unless there are other connections which will permit easy removal of the valve. Unions shall also be provided in piping at locations adjacent to devices or equipment which may require removal in the future and at locations required by the drawings or specifications.

2. Taps for pressure gauge connections on the suction and discharge of pumping units shall be provided with a nipple and a shutoff gauge cock.

3. Pipe hangers and supports shall be provided as specified in Section 15126: Hangers and Supports.

H. Vented Ball Valves for Sodium Hypochlorite Service:

1. Provide PVC vented ball valves for sodium hypochlorite service.

I. Quick Connect Couplings:

1. Quick connect couplings for Chemical Service shall be male adaptor/female thread type. Provide dust cap and security chain with each coupler. Bodies shall be glass fiber reinforced polypropylene. Gaskets shall be Teflon. Adaptors shall be Ever-tite Coupling Co. Port A/DC, Banjo Corporation Male Adapter/Female Thread with dust cap, Murray Equipment Inc., Style A/DC, or approved equal.

J. PVC Wye Strainer:

1. Refer to Section 15100: Valves and Appurtenances.

2.03 HEAT TRACING

A. Caustic or sodium hydroxide feed lines located outside and exposed to atmosphere of the chemical feed building, shall have heat tracing to prevent crystallization of the solution at low temperature. The heat tracing shall be electrical self-regulating heating cables designed to provide freeze protection or process temperature maintenance to non metallic piping. The heat tracing system shall be Chromalox, SLCAB, or engineered approved equal.

B. The heat output should vary according to the surrounding conditions along the entire length of the circuit. The heat tracing system shall include a manual controlled thermostat, with adjustable pipe sensors to be placed in required temperature ranges and amperage ranges for both ordinary and hazardous location. The heat tracing system shall be capable of automatically maintaining the caustic solution temperature greater than 55^{o}F when outside temperatures fall below this temperature.

C. All heat traced pipe shall be insulated in accordance with Section 15127: Pipe Insulation.

D. Tracer Tape

1. Tracer tape shall consist of self-limiting, parallel circuit construction with a continuous inner core of conductive material between two copper bus wires.

2. The resistance and heating capacity of the heating material shall vary in response to piping temperature changes.

3. Tape shall withstand continuous exposure to 150 degree F temperature.

4. Tracer tape shall operate using 120 volt AC, 1 phase, 60 Hz power.

5. Tracer tape shall be provided with copper shield and fluoropolymer jacket.

6. All tracer tape shall be explosion proof.

7. Tracer tape shall have a thermal rating of 4 watts per foot at 50 degrees.

E. Heat Tracing Control:

1. Each length of tracer tape shall be controlled by a thermostat. Thermostat shall be provided in an aluminum, NEMA 4X, watertight enclosure.

2. Each length of tracer tape shall be provided with a signal light wired to the terminating end. Light shall indicate that tape is energized.

3. Thermostat shall control by sensing ambient temperature with the following characteristics

a. Rating: 22 amperes at 120V AC
b. Control temperature range: 15 to 140 degrees F
c. Calibration tolerance: 2 degrees F
d. Sensor material: stainless steel
e. Exposure temperature: -65 to 140 degrees F
f. Temperature setting: 50 degrees F

F. Heat Tracing Installation

1. Tracer tape shall be fastened to pipe and valves as recommended by the manufacturer at intervals not exceeding 1 foot.

2. Insulation shall be provided over the tracer tape.

3. Tracer tape shall be spiral wrapped at a constant pitch as determined by the minimum tape length scheduled.

2.04 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Installation of valves and fittings shall be strictly in accordance with the manufacturer's instructions. Particular care shall be taken not to over-stress threaded connections. In making solvent weld connections the solvent shall not be spilled on valves or allowed to run from joints.

2. All chemical feed piping shall have sufficient number of unions to allow convenient removal.

3. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed.

4. All valves and equipment shall be supported independently from the pipe. Anchor valves such that the turning moment resulting from their operation will not be transmitted to the pipe.

B. Pipe:

1. Pipe shall be installed as specified, as indicated on the drawings or, in the absence of detail piping arrangement, in a manner acceptable to the Engineer.

2. Pipe shall be cut from measurements taken at the site and not from the drawings. All necessary provisions shall be taken in laying out piping to provide for expansion and contraction. Piping shall not obstruct openings or passageways. Pipes shall be held free of contact with building construction so as not transmit noise resulting from expansion.

3. PVC pipe shall be kept shaded and shall be covered with backfill immediately after installation and testing.

4. All piping shall be installed so that lines are readily accessible for cleaning. At changes in direction in all chemical piping, tees shall be provided with extra

openings plugged to facilitate cleaning. Teflon thread tape or teflon thread sealer shall be applied to the threads of all plugs so that they can be easily removed. At each point where plastic tubing is connected to rigid piping, an adapter coupling shall be provided.

C. Pipe Joints: Pipe joints shall be carefully and neatly made in accordance with the requirements which follows.

1. Threaded:

a. Pipe threads shall conform to ANSI 82.1, NPT, and shall be full and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed, after threading and before assembly, to remove all burrs.

b. Threaded joints in plastic piping shall be made up with teflon thread tape applied to all male threads. Threaded joints in stainless steel piping shall be made up with teflon thread sealer and teflon thread tape applied to all male threads.

2. Solvent Welded: All joint preparation, cutting and jointing operations shall comply with the pipe manufacturer's recommendations and ASTM D2855. Pipe ends shall be beveled or chamfered to the dimensions recommended by the manufacturer. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the set time recommended by the manufacturer. Pressure testing of solvent welded piping systems shall not be performed until the applicable curing time, set forth in Table X2.1 of ASTM D2855, has elapsed.

3. Flanged: Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but not so tight as to fracture or distort the flanges. A plain washer shall be installed under the head and nut of bolts connecting plastic pipe flanges. Anti-seize thread lubricant shall be applied to the threaded portion of all stainless steel bolts during assembly.

D. Pipe Sleeves:

1. Piping passing through or below concrete or masonry shall be installed through sleeves installed before the concrete is placed or when masonry is laid.

2. Unless otherwise indicated on the drawings, all pipes passing through or below walls or slabs shall be sealed watertight with special rubber gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

3. Buried pipe sleeves enclosing chemical-piping shall be sloped to the open end as indicated on the drawings to allow observation of leakage of the chemical piping. The upper end of each sleeve shall be sealed watertight.

E. Buried Chemical Containment Piping Systems:

1. Unless noted otherwise, chemical containment piping systems consisting of flexible carrier tubing installed within a rigid containment casing pipe shall be used for all buried chemical piping.

2. Precast concrete pull boxes shall be provided as specified in the Drawings. The pull boxes shall be placed at every 270-degrees of piping bends (3rd 90-degree bend or equivalent) and a maximum of 280 feet along buried runs of chemical feed piping to make tubing coupling connections and to provide a means of pulling the tubing through the containment casing pipe. The precast pull boxes shall be coated with chemical resistant coating to protect the concrete from chemical attack in the event of a leak. The concrete pull boxes shall have water-tight aluminum hatches as shown in Drawings.

3. Buried containment casing pipe shall be installed to slope continuously between pull boxes without dips and valleys so that leaks will drain to the boxes. Maintain minimum 0.2% slope of casing piping to pull boxes and/or low points.

4. Flexible carrier tubing sections shall be coupled together inside the containment boxes only. No coupling of tubing outside of the containment boxes will be allowed. Tubing shall be coiled inside each box to account for expansion and contraction. Coil radius shall exceed the tubing manufacturer's recommended minimum radius.

5. Fiberglass Reinforced Plastic pipe supports shall be used to support tubing inside pull boxes, however, coiled tubing shall be loosely secured to supports to allow longitudinal movement for expansion/contraction.

F. Field Painting: Pipe normally exposed to view shall be painted in accordance with Section 09961 and marked as specified in Section 09905.

3.02 INSPECTION AND TESTING

A. Pressure and Leakage Testing:

1. All specified tests shall be made by and at the expense of the Contractor in the presence, and to the satisfaction of, the Engineer. Each piping system shall be tested in accordance with Section 15044 and at a minimum, must experience no loss of pressure for at least one hour.

2. Compressed air or pressure gas shall not be used to test plastic piping unless specifically recommended by the pipe manufacturer.

3. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method acceptable to the Engineer. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the specified test pressure shall be

disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

4. Drainage and venting systems shall be tested by filling with water to the level of the highest vent stack. Openings shall be plugged as necessary. Each system shall hold the water for 30 minutes without any drop in the water level.

5. All necessary testing equipment and materials, including tools, appliances and devices, shall be furnished and all tests shall be made by and at the expense of the Contractor and at such time as directed by the Engineer.

6. All joints in piping shall be tight and free from leaks. All joints which are found to leak by observation or during any specified test shall be repaired and tests repeated.

B. Cleaning:

1. The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand, dirt, and other foreign matter when erected. The interior of all lines shall be thoroughly cleaned, to the satisfaction of the Engineer, before being placed in service.

2. Lines which have been flushed with water shall be air dried with compressed air immediately following drainage.

3. Sulfuric Acid Piping

a. After all testing has been completed, the sulfuric acid piping shall be purged with nitrogen gas or another acceptable means to remove all traces of water and moisture from piping before acid is placed in the piping.

END OF SECTION

SECTION 15100

VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment, and incidentals required to install complete and ready for operation all valves and appurtenances as shown on the Drawings as specified herein.

2. The equipment shall include, but not be limited to the following:

a. Butterfly Valves
b. Ball Valves
c. Diaphragm Valves
d. Plug Valves
e. Check Valves
f. Gate Valves
g. Pressure Relief Valves
h. Backpressure Valves
i. Isolation Valves
j. Solenoid Valves
k. Valve Operators
l. Air Release Valves
m. Expansion Joints
n. Vacuum Relief Valves
o. Strainers
p. Unions
q. Diaphragm Seals
r. Pressure Regulator Valves
s. Needle Valves

B. Related Work Described Elsewhere:

1. General Requirements: Division 1.
2. Mechanical – General Requirements: Section 15000.
3. Pipe and Fittings: Respective Sections of Division 15.
4. Process Control Valves: Section 15105
5. Pipe Hangers and Supports for Process Piping: Section 15126.
6. Couplings and Connectors: Section 15129.
7. Electrical: Division 16.
8. Instrumentation: Division 13.

C. General Design:

1. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of water, air, chemicals, etc., depending on the applications.

1.02 QUALITY ASSURANCE

A. All of the types of valves and appurtenances shall be products of well-established reputable firms who are fully experienced, reputable, and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these specifications as applicable.

1.03 SUBMITTALS

A. Submit to the Engineer within 30 days after execution of the contract a schedule of valves to be furnished. The valve schedule shall include valve tags organized by process with the valve manufacturer, supplier, and the date of delivery to the site.

B. Complete shop drawings of all valves and appurtenances shall be submitted to the Engineer for approval in accordance with the requirements of Section 01340: Shop Drawings, Working Drawings and Samples and the General Requirements. In addition, valve manufacturer shall certify in writing that valve design and materials of construction are suitable for the intended service.

C. Quality Control Submittals:

1. Certificate of Compliance for:

a. Electric operators; full compliance with AWWA C540.

b. AWWA service butterfly valves; full compliance with AWWA C504.

2. Tests and inspection data.

3. Manufacturer's Certificate of Proper Installation.

4. Operation and Maintenance Manual.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled, shipped and stored in accordance with Section 01600: Material and Equipment.

1.05 WARRANTY AND GUARANTEES

A. Provide equipment warranty in accordance with Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for 1 year after the time of completion and acceptance by the Owner.

1.06 SPARE PARTS

A. Provide one (1) replacement set of valve stem packing or seals as applicable for every five valves supplied. No less than one (1) set shall be provided for each type and model of valve supplied.

B. Provide one (1) full set of gaskets as applicable for each valve supplied.

C. Special tools, if required for normal operation and maintenance shall be supplied with the equipment.

D. Provide one (1) handheld actuator programming device for every five (5) electric motor actuators supplied.

PART 2 - PRODUCTS

2.01 GENERAL

A. Valves shall include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories as required for a complete and operable installation.

B. All valves and appurtenances shall be of the size shown on the Drawings and all equipment of the same type shall be from one manufacturer.

C. All valves and appurtenances shall have the name of the manufacturer and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

D. Unless specified otherwise, all hardware on the valve and actuator including bolts, washers, and nuts shall be at a minimum Type 316 stainless steel except for acid service valves which shall be provided with Hastelloy C-276 hardware.

E. Factory Finishing:

1. Epoxy Lining and Coating:

a. NSF approved and in accordance with AWWA C550 unless otherwise specified.

b. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as "fusion" or "fusion bonded" epoxy.

c. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2. Exposed Valves:

a. In accordance with Section 09961: High Performance Paints and Coatings.

b. Safety isolation valves and lockout valves with handles, handwheels, or chain wheels "safety yellow."

3. Stainless Steel Valves:

a. Pickling & Passivation shall be provided for all stainless steel valves to provide a bright, uniform finish of the valve body interior and exterior surfaces, including the valve trim, and hardware.

2.02 MATERIALS AND EQUIPMENT

A. Approved Materials:

1. All materials that come into contact with the water being treated or potable water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555.320(3) Florida Administrative Code.

2. Brass and bronze valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

3. Approved alloys are of the following ASTM designations:

a. B61, B62, B98 (Alloy UNS No. C65100, C65500, or C66100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.

b. Stainless steel Alloy 18-8 may be substituted for bronze.

B. Butterfly Valves:

1. General:

a. Butterfly valves shall meet or exceed the design standards of AWWA C504-150B, unless otherwise noted.

b. Valves shall be bubble tight in either direction at the rated pressure and shall be suitable for throttling and/or operation after long periods of inactivity.

c. All valves shall be furnished with position indication.

2. BFV1:

a. Valve: Butterfly valve shall be wafer or lugged style (per the Drawings), cast or ductile iron fully rubber lined body ASTM A126 with a solid 316 stainless steel shaft AWWA 75B. Disc shall be 316 stainless steel with TFE coated stainless steel bearings and EPDM resilient seat. Seals shall be EPDM or PTFE.

b. Operator: Weatherproof 2" Square Nut.

c. Pressure: 150 psi.

d. Service: Water that has been pH adjusted to a minimum of 3 with sulfuric acid or hydrochloric acid and a maximum of 12 with sodium hydroxide.

e. DeZurik Model BOS-US (wafer or lugged), Pratt MK2 (wafer), Bray Controls Series 30 (water), or Bray Controls Series 31 (lugged).

3. BFV2:

a. Valve: Butterfly valve shall be as specified in 2.02 B., BFV1.

b. Operator: Lever.

c. Pressure: 150 psi.

d. Service: Water that has been pH adjusted to a minimum of 3 with sulfuric acid or hydrochloric acid and a maximum of 12 with sodium hydroxide.

e. DeZurik Model BOS-US (wafer or lugged), Pratt MK2 (wafer), Bray Controls Series 30 (water), or Bray Controls Series 31 (lugged).

4. BFV3:

   a. Valve: Butterfly valve shall be as specified in 2.02 B., BFV1.

   b. Operator: Weatherproof Handwheel.

   c. Pressure: 150 psi.

   d. Service: Water that has been pH adjusted to a minimum of 3 with sulfuric acid or hydrochloric acid and a maximum of 12 with sodium hydroxide.

   e. DeZurik Model BOS-US (wafer or lugged), Pratt MK2 (wafer), Bray Controls Series 30 (water), or Bray Controls Series 31 (lugged).

5. BFV4:

   a. Valve: Butterfly valve shall be fully lugged style 316 stainless steel body ASTM A351 Type CF8M, ANSI B16 with a solid 316 stainless steel shaft and disc. Fabric PTFE bearings, PTFE/Titanium seat and PTFE V-flex packing shall be provided.

   b. Operator: Weatherproof Handwheel.

   c. Pressure: 300 psi.

   d. Service: Raw Water, High Pressure RO Feed, RO Concentrate, Membrane Cleaning Solutions (pH 2-12).

   e. DeZurik BHP, Jamesbury Series 830, or Bray Controls High Performance Valve.

6. BFV5:

   a. Valve: Butterfly valve shall be as specified in 2.02.B., BFV4.

   b. Operator: Weatherproof Electric Motor Actuator, Open/Close or Modulating Service per the Instrumentation design.

   c. Pressure: 300 psi.

   d. Service: Raw Water, High Pressure RO Feed, RO Concentrate, Membrane Cleaning Solutions (pH 2-12).

   e. DeZurik BHP, Jamesbury Series 830, or Bray Controls High Performance Valve.

7. BFV6:

   a. Valve: Butterfly valve shall be flanged body per the Drawings. Materials of construction shall be cast or ductile iron body ASTM A126 Class B with a 304 stainless steel shaft ASTM A276. Disc shall be cast iron ASTM A48 Class 40C with an EPDM resilient seat and PTFE seals and adjustable packing. Seat ring shall be 316 stainless steel.

   b. Operator: Weatherproof Handwheel.

   c. Pressure: 150 psi.

   d. Service: High Service Pump, Potable Water, Finished Water.

   e. DeZurik AWWA, Pratt AWWA Rubber Seated, or Pratt Groundhog.

8. BFV7:

   a. Valve: Butterfly valve shall be mechanical joint or flanged per the drawings, cast or ductile iron body ASTM A126 Class B with a 316 stainless steel shaft. Disc shall be 316 stainless steel ASTM A351, Grade CF8M. Interior of valve body shall have a resilient EPDM seat and lining vulcanized to the valve body. Valves shall be fully rubber lined beyond the point of pipe insertion or flange connection. Valve shall have PTFE seals and adjustable packing.

   b. Operator: Per the Drawings.

   c. Pressure: 150 psi.

   d. Service: RO Permeate, Water that has been pH adjusted to a minimum of 3 with sulfuric acid or hydrochloric acid and a maximum of 12 with sodium hydroxide, Carbonated Water, pH adjusted with CO_2.

   e. DeZurik AWWA, Pratt AWWA Rubber Seated or Pratt Groundhog (buried).

9. BFV8:

   a. Valve: Butterfly valve shall be as specified in 2.02.B., BFV6.

   b. Operator: Weatherproof 2" Square Nut.

   c. Pressure: 150 psi.

   d. Service: High Service Pump, Potable Water.

e. DeZurik AWWA or Pratt Groundhog.

10. BFV9:

a. Valve: Butterfly valves shall be lugged or wafer style. Valve body shall be manufactured of PVC conforming to ASTM D1487 cell classification 12454-A. Valve disc shall be manufactured of PVC of an equal grade to the body material or of Polypropylene conforming to ASTM D4101 cell classification PP0210B67272. Valve shall have a EPDM resilient seat. Valve stem shall be 316 stainless steel with EPDM seals.

b. Operator: Per the Drawings.

c. Pressure: 150 psi @ 75° F.

d. Service: RO Permeate, RO Permeate to Waste, Membrane Cleaning Solution (pH adjusted to a minimum of 2 with citric, sulfuric acid or hydrochloric acid and a maximum of 12 with sodium hydroxide), Degasifier Cleaning Solution.

e. Asahi/America Type 57 or George Fischer Type 567 or 578.

11. BFV10:

a. Valve: Butterfly valve shall be fully lugged style or wafer style per the Drawings, 316 stainless steel body ASTM A351 Type CF8M, ANSI B16 with a solid 316 stainless steel shaft and disc. Fabric PTFE bearings, PTFE/Titanium seat and PTFE V-flex packing shall be provided.

b. Operator: Weatherproof 2" Square Nut.

c. Pressure: 150 psi.

d. Service: Raw Water, Water, pH adjusted Raw Water to a minimum of 3 with H_2SO_4, RO Concentrate, RO Permeate, Membrane Cleaning Solutions (pH 2-12), Carbonated Water, pH adjusted with CO_2.

e. DeZurik BHP, Jamesbury Series 815, Bray Controls High Performance Valve, or Pratt HP Series.

12. BFV11:

a. Valve: Butterfly Valve shall be as specified in 2.02.B., BFV6, except shall be mechanical joint body.

b. Operator: Weatherproof 2" Square Nut.

c. Pressure: 150 psi.

d. Service: High Service Pump, Potable Water.

e. DeZurik AWWA, Pratt AWWA, or Pratt Groundhog.

13. BFV12: NOT USED.

14. BFV13:

a. Valve: Butterfly valve shall be as specified in 2.02.B., BFV10.

b. Operator: Weatherproof Handwheel.

c. Pressure: 150 psi.

d. Service: Raw Water, Water, pH adjusted Raw Water to a minimum of 3 with H_2SO_4, RO Concentrate, RO Permeate, Membrane Cleaning Solutions (pH 2-12), Carbonated Water, pH adjusted with CO_2.

e. DeZurik BHP, Jamesbury Series 815, Bray Controls High Performance Valve, or Pratt HP Series.

15. BFV14:

a. Valve: Butterfly valve shall be as specified in 2.02.B., BFV10.

b. Operator: Weatherproof Electronic Motor Actuator, Open/Close or Modulating Service per the Instrumentation design.

c. Pressure: 150 psi.

d. Service: Raw Water, Water, pH adjusted Raw Water to a minimum of 3 with H_2SO_4, RO Concentrate, RO Permeate, Membrane Cleaning Solutions (pH 2-12), Carbonated Water, pH adjusted with CO_2.

e. DeZurik BHP, Jamesbury Series 815, Bray Controls High Performance Valve, or Pratt HP Series.

16. BFV15: NOT USED

17. BFV16:

a. Valve: Butterfly valve shall be as specified in 2.02.B., BFV1.

b. Operator: Weatherproof Chainwheel.

c. Pressure: 150 psi.

d. Service: Water that has been pH adjusted to a minimum of 3 with sulfuric acid or hydrochloric acid and a maximum of 12 with sodium hydroxide.

e. DeZurik Model BOS-US (wafer or lugged), Pratt MK2 (wafer), Bray Controls Series 30 (water), or Bray Controls Series 31 (lugged).

C. Ball Valve

1. BV1:

a. Valve: Ball valves for general process service shall be manufactured of Grade I, Type I, PVC with Teflon seats. Seals shall be EPDM. Valve shall be provided with double unions and ball blocking feature.

b. Operator: Handle.

c. Pressure: 150 psi @ 73°F.

d. Service: Raw Water, RO Permeate, RO Concentrate, Finished Water, Potable Water, Membrane Cleaning Solutions, Antiscalant, Sodium Hydroxide, Phosphate Corrosion Inhibitor.

e. Plast-O-Matic True Blue or Asahi/America Type 21 Ball Valve.

2. BV2:

a. Valve: Ball valve shall be manufactured of Type 4, Grade I CPVC with Teflon seats and Viton seals. Valve shall be provided with double unions and ball blocking feature.

b. Operator: Handle.

c. Pressure: 150 psi @ 73°F.

d. Service: 93% Sulfuric Acid.

e. Plast-O-Matic True Blue or Asahi/America Type 21 Ball Valve.

3. BV3:

a. Valve: Ball valves shall be manufactured of Grade I, Type I, PVC with Teflon seats. Seals shall be Viton with acidic and oxidizing process services. Valve shall be provided with double unions and ball blocking

feature. Ball valves for sodium hypochlorite service shall have a 1/8 inch vent hole drilled and deburred by the manufacturer. The valve shall be installed with the vent hole on the upstream side of the system to keep the cavity of the ball fluidized.

b. Operator: Handle.

c. Pressure: 150 psi @ 73°F.

d. Service: Sodium Hypochlorite.

e. Plast-O-Matic True Blue or Asahi/America Type 21 Ball Valve.

4. BV4:

a. Valve: PVC ball valve shall be as specified for BV3.

b. Operator: Electric Motor.

c. Pressure: 150 psi @ 73°F.

d. Service: Sodium Hypochlorite.

e. Plast-O-Matic True Blue or Asahi/America Type 21 Ball Valve.

5. BV5: NOT USED

6. BV6:

a. Valve: Ball valves shall be the full ported type with flanged connections or threaded connections. Valve shall be 1 piece ASTM A351 Grade CF8M type 316 stainless steel body ANSI B16 with a solid 316 stainless steel ball and stem. Seats and seals shall be teflon.

b. Operator: Handle

c. Pressure: 150 psi

d. Service: RO Permeate, Membrane Cleaning Solutions, RO Concentrate Carbonated Water, pH adjusted with CO_2.

e. DeZurik, Neles-Jamesbury, or Flow-Tek.

7. BV7:

a. Valve: Ball valves in sizes ¼”-3” for water and high pressure process services shall be 2-piece body ball valves with standard ports and

threaded end connections. Valves shall be manufactured of Type 316 stainless steel body and wetted internals conforming to ASTM A351 Grade CF8M and ANSI B16 with a solid 316 stainless steel ball and stem. Fabric PTFE bearings, PTFE/Titanium seat and PTFE V-flex packing shall be provided with Teflon seats.

b. Operator: Handle with Safety Lockout Feature.

c. Pressure: 300 psi.

d. Service: Raw Water, RO Feed, RO Permeate, RO Concentrate, Carbonated Water, pH adjusted with CO_2, High Pressure Samples, Low Pressure Samples

e. Flow-Tek, Jamesbury, Apollo. High pressure valves to be NUPRO, or engineer approved equal. Low pressure samples to be ¼-inch PVC labcock valves by Asahi or engineer approved equal.

8. BV8:

a. Valve: Ball valves shall be manufactured of ASTM D3222 PVDF with PTFE seats and Viton seals. Valve shall be provided with double unions and ball blocking feature.

b. Operator: Handle.

c. Pressure: 150 psi @ 73°F.

d. Service: 93% Sulfuric Acid.

e. Asahi/America Type-21 Ball Valve or Plast-O-Matic True Blue.

D. Diaphragm Valves:

1. DV1:

a. Valve: Diaphragm valves shall be of solid thermoplastic construction with molded flanged ends. PVC conforming to ASTM D1784 Cell Classification 12454-A. Diaphragm shall be EPDM. Valve shall provide bubble-tight closure at operating pressure. Valves shall come standard with a position indicator, travel stop, and bonnet o-ring sealing arrangement.

b. Operator: Handwheel with capped indicator stem.

c. Pressure: 150 psi @ 100° F.

d. Service: Antiscalant, Sodium Hydroxide, Phosphate Corrosion Inhibitor.

e. Asahi/America Type 14 or Hayward.

2. DV2:

a. Valve: Diaphragm valves shall be of solid thermoplastic construction with molded flanged ends. Body material shall be CPVC conforming to ASTM D1784 Cell Classification 23567-A. Bonnet material shall be PPG conforming to ASTM D4101 Cell Classification PP0110M20A21130. Diaphragm shall be Viton. Valve shall provide bubble-tight closure at operating pressure. Valves shall come standard with a position indicator, travel stop, and bonnet o-ring sealing arrangement.

b. Operator: Handwheel with capped indicator stem.

c. Pressure: 150 psi @ 100° F.

d. Service: 93% Sulfuric Acid.

e. Asahi/America Type 14 or Hayward.

3. DV3:

a. Valve: Diaphragm valves shall be of solid thermoplastic construction with molded flanged ends. PVC conforming to ASTM D1784 Cell Classification 12454-A. Diaphragms shall be PTFE and shall accept the installation of a PVDF gas barrier between the layers of EPDM and PTFE. Valve shall provide bubble-tight closure at operating pressure. Valves shall come standard with a position indicator, travel stop, and bonnet o-ring sealing arrangement.

b. Operator: Handwheel with capped indicator stem.

c. Pressure: 150 psi @ 73° F.

d. Service: 12.5% Sodium Hypochlorite, RO Permeate.

e. Asahi/America Type 14 (1/2” to 4”), Type G (8” to 10”), Hayward or Chemline Plastics Type 72 (8” to 10”).

4. DV4:

a. Valve: Diaphragm valves shall be of solid thermoplastic construction with molded flanged ends. PVDF conforming to ASTM D3222 Cell Classification Type II. Diaphragm shall be Viton. Valve shall provide bubble-tight closure at operating pressure. Valves shall come standard

with a position indicator, travel stop, and bonnet o-ring sealing arrangement.

b. Operator: Handwheel with capped indicator stem.

c. Pressure: 150 psi @ 73° F.

d. Service: 93% Sulfuric Acid.

e. Asahi/America Type 14.

E. Plug Valves:

1. General:

a. Plug valves shall be the non-lubricated eccentric type for use in wastewater service with flanged or mechanical joint ends as specified herein or as shown on the drawings. Valves shall open by turning to the left (counter-clockwise), when viewed from the stem. Port area of the valves shall be a minimum of 80 percent of full pipe area. Valves shall be capable of providing drip-tight shutoff to the full valve rating with the pressure in either direction.

b. Plug valves shall be tested in accordance with AWWA C504-80 Section 5. Each valve shall be performance tested in accordance with 5.2 and shall be given leakage test and hydrostatic test as described in paragraph 5.3 and 5.4. The leakage test shall be applied to the face of the plug tending to unseat the valve. The leakage test shall be performed at valve rating pressure as specified in B above. The manufacturer shall furnish certified copies of reports covering proof of design testing as described in Section 5.5.

c. All interior ferrous surfaces of the valve that will have contact with wastewater shall be coated with a factory applied, thermally bonded epoxy coating in accordance with AWWA C550, latest revision. Surfaces shall be clean, dry and free from rust, oil, and grease before coating. Exterior surfaces of valve shall be coated as specified hereinafter.

d. Valve joints. All plug valves installed above-ground, in valve vaults or on flanged piping shall have flanged ends unless shown otherwise on the drawings. Flanges shall comply with facing, drilling and thickness of ANSI Standards for Class 125 dimensions. Nuts and bolts for flanged connections in valve vaults or corrosive atmospheres shall be Type 304 stainless steel in accordance with ASTM A320, Class 2. Nuts and bolts for above-ground installations or non-corrosive atmospheres shall be carbon steel in accordance with ASTM A307, Grade B. All buried plug valves shall have mechanical joint ends with dimensions, bolting

patterns and assembly in strict accordance with ANSI/AWWA C111 latest revision. Tee head bolts and nuts for mechanical joints shall be manufactured of CORTEN-A, high strength, low alloy, corrosion resistant steel as manufactured by NSS Industries, Plymouth, Michigan or an equal approved by the Engineer.

e. Plug valves 4-inch in size buried underground, and all plug valves 6-inch in size and larger installed above-ground, buried or in valve vaults shall be furnished with mechanical gear actuators. Gear actuators shall be furnished with AWWA Standard 2-inch square operating nuts for buried valves, or handwheel, chainwheel or 2-inch square nut operators for above-ground or valve vault installation, as shown on the drawings. Gear actuator shall be sized for the maximum pressure differential across the valve, equal to the pressure rating of the valve. All gearing shall be enclosed in a high strength cast iron housing, suitable for running in a lubricant.

2. PV1:

a. Valve: Valve bodies shall be constructed of high strength cast iron conforming to ASTM A126, Class B and AWWA C504, latest revisions. Valve bodies shall be cast with raised eccentric seats which have a corrosion resistant welded-in overlay of not less than 90 percent pure nickel on all surfaces contacting the plug face. Valve seats shall be in accordance with AWWA C504 and AWWA C507, latest revisions. Valves shall be furnished with resilient faced plugs and Neoprene facing, suitable for use with wastewater. Valves shall be furnished with replaceable, permanently lubricated, stainless steel, sleeve-type bearings in the upper and lower plug stem journals. Plug stem bearings shall comply with AWWA C504 and C507, latest revisions. Valves shall be bolted bonnet design. Valves shaft seals shall be designed so that they can be repacked without removing the bonnet and the packing shall be adjustable. Packing material shall be Buna-Vee type packing. Valve shaft seals shall be in accordance with AWWA C504 and AWWA C507, latest revisions. All exposed valve nuts, bolts, springs, washers and the like shall be Type 304 stainless steel.

a. Operator: 4” and below – Lever, 6” and above – Weatherproof Handwheel.

c. Pressure Rating: ANSI B16.1-1967:

i. 12 inch and less: 175 psi

ii. 14 inch through 54 inch: 150 psi

d. Service: Wastewater.

e. DeZurik Fig. 118.

3. PV2:

a. Valve: Valve bodies shall be constructed of high strength cast iron conforming to ASTM A126, Class B and AWWA C504, latest revisions. Valve bodies shall be cast with raised eccentric seats which have a corrosion resistant welded-in overlay of not less than 90 percent pure nickel on all surfaces contacting the plug face. Valve seats shall be in accordance with AWWA C504 and AWWA C507, latest revisions. Valves shall be furnished with resilient faced plugs and Viton facing, suitable for use with chlorinated water. Valves shall be furnished with replaceable, permanently lubricated, stainless steel, sleeve-type bearings in the upper and lower plug stem journals. Plug stem bearings shall comply with AWWA C504 and C507, latest revisions. Valves shall be bolted bonnet design. Valves shaft seals shall be designed so that they can be repacked without removing the bonnet and the packing shall be adjustable. Packing material shall be PTFE type packing. Valve shaft seals shall be in accordance with AWWA C504 and AWWA C507, latest revisions. All exposed valve nuts, bolts, springs, washers and the like shall be Type 316 stainless steel.

b. Operator: 4" and below – Lever, 6" and above – Weatherproof Handwheel.

c. Pressure Rating: ANSI B16.1-1967:

i. 12 inch and less: 175 psi

ii. 14 inch through 54 inch: 150 psi

d. Service: Chlorinated Water.

e. DeZurik Fig. 118.

2. PV3:

a. Valve: Valve bodies shall be constructed of high strength cast iron conforming to ASTM A126, Class B and AWWA C504, latest revisions. Valve bodies shall be cast with raised eccentric seats which have a corrosion resistant welded-in overlay of not less than 90 percent pure nickel on all surfaces contacting the plug face. Valve seats shall be in accordance with AWWA C504 and AWWA C507, latest revisions. Valves shall be furnished with resilient faced plugs and Viton facing, suitable for use with chlorinated water. Valves shall be furnished with replaceable, permanently lubricated, stainless steel, sleeve-type

bearings in the upper and lower plug stem journals. Plug stem bearings shall comply with AWWA C504 and C507, latest revisions. Valves shall be bolted bonnet design. Valves shaft seals shall be designed so that they can be repacked without removing the bonnet and the packing shall be adjustable. Packing material shall be PTFE type packing. Valve shaft seals shall be in accordance with AWWA C504 and AWWA C507, latest revisions. All exposed valve nuts, bolts, springs, washers and the like shall be Type 316 stainless steel.

b. Operator: 4" and below – Lever, 6" and above – Weatherproof Handwheel.

c. Pressure Rating: ANSI B16.1-1967:

i. 12 inch and less: 175 psi

ii. 14 inch through 54 inch: 150 psi

d. Service: Wastewater, Laboratory Waste, Neutralized Cleaning Solutions.

e. Flowserve Durco T4E or engineer approved equal.

F. Check Valves:

1. General:

a. Check valves for cast iron and ductile iron pipelines 2-inch through 12-inch shall be swing type and shall conform to the material requirement of AWWA Specification C508.

b. Prior to shipment from the factory, the interior ferrous surfaces of the valve, except for finished or bearing surfaces, shall be coated with a two-part thermosetting epoxy coating in accordance with AWWA C550, latest revision. Surfaces shall be clean, dry and free from rust and grease before coating.

2. CV1:

a. Valve: Check valves shall be the double door type, fully lugged or wafer style body per the Drawings, with Type 316 stainless steel body and trim. The stainless steel body and doors shall be castings of ASTM A351 Grade CF8M. The hinge pin, stop pin, pin retainers, spring, and lifting eye bolt shall be Type 316 stainless steel ASTM A276 S31600. The seat material shall be EPDM. In lieu of the double door type, wafer style body per the Drawings, the Check Rite wafer swing check valve may be furnished. The Check Rite shall be of equivalent materials and pressure class as the double door type.

b. Pressure: 300 psi.

c. Service: High Pressure RO Feed, RO Concentrate, Membrane Cleaning Solutions (pH adjusted to a minimum of 2 with citric or hydrochloric acid and a maximum of 12 with sodium hydroxide or sodium hypochlorite).

d. APCO Series 9000, Mueller Steam 72H, Titan Flow Control CV42L-SS, or Bray Check Rite.

3. CV2:

a. Valve: Check valves shall be the slanting (tilted) disc type. The valve housing shall consist of two cast iron ASTM A126 Grade B body sections bolted together at a central diagonal flange, which shall be inclined at an angle of 55 degrees. Valves shall be designed for a pressure of 150 psi. Ends shall be 125 pound ANSI B16.1 flanges or 125 pound ANSI B2.1 threaded fittings. Each body section must have an access covered hole for internal inspection and each body half and disc fully machined to accept attachment of a bottom mounted oil dash pot. Provide bottom or top mounted dashpot as indicated on the Drawings. Opening and closing speed shall be field adjustable through the dash pot and needle valve. The disc shall be made of ductile iron ASTM 536. The seat ring and disc ring shall be bronze, ASTM B271 C92200, and must be of the design that permits replaceability in the field without need for special tools or machining. The pivot pins in the body and the bushings in the disc lugs shall be stainless steel, but of different hardness to prevent galling and must therefore conform to ASTM specifications A562 T303 and A276 T304, respectively. The flow area, through the valve body inlet and outlet, shall be equal to the pipe size, and gradually increased to an area 40 percent greater than the pipe size through the valve seat. Inspection ports shall be provided upstream and downstream of the valve disc. An indicator must be supplied and visually show the disc position at all times. An electrical signal switch shall be provided with each valve which can be mounted on the indicator cover to give a remote signal indicating whether the valve is opened or closed.

b. Pressure: 150 psi.

c. Service: Finished Water (Transfer Pumps), Potable Water (High Service Pumps).

d. APCO Series 800, Val-Matic Series 9000, Crispin TD Series, or approved equal.

4. CV3:

a. Valve: Check valves shall be swing check type. The valve body shall be iron, bronze mounted, single disc, 150 psi working water pressure, non-shock, and hydrostatically tested at 300 psi. Ends shall be 125 pound ANSI B16.1 flanges or 125 pound ANSI B2.1 threaded fittings depending upon location. Swing check valves shall be completely bronze fitted with a renewable bronze seat ring and a rubber faced disc. Where shown in the instrumentation design, an electrical limit switch shall be provided with each valve to give a remote signal indicating whether the valve is opened or closed.

b. Operator: Outside lever and weight.

c. Pressure: 150 psi.

d. Service: Water, Wastewater.

e. APCO Series 6000, Kennedy Figs. 106A-LW or Crispin SWC Series.

5. CV4:

a. Valve: Diaphragm check valve shall be provided and manufactured of Type I, Grade 1 PVC with an EPDM diaphragm, except for sodium hypochlorite service, for which the diaphragm shall be Viton. The check valve shall utilize a normally closed design which is entirely automatic in action. The check valve must operate effectively in any position it is installed in.

b. Pressure: 150 psi @ 73°F.

c. Service: Antiscalant, Sodium Hydroxide, Phosphate Corrosion Inhibitor, Sodium Hydroxide.

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d. Plast-O-Matic Series CKM (1/2" to 1"), CKS (1-1/2" to 3").

6. CV5:

a. Valve: Diaphragm check valve shall be as specified in 2.02.F, CV4, except the housing shall be CPVC for the sulfuric acid overflow connection, PVDF for the sulfuric acid fill connection, and the diaphragm shall be Viton.

b. Pressure: 150 psi @ 73°F.

c. Service: Sulfuric Acid Bulk Storage Overflow and Vent.

d. Plast-O-Matic Series CKM (1/2" to 1"), CKS (1-1/2" to 3").

7. CV6:

   a. Valve: Ball check valve shall be manufactured of Type I, Grade 1 PVC with EPDM seals, and designed for horizontal or vertical installation with equal effectiveness. Valves shall be provided with double true unions.

   b. Pressure: 150 psi @ 73°F.

   c. Service: Antiscalant, Sodium Hydroxide, Phosphate Corrosion Inhibitor.

   d. Asahi/America or Hayward True Check.

8. CV7:

   a. Valve: Ball check valve shall be manufactured of Type I, Grade 1 PVC with Viton seals, and designed for horizontal or vertical installation with equal effectiveness. Valves shall be provided with double true unions.

   b. Pressure: 150 psi @ 73°F.

   c. Service: Sodium Hypochlorite.

   d. Asahi/America or Hayward True Check.

9. CV8:

   a. Valve: Double-door check valves shall be manufactured of Type I, Grade 1 PVC with Viton seals, and designed for equal effectiveness when installed in any position.

   b. Pressure: 150 psi @ 70°F.

   c. Service: Finished Water, RO Permeate, RO Concentrate (low pressure), Degasifier cleaning solution.

   d. Stayflow VCDD-P Double Disc Check Valve or engineer approved equal.

10. CV9:

   a. Valve: Diaphragm check valve shall be as specified in 2.02.F, CV4, except the housing shall be PVDF and the diaphragm shall be Viton.

   b. Pressure: 150 psi @ 73°F.

   c. Service: 93% Sulfuric Acid.

d. Plast-O-Matic Series CKM (1/2” to 1”), CKS (1-1/2” to 3”).

11. CV10:

a. Valve: Check valves shall be globe style silent check valve with flanged connections. Materials of construction shall be Type 316 stainless steel body and trim. The stainless steel body and disc shall be castings of ASTM A351 Grade CF8M. The guide pins and bushings, pin retainers, spring, and lifting eye bolt shall be Type 316 stainless steel ASTM A276 S31600. The seat material shall be EPDM.

b. Pressure: 150 psi.

c. Service: Raw Water.

d. APCO Series 600, Mueller Steam 105MHT, or Titan Flow Control CV51-SS.

12. CV11: NOT USED

13. CV12: NOT USED

14. CV13:

a. Valve: Check valves shall be the double door type, fully lugged style as specified in 2.02.F., CV1.

b. Pressure: 150 psi.

c. Service: Water, pH adjusted to a minimum of 3 with sulfuric acid, RO Concentrate.

d. APCO Series 9000, Mueller Steam 72H, Titan Flow Control CV42L-SS, or Bray Check Rite.

15. CV14:

a. Valve: Ball check valve shall be manufactured of CPVC conforming to ASTM D1784 Cell Classification 23447 or 23567-A with Viton seals, and designed for horizontal or vertical installation with equal effectiveness. Valves shall be provided with double true unions.

b. Pressure: 150 psi @ 73°F.

c. Service: 93% Sulfuric Acid.

d. Asahi/America or Hayward True Check.

16. CV15:

    a. Valve: Ball check valve shall be manufactured of ASTM D3222 PVDF with Viton seals, and designed for horizontal or vertical installation with equal effectiveness. Valves shall be provided with double true unions.

    b. Pressure: 150 psi @ 73°F.

    c. Service: 93% Sulfuric Acid.

    d. Asahi/America Ball Check Valve or Plast-O-Matic True Blue.

17. CV16:

    a. Valve: Ball check valve shall be manufactured of Type 316 stainless steel, with Viton seals, and designed for horizontal or vertical installation with equal effectiveness. Valves installed on threaded piping 3-inches in diameter and less shall be provided with FNPT connections and a minimum of 1 union on the adjacent piping to allow for maintenance and removal. Valves installed on stainless tubing with compression fittings shall be compression fitting type.

    b. Pressure: 300 psi.

    c. Service: RO Permeate, RO Concentrate, Membrane Cleaning Solutions (pH adjusted to a minimum of 2 with citric or hydrochloric acid and a maximum of 12 with sodium hydroxide or sodium hypochlorite).

    d. Swagelok, Apollo, or NUPRO.

18. CV17:

    a. Valve: Ball check valve shall be manufactured of Type I, Grade 1 PVC with EPDM seals, and designed for horizontal or vertical installation with equal effectiveness. Valves shall be provided with flanged single unions.

    b. Pressure: 150 psi @ 73°F.

    c. Service: Carbonated Water, pH adjusted with CO_2.

    d. Asahi/America or Approved Equal.

G. Gate Valves:

1. General:

a. Gate valves shall have a clear waterway equal to the nominal diameter of the pipe when fully open.

ii. Operating nut or wheel shall have an arrow cast in the metal indicating the direction of opening. Each valve shall have the manufacturer's distinctive marking, pressure rating and year of manufacture cast on the body. Prior to shipment from the factory, each valve shall be tested by applying to it a hydrostatic pressure equal to twice the specified working pressure.

c. Hydrostatic and leakage test shall be conducted in strict accordance with ANSI/AWWA C500, latest revision or ANSI/AWWA C509, latest revision whichever is applicable.

d. All gate valves which are installed on pipe sizes greater than 3 inches shall have mechanical joint or flanged ends to fit the pipe run in which they are to be used. Flanged valves shall be faced and drilled to ANSI 125/150 pound standard. Mechanical joint ends shall be to the AWWA Standard C111-72. Gate valves installed on pipes 3" and smaller shall have slip on joints or screwed ends. Screwed ends shall be to the NPT standard.

e. Gate valves shall open left or counter-clockwise when viewed from the stem.

f. Buried gate valves shall be furnished with 2-inch square AWWA standard nut operators with a valve box and cover. Gate valves located above ground or inside structures shall be furnished with handwheel operators and shall have a suitable indicator arrow to give valve position from fully open to fully closed.

2. GV1:

a. Valve: Gate valves with nominal sizes from 2 to 3 inches shall conform to ANSI/AWWA C500, latest revision. Valves shall be iron body, bronze mounted, double disc, parallel seat, non-rising stem type with O-ring stem seals. Interior ferrous surfaces of valve, except for finished or bearing surfaces, shall be coated with a two-part thermosetting epoxy coating in accordance with AWWA C550, latest revision. Surfaces shall be clean, dry and free from rust and grease before coating. Exterior surfaces of valve shall be as specified hereinafter.

b. Operator: Handwheel, lever, or 2-inch Square Nut as required.

c. Pressure: 150 psi.

d. Service: Water.

e. Mueller Co. AWWA Gate Valve, American Valve and Hydrant Co. or approved equal.

3. GV2:

a. Valve: Gate valves with nominal sizes from 4 to 16 inches shall conform to ANSI/AWWA C515, latest revision except for differences in materials of construction as listed below. Valves shall be ductile iron body, resilient seat type with non-rising stem and O-ring stem seals. The valve stem shall be 316 stainless steel and the stem nut shall be of nickel-aluminum bronze. The glands and bushings shall be bronze. Valve disc shall be constructed to assure uniform seating pressure between disc seat ring and body seating surface. Body seating surface shall be machined. The valve wedge shall be constructed of ductile iron completely encapsulated in EPDM rubber. Interior and exterior to valve body and valve disc shall have a fusion bonded epoxy coating which is NSF certified and in accordance with AWWA C550, latest revision. Surfaces shall be clean, dry and free from rust and grease before coating.

b. Operator: 2-inch Square Nut or Handwheel.

c. Pressure: 150 psi.

d. Service: Water.

e. Mueller Co. AWWA Gate Valve, American Valve and Hydrant Co. CRS-80 or approved equal.

4. GV3 (Tapping Valves):

a. Tapping valves shall conform to ANSI/AWWA C500 or C509, latest revision and shall be designed for a minimum working pressure of 150 psi.

b. Cast iron tapping sleeves shall be of the mechanical joint type, with working pressure rating of 200 psi for sizes 4 inches through 12 inches and 150 psi for sizes 14 inches and larger, and shall conform to the applicable Sections of AWWA Standard C110 of latest revision.

Sleeve and glands shall be split type for assembly on pipe, and sleeve and mechanical joint glands and gaskets shall be sized for use with the

class and type of pipe being tapped. Sleeve and glands shall be Standard Bituminous Coated, and shall be furnished complete with all accessories. Outlet flange shall be Class 125 Standard. Contractor shall obtain approval from the Engineer for drilling machine used prior to tapping operations.

c. Stainless steel tapping sleeves shall be of the split type, suitable for corrosive service with a working pressure rating of 250 psi for sizes 4 inches through 12 inches and 200 psi for sizes 14 inches and larger, and shall conform to the applicable Sections of AWWA Standard C110 of latest revision. Stainless steel tapping sleeves shall be used for raw water, RO permeate and RO concentrate lines where shown on the drawings.

Material shall be 304 stainless steel which meets or exceeds all applicable requirements of ANSI B16.1, class 125 and B16.42 class 150. Sleeve and glands shall be split type for assembly on pipe, and sleeve gaskets shall be sized for use with the class and type of pipe being tapped. Sleeves shall be fully passivated, and shall be furnished complete with all accessories. Outlet flange shall be Class 125 Standard. Side bars, nuts and bolts shall be of 304 stainless steel, coated with an anti-galling compound. Contractor shall obtain approval from the Engineer for drilling machine used prior to tapping operations.

d. Tapping valves 3 to 12 inches in size:

i. Valve: Tapping valves 3 to 12 inches in size shall be resilient seat type gate valves as specified hereinabove for gate valves 3 to 12 inches in size. Resilient seat type tapping valves shall be furnished with a raised guide ring cast integrally on the flanged end which is designed to match the groove in the tapping sleeve. The purpose of this guide ring shall be to ensure true alignment of the valve with the tapping sleeve.

ii.. Operator: 2-inch Square Nut.

iii. Pressure: 150 psi.

iv.. Service: Potable Water.

v. Manufacturer: Mueller Co., American Valve and Hydrant Co., Kennedy Valve, or approved equal.

d. Tapping valves larger than 12 inches in size:

i. Valve: Tapping valves larger than 12 inches shall be iron body, bronze mounted gate valves, with double disc, parallel seat and

non-rising stem. Stem shall be bronze and sealed by two "O" rings. Stem nut shall be bronze and cast integrally into the top wedge. The valve disc seating mechanism shall be bottom wedging, hook and wedge type, with disc hooks and wedges as separate interacting parts.

Valve shall be designed for vertical mounting in approximately level setting on buried water lines. Valve ends shall be flanged American Standard Class 125 pound steam pressure rating on one side of the valve and mechanical joint on the other side for use with the class and type of pipe to be installed from the tapping valve. Tapping valves 12 inches and larger shall be furnished with a raised guide ring cast integrally on the flanged end as specified above for resilient seat type tapping valves. Interior ferrous surfaces of the valve, except for finished and bearing surfaces, shall be coated with a two-part thermosetting epoxy coating in accordance with AWWA C550, latest revision. Surfaces shall be clean, dry and free from rust and grease before coating. Exterior surfaces of valve shall be coated as specified hereinafter. The valve shall open left or counterclockwise when viewed from the stem. The valve shall be furnished with a 2-inch square AWWA standard nut operator with a valve box and cover.

ii. Operator: 2-inch Square Nut.

iii. Pressure: 150 psi.

iv. Service: Potable Water.

v. Manufacturer: Mueller Co., American Valve and Hydrant Co., Kennedy Valve, or approved equal.

5. GV4:

a. Valve: Gate valves (sizes 1/2 to 2-inch) shall be Type 316 stainless steel body and solid wedge disc confirming to ASTM A351, Grade CF8M with adjustable packing and non-rising stem. The valve bonnet, gland nut, and stem shall be Type 316 stainless steel body confirming to ASTM A351, Grade CF8M. The body seal and stem packing shall be PTFE. Valve ends connections shall be threaded NPT confirming to ANSI B1.20.1. Valves shall be pressure tested per API 598 standards.

b. Operator: Handwheel.

c. Pressure: 150 psi.

d. Service: Potable Water.

e. FNW 15B-200 or approved equal.

6. Knife Gate Valve (KGV):

a. General: Knife gate valves shall be resilient seated, full, round port design for high flow capacity and minimal pressure drop. The valve body port area shall not be less than 80% of the nominal pipe diameter. Valves shall be designed for positive drip-tight shutoff at 150 psi. All materials of construction shall be as specified herein and shall be suitable for use with finished water. Valve shall be equipped with a floor stand operator with handwheel and extensions where shown in the Drawings.

b. Body and Gate: The body material shall be 316 stainless steel ASTM A351, CF8M. Body shall have a lugged design drilled tapped in accordance with ANSI 150 standards. Gate shall be constructed of 316 stainless steel in accordance with ASTM A240, Type 316, finish ground on each side to prevent packing or seat damage.

c. Packing Gland and Packing: Packing gland shall be Type 316 stainless steel ASTM A351 CF8M. Packing gland shall have three (3) layers of fiber packing, and a fourth layer of EPDM seal. Valve packing shall be square braided PTFE impregnated synthetic fiber. Removal or replacement of packing shall be accomplished without necessitating removal of the valve from the pipe line.

d. Yoke Sleeve: Yoke super structure shall be constructed of Type 316 stainless steel ASTM A351 CF8M. Yoke sleeve shall be aluminum bronze in accordance with ASTM B30 alloy C84400. The stem shall be 316 stainless steel and have double lead threads.

e. Seat Ring and Seat: Seat Ring shall be 316 stainless steel in accordance with ASTM A240, Type 316. Resilient seat material shall be EDPM and shall be bonded to the seat ring.

f. Valve shall be as manufactured by DeZurik KGN-RSB, Red Valve Series D, or Engineer-approved equal.

H. Pressure Relief Valves:

1. PRV1:

a. Valve: Pressure relief valve shall be of the angle pattern design and manufactured of Grade 1, Type 4, CPVC with a Teflon shaft and Viton seals. Valve shall be provided with threaded-end connections.

b. Operator: Adjusting screw.

c. Pressure: 100 psi.

d. Service: Antiscalant, Phosphate Corrosion Inhibitor.

e. Plast-O-Matic, Blacoh, Griffco, or Simtech.

2. PRV2:

a. Valve: Pressure relief valve shall be of the angle or in-line pattern design and manufactured of Grade 1, Type 1, PVC with a Teflon shaft and EPDM seals. Valve shall be provided with threaded-end connections.

b. Operator: Adjusting screw.

c. Pressure: 100 psi.

d. Service: Potable Water, Finished Water, Antiscalant, Sodium Hydroxide, Phosphate Corrosion Inhibitor.

e. Plast-O-Matic, Blacoh, Griffco, or Simtech.

3. PRV3:

a. Valve: Pressure relief valve shall be of the angle or in-line pattern design and manufactured of Grade 1, Type 1, PVC with a Teflon shaft and Viton seals. Valve shall be provided with threaded-end connections.

b. Operator: Adjusting screw.

c. Pressure: 100 psi.

d. Service: Sodium Hypochlorite.

e. Plast-O-Matic, Blacoh, Griffco, or Simtech.

4. PRV4:

a. Valve: Pressure relief valve shall be of the angle or in-line pattern design and manufactured of Teflon with a Teflon shaft and Viton seals. Valve shall be provided with threaded-end connections.

b. Operator: Adjusting screw

c. Pressure: 100 psi

d. Service: 93% Sulfuric Acid.

e. Plast-O-Matic, Blacoh, Griffco, or Simtech.

5. PRV5:

a. Valve: Pressure relief valve shall be of the angle or in-line pattern design and manufactured of 316 stainless steel with a PTFE shaft and seals. Valve shall be provided with threaded-end connections.

b. Operator: Adjusting screw

c. Pressure: 150 psi

d. Service: Water.

e. Blacoh or Griffco.

I. Globe Surge Relief Valves:

1. SRV1:

a. Valve: Valves shall be globe style surge relief valve, angle pattern design meeting ANSI requirements. Body and disc shall be type 316 stainless steel, ASTM A351.

b. Pressure: 250 psi.

c. Service: Raw Water

d. GA industries, Cla-Val, APCO, or approved equal.

J. Backpressure Valves:

1. BPV1:

a. Valve: The back pressure sustaining valve shall throttle to maintain a pre-set pressure on the upstream side of the valve. If upstream pressure drops below valve setting, the valve will close. Turning clockwise on the sustaining pilot handwheel will increase the setting and turning counterclockwise will decrease the setting. Backpressure valve shall be of the in-line pattern design and manufactured of Teflon with Teflon wetted diaphragm, zinc plated steel spring, and HDPE adjusting screw. Valve shall be supplied with Hastelloy C hardware.

b. Operator: Adjusting screw.

c. Pressure: 150 psi.

d. Service: 93% Sulfuric Acid.

e. Plast-O-Matic, Blacoh, Griffco, or Simtech.

2. BPV2:

a. Valve: The back pressure sustaining valve shall throttle to maintain a pre-set pressure on the upstream side of the valve. If upstream pressure drops below valve setting, the valve will close. Turning clockwise on the sustaining pilot handwheel will increase the setting and turning counterclockwise will decrease the setting. Backpressure valve shall be of the in-line pattern design and manufactured of PVC with Teflon wetted diaphragm, 316 stainless steel spring, and HDPE adjusting screw. Valve shall be supplied with 316 stainless steel hardware. Spring and hardware shall be of Hastelloy C for sodium hypochlorite.

b. Operator: Adjusting screw.

c. Pressure: 150 psi.

d. Service: RO Permeate, Antiscalant, Sodium Hydroxide, Sodium Hypochlorite, Phosphate Corrosion Inhibitor.

e. Plast-O-Matic, Blacoh, Griffco, or Simtech.

K. Isolation Valves:

1. IV1: Not used

L. Solenoid Valves:

1. SV1:

a. Valve: Solenoid valve shall be normally closed equipped with a manual override operator. Valve shall be bronze body, resilient seated, general purpose.

b. Operator: Solenoid, 120 volt service.

c. Pressure: 100 psi

d. Service: Potable Water or Air Service.

e. ASCO Red-Hat or approved equal.

2. SV2: NOT USED

3. SV3:

a. Valve: Solenoid valve shall be normally closed equipped with a manual override operator. Valve shall be PVC with EPDM seals.

b. Operator: Solenoid, 120 volt service.

c. Pressure: 100 psi.

d. Service: RO Concentrate, Corrosive Process Samples.

e. Manufacturer: Plast-O-Matic or approved equal.

M. Air Release Valves:

1. ARV1:

a. The manual air release valve shall be a 1/4" minimum, Type 1, Grade 1 PVC laboratory ball cock valve with EPDM o-rings. The valve shall be designed to withstand 150 psi.

b. Pressure: 150 psi.

c. Service: Raw Water, General Service.

d. Manufacturer: APCO Model No. 65, Val-matic Model No. 25 or approved equal.

2. ARV2:

a. Valve: The automatic air release valve shall be designed to operate while the system is pressurized, allowing entrained air to escape through the air release orifice. After entrained air escapes through the air release orifice, the valve orifice shall be closed by a needle mounted on a simple level mechanism energized by a float. The main valve shall remain closed until more air accumulates and the opening cycle repeats automatically. The valve body and cover shall be manufactured of cast iron. With the exception of the Buna-N seat, the linkage mechanism, float and all other internal trim shall be of stainless steel. The valve shall be furnished with a 3/4 inch shutoff valve and have a 3/4 inch inlet and 1/8 inch discharge orifice. The discharge from the air release valve shall be piped to direct the discharge to the concrete slab.

b. Pressure: 150 psi.

c. Service: Potable Water.

d. Manufacturer: APCO Model No. 65, Val-matic Model No. 25 or approved equal.

3. ARV3:

a. Valve: The combination air release and vacuum valve shall be of the single housing style that combines the operating features of both an Air/Vacuum and Air Release Valve.

The Air/Vacuum portion shall automatically exhaust large quantities of air during the filling of the pipeline and automatically allows air to re-enter the pipeline when the internal pressure of the pipeline approaches a negative value due to column separation, draining of the pipeline, power outage, pipeline break, etc. The Air Release portion shall automatically release small pockets of air from the pipeline while the pipeline is in operation and under pressure. The valve shall have NPT inlet and outlet connections as shown on the drawings and a 3/32" diameter orifice for a maximum working pressure of 300 psi. The materials of construction shall be: Body, Cover and Baffle of cast iron; float and all other trim shall be of stainless steel with the exception of the Buna-N Seat and adjustable Viton Orifice Button. The discharge from the valve shall be piped to direct the discharge to the concrete slab.

b. Pressure: 150 psi.

c. Service: High Service Pump, Finished Transfer Pump, Finished Water, Potable Water, RO Concentrate.

d. Manufacturer: ARI Model D-040-C, Val-matic Model Nos. 201C, 202C, 203C, or approved equal.

4. ARV4:

a. Valve: The automatic air release valve shall be designed to operate while the system is pressurized, allowing entrained air to escape through the air release orifice. The valve shall be a single chamber design, directly operated by the flow medium. The valve shall close and fully seal when water fills the valve, and shall release accumulated air from the system while it is under pressure.

b. Pressure: 1/2" thru 1" NPT connections - 230 psi at 140°F.

c. Service: Raw Water, RO Permeate, RO Concentrate (low pressure), Membrane Cleaning Solutions, Carbonated Water, pH adjusted with CO_2.

d. Manufacturer: A.R.I. Model S-050 LP, equal model by Hayward, or Engineer approved equal.

5. ARV5:

a. Valve: The automatic air release valve shall be designed to operate while the system is pressurized, allowing entrained air to escape through the air release orifice. After entrained air escapes through the air release orifice, the valve orifice shall be closed by a needle mounted on a simple level mechanism energized by a float. The main valve shall remain closed until more air accumulates and the opening cycle repeats automatically. The valve body and cover shall be manufactured of cast iron. With the exception of the Buna-N seat, the linkage mechanism, float and all other internal trim shall be of stainless steel. The valve shall be furnished with a 2-inch shutoff valve and have a 2-inch inlet and 1/2 inch discharge orifice.

b. Pressure: 1/2" thru 1" NPT connections - 250 psi at 140°F.

c. Service: Sanitary Water, Mixed Wastewater.

d. Manufacturer: APCO Model No. 400, Val-matic Model No. 48 or approved equal.

6. ARV6:

a. Valve: The combination air release and vacuum valve shall be of the compact single chamber design with solid cylindrical HDPE control floats housed in a tubular stainless steel body with steel ends secured by means of stainless steel tie rods. The valve shall have an integral anti-shock orifice mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure to two times valve rated working pressure. Valve size shall be as noted on the Drawings. The top of the valve shall have a stainless steel AISI 316 top flange with a screen mesh from stainless steel AISI 104, and AISI 316 bottom flange.

b. Body: Valve body shall be constructed from 316 stainless steel with 316 stainless steel trim, float with EPDM seat and stainless steel diffuser screen.

c. Floats: Designs having levers and weights attached to floats will not be permitted. The interior float system for the valves shall contain four (4) major components; a baffle plate, bottom float, a top float, and an anti-

shock orifice. The baffle plate shall be constructed of 316 stainless steel. The two (2) floats and anti-shock orifice shall be constructed of high density polyethylene.

d. Top: The top of the valve shall have a stainless steel 304L flange with a screen mesh from stainless steel AISI 104, and AISI 304 bottom flange.

e. Ends: Valve ends shall be threaded for valves less than 4-inches. All air valves shall be isolated from the service line with a 316 stainless steel ball for valves up to 3 inches, and a flanged body stainless steel butterfly valve for valves greater than 3 inches (provide a spacer plate or pipe spool if required to clear the rotation of the butterfly disc).

f. Pressure: Valves shall have a working pressure of at least 400 psi.

g. Service: Raw Water.

h. Manufacturer: Vent-O-Mat Series RBX, or approved equal.

7. ARV7:

a. Valve: Air release valve shall be as specified in 2.02.M., ARV4, except Viton seals shall be provided.

b. Pressure: 1/2" thru 1" NPT connections - 230 psi at 140°F.

c. Service: Sodium Hypochlorite.

d. Manufacturer: A.R.I. Model S-050 LP, equal model by Hayward, or Engineer approved equal.

8. ARV8:

a. Valve: The combination air release and vacuum valve shall be of the single housing style that combines the operating features of both an Air/Vacuum and Air Release Valve. The Air/Vacuum portion shall automatically exhaust large quantities of air during the filling of the pipeline and automatically allows air to re-enter the pipeline when the internal pressure of the pipeline approaches a negative value due to column separation, draining of the pipeline, power outage, pipeline break, etc. The Air Release portion shall automatically release small pockets of air from the pipeline while the pipeline is in operation and under pressure. The valve shall have 2" NPT inlet and outlet connections and a 3/32" diameter orifice for a maximum working pressure of 300 psi. The materials of construction shall be: Body, Cover and Baffle of ASTM A351 Grade CF8M stainless steel; float and all other trim shall be of Stainless Steel with the exception of the Buna-N Seat

and adjustable Viton Orifice Button. The discharge from the valve shall be piped to direct the discharge to the concrete slab.

b. Pressure: 150 psi.

c. Service: RO Permeate.

d. Val-matic Model No. 202C or approved equal.

N. Vacuum Relief Valves

1. VRV1:

a. Valve: Vacuum breaker valve shall be manufactured of Type I, Grade 1 PVC and shall be provided with a EPDM diaphragm. The relief valve shall utilize a normally closed design which is entirely automatic in action. The valve shall have threaded connections.

b. Pressure: 100 psi @ 73°F.

c. Service: RO Permeate, RO Concentrate (low pressure), Sodium Hydroxide, Phosphate Corrosion Inhibitor.

d. Plast-O-Matic Series VBM or approved equal.

2. VRV2:

a. Valve: Vacuum breaker valve shall be manufactured of Type I, Grade 1 PVC and shall be provided with a Viton seals and a Teflon encapsulated stainless steel spring in services other than sulfuric acid. Valves in sulfuric acid service shall be manufactured of Type 1, Grade 1 CPVC with Viton seals and a Teflon encapsulated stainless steel spring. The relief valve shall utilize a normally closed design which is entirely automatic in action. The valve shall have solvent welded connections.

b. Pressure: 100 psi @ 73°F.

c. Service: Sodium Hypochlorite, 93% Sulfuric Acid (Tank Vent).

d. Plast-O-Matic Series VBM/VBS or approved equal.

O. Reduced Pressure Backflow Preventors

1. RPBP1 (Potable Water Service):

a. Reduced pressure backflow preventers for potable water service shall meet the requirements of AWWA C511 and shall be as specified in Section 15410: Plumbing System Valves.

P. Needle Valve

1. NV1:

a. Valve: Needle valves shall be constructed of Type 316 stainless steel, ASTM A182 body with Type 316 stainless steel internals and trim. Needle valves shall be used for fine flow control of process analyzer streams, and valve sizing, flow rate, and pressure requirements shall be confirmed by the instrument supplier. The valve body pattern shall be angle pattern or straight pattern as required for the proposed manner of installation and plumbing configuration (panel mounted or directly located on process piping). Valve end connections shall be NPT threaded or tubing compression fitting type based on the connecting plumbing type. The valve handle shall be Type 316 stainless steel bar. Valve seals shall be Viton.

b. Pressure: 300 psi

c. Service: Process Instrument Sample, RO Permeate, RO Concentrate, Finished Water, Potable Water.

d. Swagelok Integral-Bonnet Needle Valves, Tylok Ty-Flo Needle Valves or Engineer approved equal.

2. NV2

a. Valve: Needle valves shall be constructed of Grade I, Type I, PVC with Teflon seats and Viton o-rings. Needle valves shall be used for fine flow control of chemical flow streams. The valve body pattern shall be angle pattern or straight pattern as required for the proposed manner of installation and plumbing configuration. Valve end connections shall be NPT threaded or solvent welded. The valve handle shall be a PVC thumb wheel for adjusting the valve seat position. Needle valve shall have a fine pitch stem threads for precise adjustment.

e. Pressure: 150 psi @ 70°F.

f. Service: RO Permeate.

g. Hayward, Plast-O-Matic, or approved equal.

Q. Pressure Regulator/Reducing Valves

1. PRRV1:

a. Valve: Thermoplastic pressure regulator valves (sizes ½ through 3 inches) shall be constructed of PVC with threaded port FPT connections. The valve shall use of a diaphragm design and be externally adjustable by means of a screwdriver or hex head bolt with a locking nut. The valve shall automatically regulate downstream pressure to an adjustable set point of 5-125 psi. The valve shall be a one piece body construction and shall be designed to have no metal to media contact. The diaphragm shall be constructed of Viton, PTFE, or encapsulated by PTFE. Valve seals shall be Viton.

b. Pressure: 150 psi

c. Service: Potable Water, Wastewater.

d. Plast-O-Matic PR/PRH Series, Griffco G Series or Engineer approved equal.

R. Sample Valves

1. SP1:

a. Sample valves shall be mounted to the panel fronts or located directly on process piping as shown in the Contract Documents. Each valve shall be fitted with a 1/4-inch 316 SS tubing discharge spout, to prevent splashing.

b. Sample valves shall be Type 316 stainless steel, 1/4 turn plug valves, 1/4-inch size, as manufactured by Swagelok, NUPRO or Ham-Let.

c. Tubing and tubing connectors shall be Type 316 stainless steel, 1/4-inch steel design, with p lastic tube inserts, Swagelok or engineer approved equal.

S. Valve Operators:

1. General:

a. Size all operators to operate the valve at 150% of the valve's full-rated pressure.

b. Valve operators, handwheels or levers shall open by turning counter-clockwise.

c. Non-buried (exposed) valve operators shall be furnished with chainwheel operators, geared operators, extension stems, floor stands, and other elements to permit operation from the normal operating level. Valves located in process piping trenches, vaults, clearwells,

wetwells, sumps and similar confined spaces shall be furnished with all necessary appurtenances to allow valve operation from the finished floor or above-grade level.

d. Ferrous materials of construction may be used on valve operators where permitted within the specifications. Operators for valves used in corrosive services (e.g. process valves made of stainless steel or thermoplastic construction) shall be fully protected from corrosion due to leaks, sprays, and fumes from the process water and from high humidity, condensation, and moist/damp environmental conditions. Fusion bonded epoxy coating systems shall be used to encapsulate all ferrous components from such conditions. Components subject to wear from mechanical operation shall be stainless steel of suitable grade to resist corrosion from the environment. Soley using galvanized treatment of ferrous materials is not considered acceptable to meeting these requirements.

2. Manual Operators:

a. Manual operators include handwheel, chainwheel, lever and handle type operators. When the maximum force to operate a valve under full operating head exceeds 40 pounds, gear reduction operators shall be provided.

b. Lever Operator:

i. Lever shall be fabricated steel. They shall include a set screw and grease lubricated.

ii. Operator shall be capable of being locked in any position and shall be provided within adjustable memory stop.

c. Handwheel:

i. Gate operators shall be selected so that no more than 40 pounds (lb) effort on the operator will be required to open or close a gate. Gate operators shall be located at a maximum height of 42-inches above the structure. When the normal yoke elevation is above 42-inches above structure, the geared lift shall be coupled to a 90 degree bevel gear box by means of a floating shaft and lovejoy couplings. This gearbox shall be mounted on the edge of the self-contained yoke. All shafts and couplings shall be Type 304 stainless steel and aligned to acceptable coupling tolerance. All cast iron gearbox housings shall be epoxy coated in accordance with Section 09961: High Performance Paints and Coatings.

ii. All operators shall be geared and shall have a weatherproof cast iron housing or pedestal with a bronze operating nut. An effective gear ratio of at least 2:1 is required.

iii. Operator shall include position indicator and self-locking feature to prevent the disc or plug from creeping.

iv. Gear operators shall be totally enclosed and lubricated. Operators shall be grease lubricated and provided with grease fittings.

v. Handwheel operators supplied with floorstands and benchstands shall be self-locking at any position of stem travel. Cranks and handwheels shall be cast iron and hot dip galvanized after fabrication. Cranks shall be no less than 12-inches long and shall be keyed to the operating nut. Handwheels shall not have a diameter greater than 30-inches.

vi. Self-locking gear shall be a one-piece design of gear bronze material (ASTM B 427), accurately machine cut. The sector gear shall be hardened alloy steel (ASTM A 322), grade G41500 or ASTM-A 148, Grade 105-85, with thread ground and polished. The reduction gearing shall run in a proper lubricant.

d. Chainwheel:

i. Where valve location is not accessible from a standing position at a walkway or slab floor, Chainwheel operators shall be provided. Gearboxes shall be as specified for handwheel operators above, only with a chainwheel and chain guide assembly.

ii. Chain shall be type 304 stainless steel for ferrous valves, and type 316 stainless steel for stainless steel and thermoplastic valves and for valves located in chemical or corrosive process areas.

e. Buried Operators:

i. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2-inches and smaller shall have cross handle for operation for forked key. All moving parts of the valve and operators shall be enclosed in a housing to prevent contact with the soil.

ii. Buried service operators for quarter-turn valves shall be designed to withstand 450 foot-pounds of input torque at the

fully open or fully closed positions without damage to the valve or operator and shall be grease packed and gasketed to withstand a submersion in water to 10 psi.

iii. Valves shall be installed with extension stems, as required, and valve boxes.

3. Electric Motor Operated Valve Actuators:

a. General:

i. The actuators shall be suitable for use on a nominal 460 volt three-phase 60 Hertz power supply and are to incorporate motor, integral reversing starter, local control facilities, and terminals for remote control and indication connections.

i. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator.

iii. It shall be possible to carry out the setting of the torque, turns, and configuration of the indication contacts without the necessity to remove any electrical compartment covers.

b. Actuator Sizing:

i. The actuator shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. The operating speed shall be such as to give valve closing and opening at approximately 10-12 inches per minute.

c. Ambient Temperature:

i. The actuator shall be capable of functioning in an ambient temperature ranging from minus 22 °F (-30°C) to + 158°F (+70°C).

d. Motor:

i. The electric motor shall be Class F insulated with a time rating of at least 15 minutes at 104°F (40°C) or twice the valve stroking time, whichever is the longer, at an average load of at least 33% of maximum valve torque.

ii. Electrical and mechanical disconnection of the motor should be possible without draining the lubricant from the actuator gear case.

e. Motor Protection:

i. Protection shall be provided for the motor as follows:

(a) The motor shall be de-energized in the event of stall when attempting to unseat a jammed valve.

(b) Motor temperature shall be sensed by a thermostat to protect against overheating.

(c) Single phasing protection.

f. Gearing:

i. The actuator gearing shall be totally enclosed in an oil-filled gear case suitable for operation at any angle. All main drive gearing must be of metal construction. Where the actuator operates gate valves or large diameter ball or plug valves, the drive shall incorporate a lost-motion hammerblow feature. For rising spindle valves, the output shaft shall be hollow to accept a rising stem and incorporate thrust bearings of the ball or roller type at the base of the actuator, and the design should be such as to permit the gear case to be opened for inspection or disassembled without releasing the stem thrust or taking the valve out of service.

ii. Gear lubricant shall be as specified and warranted by the actuator manufacturer.

g. Hand Operation:

i. A handwheel shall be provided for emergency operation engaged when the motor is declutched by a lever or similar means; the drive being restored to power automatically by starting the motor. The hand/auto selection lever should be padlockable in both "Hand" and "Auto" positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in "Hand" without damage to the drive train.

ii. The handwheel drive must be mechanically independent of the motor drive, and any gearing should be such as to permit emergency manual operation in a reasonable time. Clockwise

operation of the handwheel shall give closing movement of the valve.

h. Drive Busing:

i. The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. Normally the drive bushing shall be positioned in a detachable base of the actuator. Thrust bearings, when housed in a separate thrust base, should be of the sealed-for-life type.

i. Torque and Turns Limitations:

i. Torque and turns limitation to be adjustable as follows:

(a) Position setting range: 2.5 to 100,000 turns, with resolution to 7.5° of actuator output.
(b) Torque setting: 40% to 100% rated torque.
(c) Torque sensing must be affected directly electrically or electronically.
(d) “Latching" to be provided for the torque sensing system to inhibit torque off during unseating or during starting in mid-travel against high inertia loads.

ii. The electric circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit. An inexpensive setting tool is required for non-intrusive calibration and interrogation of the actuator. This setting tool will provide speedy interrogation capabilities as well as security in a non-intrusive intrinsically safe watertight casing.

j. Remote Valve Position/Actuator Status Indication:

i. Four contacts shall be provided which can be selected to indicate any position of the valve with each contact externally selectable as normally open or normally closed. The contacts shall be rated at 5A, 250V AC, 30V DC.

ii. As an alternative to providing valve position, any of the four above contacts shall be selectable to signal one of the following:

(a) Valve Opening or Closing
(b) Valve Moving (Continuous or Pulsing)
(c) Local Stop Selected
(d) Local Selected
(e) Remote Selected

(f) Open or Close Interlock Active
(g) ESD Active
(h) A common fault that includes any of the following:

(1) Motor Tripped on Torque in Mid-Travel
(2) Motor Tripped on Torque Going Open
(3) Motor Tripped on Torque Going Closed
(4) Pre-Set Torque Exceeded
(5) Valve Jammed
(6) Actuator Being Operated by Handwheel
(7) Lost Main Power Phase
(8) Customer 24V DC or 120V AC Supply Lost
(9) Internal Failure Detected
(10) Thermostat Tripped

iii. Provision shall be made in the design for the addition of a contact less transmitter to give a 4-20mA analog signal corresponding to valve travel for remote indication when required.

k. Local Position Indication:

i. The actuator must provide a local display of the position of the valve. The display shall be able to be rotated in 90 degree increments so as to provide easy viewing regardless of mounting position.

ii. The actuator shall include a digital position indicator with a display from fully open to fully closed in 1% increments. Red, green, and yellow lights corresponding to Open, Closed, and Intermediate positions shall be included on the actuator. The digital display shall be maintained even when the power to the actuator is isolated.

iii. The local display should be large enough to be viewed from a distance of six feet (6') when the actuator is powered up.

l. Integral Starter and Transformer:

i. The reversing starter, control transformer, and local controls shall be integral with the valve actuator, suitably housed to prevent breathing and condensation buildup. For ON/OFF service, this starter shall be an electromechanical type suitable for 60 starts per hour and of rating appropriate to motor size. For modulating duty, the starter shall be suitable for up to a maximum of 1,200 starts per hour. The controls supply transformer shall be fed from two of the incoming three phases.

It shall have the necessary tapings and be adequately rated to provide power for the following functions:

ii. 120V AC energization of the contactor coils

(a) 24V DC output where required for remote controls
(b) Supply for all the internal electrical circuits
(c) The primary and secondary windings shall be protected by easily replaceable fuses.

m. Integral Push Buttons and Selector:

i. Integral to the actuator shall be local controls for Open, Close, and Stop, and a local/remote selector Switch, padlockable in any one of the following three positions:

(a) Local Control Only
(b) Off (No Electrical Operation)
(c) Remote Control plus Local Stop Only

ii. It shall be possible to select maintained or non-maintained local control.

iii. The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.

n. Control Facilities:

i. The necessary wiring and terminals shall be provided in the actuator for the following control functions:

ii. Removable links for substitution by external interlocks to inhibit valve opening and/or closing.

iii. Connections for external remote controls fed from an internal 24V DC supply and/or from an external supply of (min. 12V, max. 120V) to be suitable for any one or more of the following methods of control:

(a) Open, Close, and Stop
(b) Open and Close
(c) Overriding Emergency, Shutdown to Close (or Open) Valve from a "Make" Contact.

iv. Selection of maintained or push-to-run control for modes (a) and (b) above shall be provided and it shall be possible to

reverse valve travel without the necessity of stopping the actuator. The starter contactors shall be protected from excessive current surges during travel reversal by an automatic time delay on energization of approximately 300 ms.

v. Provision shall be made for connectivity with field bus control systems via a plug-in card. The following interfaces shall be available:

(a) DeviceNet
(b) Hardwired Connections

vi. The internal circuits associated with the remote control and monitoring functions are to be designed to withstand simulated lightning impulses of up to 2.0 kV.

o. Monitoring and Diagnostics Facilities:

i. Facilities shall be provided for monitoring actuator operation and availability as follows:

ii. Monitor (availability) relay, having one change-over contact, the relay being energized from the control transformer only when the Local/Off/Remote selector is in the "Remote" position to indicate that the actuator is available for remote (control room) operation.

iii. Where required, it shall be possible to provide indication of thermostat trip and "Remote" selected as discreet signals.

iv. A non-intrusive hand-held computer must be available, capable of duplex communication for uploading and downloading all variables for the actuator as well as performing detailed diagnostics.

v. Actuators shall include a diagnostic module, which will store and enable download of historical actuator data to permit analysis of changes in actuator or valve performance. A software tool shall be provided to allow configuration and diagnostic information to be reviewed and analyzed and reconfigured.

vi. Diagnostic status screens must be provided to show multiple functions simultaneously so troubleshooting can be affected rapidly and efficiently. All diagnostic information should be

contained on no more than eight (8) screens so multiple functions can be checked simultaneously.

vii. Provision shall be made to display valve torque demand as a percent of rated actuator torque and position simultaneously, so as to facilitate valve troubleshooting and diagnostics.

p. Wiring and Terminals:

i. Internal wiring shall be of tropical grade PVC insulated stranded cable of appropriate size for the control and three-phase power. Each wire shall be clearly identified at each end.

ii. The terminals shall be embedded in a terminal block of high tracking resistance compound.

iii. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal.

iv. The terminal compartment of the actuator shall be provided with a minimum of three threaded cable entries. When required, a forth cable entry shall be provided.

v. All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable.

vi. Control logic circuit boards and relay boards must be mounted on plastic mounts to comply with double insulated standards. No more than a single primary size fuse shall be provided to minimize the need to remove single covers for replacement.

vii. A durable terminal identification card showing plan of terminals shall be provided attached to the inside of the terminal box cover indicating:

(a) Serial Number
(b) External Voltage Values
(c) Wiring Diagram Number
(d) Terminal Layout

viii. This must be suitable for the contractor to inscribe cable core identification beside terminal numbers.

q. Enclosure:

i. Actuators shall be 'O' ring sealed, watertight to NEMA 6, and shall at the same time have an inner watertight and dustproof 'O' ring seal between the terminal compartment and the internal electrical elements of the actuator fully protecting the motor and all other internal electrical elements of the actuator from ingress of moisture and dust when the terminal cover is removed on site for cabling.

ii. Enclosure must allow for temporary site storage without the need for electrical supply connection.

iii. All external fasteners should be of stainless steel.

iv. Actuators for explosion/hazardous applications shall in addition be certified flameproof for Zones 1 and 2 (Divisions 1 and 2) Group gases.

r. Startup Kit:

i. Each actuator shall be supplied with a startup kit comprising installation instruction, electrical wiring diagram, and sufficient spare cover screws and seals to make good any site losses during the commissioning period.

s. Performance Test Certificate:

i. Each actuator must be performance tested and individual test certificates shall be supplied free-of-charge. The test equipment should simulate a typical valve load and the following parameters should be recorded:

(a) Current at maximum torque setting.
(b) Torque at maximum torque setting.
(c) Flash Test Voltage.
(d) Actuator Output Speed or Operating Time.

ii. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

t. Warranty:

i. Each actuator shall be warranted for a minimum of 24 months of operation following start-up, up to a maximum of 36 months from shipment.

u. Experience:

i. All technologies and devices used in the actuator must have a minimum of five years' of commercial operating experience for that specific manufacturer, including torque and position sensing, lubrication, and electrical compartment design. Manufacturer must provide five (5) Florida municipal site references of similar applications.

v. Acceptable Manufacturers:

i. Rotork Controls, Inc.
ii. Limitorque Valve Controls.
iii. No equals will be considered.

4. Accessories:

a. Valve boxes for Buried Service Valves:

i. Valve boxes shall be two-piece sliding type cast iron with extension shafts. Units shall be Mueller H-10364, Clow Figure F-2452, or approved equal.

ii. Extension pipe shall be cast iron cut to fit finished grade. Coat buried cast iron pieces with coal tar epoxy.

b. Extension Stems for Buried Valve Operators:

i. Where the depth of the valve is such that its centerline is more than four feet below grade, provide operating extension stems to bring the operating nut to a point of six inches below the surface of the ground and/or box cover.

ii. Extension stems shall be steel and shall be complete with a two-inch operating nut.

iii. Where the location of the valve is such that it is located directly below another pipe, install the gear reducing operator on the side of the valve with the operating nut in the vertical position to provide easy access to the operator.

c. Valve Tags:

i. Each valve operator shall be provided with a 1-1/2-inch minimum diameter stainless steel tag. Each tag shall bear the valve number shown on the Drawings. The tags shall be attached to the operator with stainless steel key rings so that

ring and tag cannot be removed. The numbers and letters shall be of block type, with 1/4-inch high numbers and letters stamped thereon.

2.03 ACCESSORIES

A. Expansion Joints:

1. Water Service

a. Expansion joints shall be manufactured of molded EPDM with a single wide arch. Expansion joints shall be suitable for buried service or above ground service. Flanges shall be drilled to ANSI 125#. Working pressures are as follows:

Size	Pressure
2" – 12"	150#
14"	130#
16" – 20"	110#
24" – 30"	100#
36"	90#

b. Maximum temperature shall be 250 degrees F. Expansion joints shall be Model 100 HT/711 as manufactured by Metraflex or approved equal.

c. Expansion joints shall be furnished with 316 stainless steel split, beveled retaining rings and control rod assemblies to limit over expansion or compression. A minimum of two control units shall be furnished with each expansion joint and shall be suitable for working pressures as specified above.

2. Chemical Solution Service:

a. Expansion joints shall be manufactured of molded elastomer with a single wide arch, regular or reducing style as shown in the drawings. Expansion joints shall be suitable for above ground service with PVC piping. Elastomers shall be suitable for the proposed chemical service as follows:

Solution Type	Cover/Tube Material
Membrane Cleaning Solutions	EPDM
RO Permeate	EPDM

Flanges shall be drilled to ANSI 125#. Working pressures are as follows:

Size	Pressure
2" – 12"	150#
14"-24"	100#

b. Maximum temperature shall be 250 degrees F. Expansion joints shall be as manufactured by PROCO Series 260 or approved equal.

c. Expansion joints shall be furnished with 316 stainless steel split, beveled retaining rings and control rod assemblies to limit over expansion or compression. A minimum of two control units shall be furnished with each expansion joint and shall be suitable for working pressures as specified above.

3. Wastewater Service

a. Expansion joints shall be manufactured of molded chlorobutyl and polyester with a filled single arch. Expansion joints shall be suitable for buried service or above ground service. Flanges shall be drilled to ANSI 125#. Working pressures are as follows:

Size	Pressure
2" – 12"	150#
14"	130#
16" - 20"	110#
24" - 30"	100#
36"	90#

b. Maximum temperature shall be 250 degrees F. Expansion joints shall be Model 100 HT/711 as manufactured by Metraflex or approved equal.

c. Expansion joints shall be furnished with 304 stainless steel split, beveled retaining rings and control rod assemblies to limit over expansion or compression. A minimum of two control units shall be furnished with each expansion joint and shall be suitable for working pressures as specified above.

B. Strainers:

1. Strainers shall be installed as shown on the Drawings and shall be of the "Y" type. Strainers for water service shall have bronze bodies with a removable bronze screen.

2. PVC wye strainers shall be manufactured of the same material as the PVC pipe to which it is installed, with 30-mesh screens and viton seals. Connecting ends

shall be socket type, solvent weld. Provide one (1) spare screen for each strainer.

C. Unions:

1. Unions on ferrous pipe 2 inches in diameter and smaller shall be 150 pounds malleable iron, zinc-coated. Unions on water piping 2-1/2 inches in diameter and larger shall be flange pattern, 125-pound class, zinc-coated. Gaskets for flanged unions shall be of the best quality fiber, plastic, or leather. Unions shall not be concealed in walls, ceilings, or partitions.

D. Diaphragm Seals:

1. Diaphragm seals shall be installed on pressure gauge connections to protect pressure gauges and switches used to monitor pressures from excessive pressures. The diaphragm shall be "thread attached" to both piping and pressure switches. The top housing, bottom housing and diaphragm shall be constructed of 316 stainless steel, except that the bottom housing of all diaphragm seals connected to PVC or CPVC lines shall be constructed of matching material.

2. Diaphragm seals shall have a flushing connection and be Type RA by Mansfield and Green, equal product manufactured by Trerice or Marshalltown, Instruments, or approved equal.

E. T-Handled Operating Wrench:

1. One each galvanized operating wrenches, 4 feet long.

2. Manufacturers and Products:

a. Mueller; No. A-224610.

b. Clow No.; F-2520.

F. Extension Bonnet for Valve Operator: Complete with stem and accessories for valve and operator.

1. Manufacturers and Products:

a. Pratt.

b. DeZurik

G. Floor Box and Stem:

1. Plain type, for support of nonrising type stem.

2. Complete with stem, operating nut, and stem guide brackets.

3. Stem Guide: Space such that stem L/R ratio does not exceed 200.

4. Anchor Bolts: Type 304 SST.

5. Manufacturers and Products:

a. Neenah Foundry: R 7506.

b. Clow; No. F5690.

2.04 MONITORING AND CONTROL

A. The supplier of equipment under this section is responsible for coordinating with the I&C System Supplier to ensure that its equipment is compatible with and provides all necessary ancillary and accessory equipment to accept control signals provided by the SCADA system and provide monitoring and feedback signals to the SCADA system that are specified in Section 13410: Basic Instrumentation Requirements. This shall include all equipment control switches, flow detection switches, motor winding temperature switches and position switches that are mounted on or adjacent to the equipment for monitoring the performance of that piece of equipment. This shall also include all relays, transmitters, dry contacts and termination switches that are required on, adjacent to or in control panels supplied by the equipment vendor that are necessary to interface with the PLC/SCADA control system.

2.05 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION

A. All exterior surfaces of iron body valves shall be clean, dry and free from rust and grease before coating.

B. For valves installed underground or in valve vaults, all exterior ferrous parts or valve and actuator shall be coated at the factory with a thermally bonded epoxy coating in accordance with AWWA C550, latest revision, or with coal tar epoxy. Coal tar epoxy shall be applied in two 8 mil dry film thickness coats for a minimum total finish dry film thickness of 16 mils. Prior to backfilling, all uncoated nuts, bolts, glands, rods and other part of joints shall be coated in the field with coal tar epoxy. The coal tar epoxy shall be Carboline Bitumastic No. 300-M, Americoat No. 78, or approved equal.

C. For above-ground service, the exterior ferrous parts of all valves shall be coated as follows:

1. Prior to shipment from the factory, valves shall be coated with a thermally bonded epoxy coating in accordance with AWWA C550, latest revision, or shall be shop painted with one coat, 1.5 mils dry film thickness, of a combination lead and chromate primer with rust-inhibitive pigments and synthetic resins.

2. Following installation in the field, valves shall be painted with one coat, 1.5 mils dry film thickness, of a combination lead and chromate primer with rust-inhibitive pigments and synthetic resins. Valves shall be finish painted with two coats, 1.5 mils dry film thickness each coat, of a medium to long oil alkyd resin coating. Field applied coatings shall be as manufactured by the Carboline or an equal approved by the Engineer. The color of the finish coats shall be in accordance with the piping color code in the painting schedule.

D. All exterior surfaces of stainless steel valves shall be clean, dry and free from rust and surface contaminants. Stainless steel castings shall be of a smooth, bright, pit-free appearance. Fabricated stainless steel valve bodies shall be pickled and passivated following the fabrication process to remove surface contaminants.

3.02 INSTALLATION

A. All valves and appurtenances shall be installed 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. After installation, all valves and appurtenances shall be tested at least 2 hours at the working pressure corresponding to the class of pipe, unless a different test pressure is specified. If any joint proves to be defective, it shall be repaired to the satisfaction of the Engineer.

C. Install all floor boxes, brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures which have a direct bearing on their location and the Contractor shall be responsible for the proper location of these valves and appurtenances during the construction of the structures.

D. Pipe for use with flexible couplings shall have plain ends as specified in the respective pipe sections in Division 15.

E. Flanged joints shall be made with bolts, nuts and washers as specified in the respective pipe sections in Division 15. Mechanical joints shall be made with mild corrosion resistant alloy steel bolts and nuts. All exposed bolts shall be painted the same color as

the pipe. All buried bolts and nuts shall be heavily coated with two (2) coats of bituminous paint comparable to Inertol No. 66 Special Heavy.

F. Pressure gauges shall not be installed until after the substantial completion date unless otherwise requested by the Owner.

G. Valve boxes with concrete bases shall be installed for each buried valve as shown on the Drawings. The valve box shall be centered accurately over the operating nut and the entire assembly shall be plumb. The tops of valve boxes shall be adjusted to the proper elevation as specified below and as shown on the Drawings.

1. In paved areas, top of valve box covers shall be set flush with pavement. Following paving operations, a 30-inch square shall be neatly cut in the pavement around the box and the paving removed. The top of the box shall then be adjusted to the proper elevation and a 30-inch square by 6-inch thick concrete pad poured around the box cover. Concrete pads in traffic areas shall be reinforced with No. 4 reinforcement bars as shown on the drawings. Concrete for the pad shall be 3,000 psi compressive strength.

2. In unpaved areas, tops of valve box covers shall be at least 0.20 foot above finished grade. After the top of the box is set to the proper elevation, a 30-inch square by 6-inch thick concrete pad shall be poured around the box cover. Concrete for the pad shall be 3,000 psi compressive strength.

3. The concrete pad for the valve box cover shall have a 2-inch diameter, bronze disc embedded in the surface as shown on the Drawings. The bronze disc shall have the following information neatly stamped on it: the size of the valve; the number of turns to open; the direction to open; and the year of installation.

H. Valve Orientation:

1. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet inches or less above finished floor, unless otherwise shown.

2. Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above finish floor, unless otherwise shown.

3. If no plug valve seat position is shown, locate as follows:

a. Horizontal Flow: The flow shall produce an "unseating" pressure, and the plug shall open into the top half of valve.

b. Vertical Flow: Install seat in the highest portion of the valve.

I. Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or the in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

J. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

K. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

3.03 INSPECTION AND TESTING

A. Completed pipe shall be subjected to hydrostatic pressure test for 4 hours at full working pressure. All leaks shall be repaired and lines retested as approved by the Engineer. Prior to testing, the gravity pipelines shall be supported in an approved manner to prevent movement during tests.

3.04 START-UP AND INSTRUCTION

A. Manufacturer's Representative: Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. One (1) person-day per completion phase for installation assistance and inspection. No less than a total of three (3) person-days of installation assistance.

2. One (1) person-day per completion phase for functional and performance testing and completion of Manufacturer's Certificate or Proper Installation and pre-startup classroom or site training. No less than a total of three (3) person-days of functional and performance testing.

B. See Section 01650: Start-Up and Demonstration.

END OF SECTION

SECTION 15101

BUTTERFLY VALVE GEAR OPERATORS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: Furnish and install replacement gear operators in the locations as shown on the Drawings and as specified herein.

B. Related Work Described Elsewhere:

1. Valves and Appurtenances: Section 15100.

2. Mechanical: Division 15.

1.02 QUALITY ASSURANCE

A. Qualifications:

1. All replacement gear operators intended for identical services shall be manufactured by one (1) manufacturer. Manufacturer shall certify that replacement gear operators are compatible with the existing butterfly valves. Any required valve modifications for the retrofit shall be provided at no extra cost to the Owner.

2. Acceptable Manufacturers:

a. Replacement gear operators shall be manufactured by Rotork or Engineer approved equal.

1.03 SUBMITTALS

A. Materials and Shop Drawings: Copies of all materials required to establish compliance with the Specification shall be submitted in accordance with the provisions of the General Conditions, Section 01340: Shop Drawings, Working Drawings, and Samples, and Section 15100: Valves and Appurtenances.

B. Contractor shall submit a detailed replacement plan providing the proposed sequence for the temporary shutdowns, replacements, and disinfection outlining the step-by-step sequence to demonstrate the capability to complete the replacements within the allotted shutdown duration.

C. Submit to the Engineer within 30 days after execution of the contract a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.

D. Complete shop drawings of all gear operators and appurtenances shall be submitted to the Engineer for approval in accordance with the requirements of Section 01340 and the General Conditions. In addition, valve manufacturer shall certify in writing that gear operator design and materials of construction are suitable for the intended service.

E. Quality Control Submittals:

1. Tests and inspection data.

2. Manufacturer's Certificate of Proper Installation.

3. Operation and Maintenance Manual.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials shall be delivered, stored and handled in accordance with Section 15100: Valves and Appurtenances.

1.05 WARRANTY AND GUARANTEES

A. The manufacturer's written warranty shall be submitted as specified in Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for one (1) year, commencing at the time of final acceptance by the Owner.

1.06 SPARE PARTS

A. Special tools, if required for normal operation and maintenance shall be supplied with the equipment.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Approved Materials

1. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555.320(3) Florida Administrative Code.

B. Gear Operators

1. Replacement gear operators shall be Rotork AB-RAW-SS quarter-turn gear operators, or Engineer approved equal, and shall be designed to withstand harsh and highly corrosive applications such as marine and chemical environments. Gears shall be composed of Type 316 stainless steel housing with a special dynamic sealing arrangement on the critical rotating position indicator, and shall include high performance axial needle bearings. Extension stems shall be Type 316 stainless steel with a 2" stainless steel nut.

2. Gear operator housing, input shaft, stop bolt covers, valve adaption hardware and fasteners, and handwheels shall be Type 316 stainless steel.

3. Stroke: 0 - 90° (± 5° adjustable).

4. Service Conditions: Chlorinated Water, Submerged.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation and retrofit shall be performed by a certified manufacturer's representative in accordance with manufacturer's recommendations and Section 15100: Valves and Appurtenances.

B. Floor Box and Stem: Extension stem length shall locate operating nut in existing floor box.

END OF SECTION

SECTION 15105

PROCESS CONTROL VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: Furnish and install process control valves for modulating service of the type(s) and size(s) and in the location(s) as shown on the Drawings and/or specified herein.

B. Related Work Described Elsewhere:

1. Reverse Osmosis Treatment Units: Section 11250.

2. Valves and Appurtenances: Section 15100.

3. Mechanical: Division 15.

4. Electrical: Division 16.

1.02 QUALITY ASSURANCE

A. Qualifications:

1. All valves intended for identical services shall be of the same type, class, and duty and shall be manufactured by one (1) manufacturer.

2. Acceptable Manufacturers:

a. V-port ball valves shall be manufactured by Dezurik, Neles-Jamesbury, or Flow-Tek. No equals will be considered.

b. High performance butterfly valves shall be manufactured by Dezurik, Neles-Jamesbury, or Bray Controls. No equals will be considered.

1.03 SUBMITTALS

A. Materials and Shop Drawings: Copies of all materials required to establish compliance with the Specification shall be submitted in accordance with the provisions of the General Conditions, Section 01340: Shop Drawings, Working Drawings, and Samples, and Section 15100: Valves and Appurtenances.

B. Submit to the Engineer within 30 days after execution of the contract a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.

C. Complete shop drawings of all valves and appurtenances shall be submitted to the Engineer for approval in accordance with the requirements of Section 01340 and the General Conditions. In addition, valve manufacturer shall certify in writing that valve design and materials of construction are suitable for the intended service.

D. Valve manufacturer shall submit sizing calculations to demonstrate compliance with acceptable control range, noise and no cavitation over operating range.

E. Quality Control Submittals:

1. Certificate of Compliance for:

a. Electric operators; full compliance with AWWA C540.

b. Ball valves; full compliance with AWWA C 507 in available sizes.

2. Tests and inspection data.

3. Manufacturer's Certificate of Proper Installation.

4. Operation and Maintenance Manual.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials shall be delivered, stored and handled in accordance with Section 15100: Valves and Appurtenances.

1.05 WARRANTY AND GUARANTEES

A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Section 01740: Warranties and Bonds. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for one (1) year, commencing at the time of final acceptance by the Owner.

1.06 SPARE PARTS

A. Provide one (1) set of valve packing for every five valves supplied. No less than one (1) set of packing shall be provided for each type and model of valve supplied.

B. Provide spare parts and/or accessories for electric motor operated actuators per Section 15100: Valves and Appurtenances.

C. Special tools, if required for normal operation and maintenance shall be supplied with the equipment.

PART 2 - PRODUCTS

2.01 SERVICE DESCRIPTION

A. Process Control Valves

1. RO Concentrate Control Valves (CCV-3, CCV-4)

a. Control valves for RO skid concentrate service shall be sized to maintain pressure and flow as specified in Table 15105-1 and shall be of the V-port design as described below.

2.02 GENERAL

A. Valve to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation.

B. All valves and appurtenances shall be of the size shown on the Drawings and all equipment of the same type shall be from one manufacturer.

C. All valves and appurtenances shall have the name of the maker and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

D. All external bolts, washers and nuts shall be Type 316 stainless steel, unless specified otherwise.

E. Factory Finishing:

1. Epoxy Lining and Coating:

a. Ferrous components shall be coated in accordance with AWWA C550 unless otherwise specified.

b. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as "fusion" or "fusion bonded" epoxy.

c. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2. Exposed Valves:

a. In accordance with Section 09961: High Performance Paints and Coatings.

b. Safety isolation valves and lockout valves with handles, handwheels, or chain wheels "safety yellow."

2.03 MATERIALS AND EQUIPMENT

A. Approved Materials

1. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555.320(3) Florida Administrative Code.

B. V-Port Ball Valves

1. Valves shall consist of a V-port ball composed of Type 316 stainless steel with hard chrome facing. Shafts shall be Type 316 stainless steel with splined ball-to-shaft connections providing a blowout proof device. Bearings shall be Type 316 stainless steel with PTFE bonded fabric.

2. The valve seat shall consist of reinforced PTFE. Reinforced PTFE seats shall provide bi-directional shutoff to ANSI Class VI. The valve shall have a removable seat retainer.

3. An encapsulated hard faced overlay shall be available on the ball and seat. Solid stellite bearings shall be available for abrasion resistance. Valve pins shall be removable without damage to the valve shaft.

4. The valve body shall be of cast Type 316 stainless steel (ASTM A351, Grade CF8M). Integral cast flanges for ANSI service as indicated in Table 15105-1. The valve shall have a removable bottom shaft cover for maintenance purposes.

5. The valve shall be controlled electrically. Actuation shall be according to Specification 15100. Manual overrides shall be provided through the use of a handwheel operator.

6. Control valves shall be capable of controlling the flow at the specified minimum and maximum flow conditions and within the acceptable operating range as indicated in Table 15105-1 herein.

7. All V-port ball valves shall be as manufactured by DeZURIK, Neles-Jamesbury, or Flow-Tek.

8. Testing: All valves shall be hydrostatic and leak tested in accordance with AWWA C-504.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's recommendations and Section 15100: Valves and Appurtenances.

3.02 START-UP AND INSTRUCTION

A. Manufacturer's Representative: Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. One (1) person-day per completion phase for installation assistance and inspection. No less than a total of three (3) person-days of installation assistance.

2. One (1) person-day per completion phase for functional and performance testing and completion of Manufacturer's Certificate or Proper Installation and pre-startup classroom or site training. No less than a total of three (3) person-days of functional and performance testing.

B. See Section 01650 - Start-Up.

TABLE 15105-1
PROCESS CONTROL VALVES - DESIGN REQUIREMENTS

Item/Design Conditions	**RO Concentrate Control Valve**
Equipment Tag Number (Match Existing Nomenclature):	CCV-3 CCV-4
Valve Type:	V-Port
Valve Size:	4-inch
Design Pressure Drop	175-psi
End Connections	ANSI Class 300# Flange
Water Rate of Flow, Min/Max	312/347 gpm
Maximum Allowable Noise Level	80 dBa
Acceptable Control Range, % Open, Min/Max	20%/80%

1. Final valve size to be coordinated by the OEM with the membrane system supplied.

END OF SECTION

SECTION 15126

PIPE HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment and incidentals and install pipe hangers, supports, concrete inserts, and anchor bolts including all metallic hanging and supporting devices for supporting exposed piping.

B. Related Work Described Elsewhere:

1. Concrete is included in Division 3.

2. Metal fabrications are included in Division 5.

3. Painting is included in Section 09961.

4. Pipe and fittings are included in respective sections of Division 15.

5. Mechanical - General Requirements: Section 15000.

C. General Design (Not Applicable)

1.02 QUALITY ASSURANCE

A. Hangers and supports 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 pipe supports shall be five (5) times the ultimate tensile strength of the material, assuming 10 feet of water filled pipe being supported.

B. 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, the Contractor shall submit a certification stating that such requirements have been complied with.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Submit to the Engineer for approval, as provided in Section 01340: Shop Drawings, Working Drawings, and Samples, shop drawings of all items to be furnished under this Section.

2. Submit to the Engineer, for approval, samples of all materials specified herein.

1.04 PRODUCT DELIVERY STORAGE AND HANDLING

A. The equipment provided under this section shall be shipped, handled and stored in accordance with the Manufacturer's written instructions, and in accordance with Section 01600: Materials and Equipment.

1.05 WARRANTY AND GUARANTEES

A. Provide equipment warranty in accordance with Section 01740: Warranties and Bonds.

PART 2 - PRODUCTS

2.01 GENERAL

A. All pipe and tubing shall be supported as required to prevent significant stresses in the pipe or tubing material, valves, and fittings and to support and cure 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. All pipe supports shall be approved prior to installation.

B. The Contractor shall select and design all piping support systems within the specified spans and component requirements. Structural design and selection of support system components shall withstand the dead loads imposed by the weight of the pipes filled with water, plus any insulation. Commercial pipe supports and hangers shall have a minimum safety factor of 5.

C. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports and details on any drawings shall not relieve the Contractor of the responsibility for providing them throughout the plant.

D. All support anchoring devices, including anchor bolts, inserts and other devices used to anchor the support onto a concrete base, roof, wall or structural steel works, shall be of the proper size, strength and spacing to withstand the shear and pullout loads imposed by loading and spacing on each particular support.

E. All materials used in manufacturing hangers and supports shall be capable of meeting the respective ASTM Standard Specifications with regard to tests and physical and chemical properties, and be in accordance with MSS SP-58.

F. Hangers and supports shall be spaced in accordance with ANSI B31.1.0 except that the maximum unsupported span shall not exceed 10 feet unless otherwise specified herein.

G. Unless otherwise specified herein, pipe hangers and supports shall be as manufactured by ITT Grinnel Co., Inc., Carpenter and Patterson, Inc., or equal. Any 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. Any item comparable in type, style, quality, design and performance will be considered for approval.

2.02 MATERIALS AND EQUIPMENT

A. Pipe Hangers and Supports for Metal Pipe:

1. Suspended single pipes shall be supported by hangers suspended by steel rods from galvanized concrete inserts, beam clamps, or ceiling mounting bolts as follows:

a. Hangers

Pipe Size, Inches	Grinnel Fig. No.
Less than 1/2	138R
1/2 through 1	97C
1-1/4 through 4	104
6 through 12	590
14 through 30	171

b. Hanger rods shall be rolled steel machine threaded with load ratings conforming to ASTM Specifications and the strength of the rod shall be based on root diameter. Hanger rods shall have the following minimum diameters:

Pipe Size, Inches	Min. Rod Diameter, In.
Less than 2-1/2	3/8
2-1/2 to 3	1/2
4	5/8
6	3/4
8 to 12	7/8
14 to 18	1

c. Where applicable, structural attachments shall be beam clamps. Beam clamps, for rod sizes 1/2-inch through 3/4-inch shall be equal to Grinnel

Fig. No. 229, and for rod sizes 7/8-inch through 1-1/4 inches shall be equal to Grinnel Fig. No. 228, or equal.

d. Concrete inserts for pipe hangers shall be; continuous metal inserts designed to be used in ceilings, walls or floors, spot inserts for individual pipe hangers, or ceiling mounting bolts for individual pipe hangers and shall be as manufactured by Unistrut Corp., Wayne, Michigan; Carpenter and Patterson, Inc., Laconia, New Hampshire; Richmond or equal and shall be as follows:

1) Continuous concrete inserts shall be used where applicable and/or as shown on the Drawings and shall be used for hanger rod sizes up to and including 3/4-inch diameter. Inserts to be used where supports are parallel to the main slab reinforcement shall be Series P3200 by Unistrut Corp., Fig 1480 Type 2 by Carpenter and Patterson, Inc., or equal. Inserts to be used where supports are perpendicular to the main slab reinforcement shall be Series P3300 by Unistrut Corp., Fig. 1480 Type I by Carpenter and Patterson, Inc. or equal.

2) Spot concrete inserts shall be used where applicable and shall be used for hanger sizes up to and including 7/8-inch diameter. Inserts shall be Fig. 650 by Carpenter and Patterson, Inc. for hanger rod sizes 1/2-inch through and including 3/4-inch, and Fig. 266 by Carpenter and Patterson Inc., for 7/8-inch hanger rods.

3) Ceiling mounting bolts shall be used where applicable and be for hanger rod sizes l-inch through and including 1-1/4 inches and shall be Fig. 104M as manufactured by Carpenter and Patterson, Inc., or equal.

e. All pipe hangers shall be capable of vertical adjustment under load and after erection. Turnbuckles, as required and where applied, shall be equal to Grinnel Fig. No. 230.

2. Wall or column supported pipes shall be supported by welded steel brackets equal to Grinnel Fig. 194, 195 and 199 as required, for pipe sizes up to and including 20-inch diameter. Additional wall bearing plates shall be provided where required.

a. Where the pipe is located above the bracket, the pipe shall be supported by an anchor chair and U-bolt assembly supported by the bracket for pipes 4 inches and larger and by a U-bolt for pipes smaller than 4 inches. Anchor chairs shall be equal to Carpenter Patterson Fig. No. 127. U-bolts shall be equal to Grinnel Fig. No. 120 and 137.

b. Where the pipe is located below the bracket, the pipes shall be supported by pipe hangers suspended by steel rods from the bracket. Hangers and steel rods shall be as specified above.

3. Floor supported pipes 3-inches and larger in diameter shall be supported by either cast-in-place concrete supports or adjustable pipe saddle supports as directed by the Engineer. In general, concrete supports shall be used when lateral displacement of the pipes is probable (unless lateral support is provided), and adjustable pipe saddle type supports shall be used where later displacement of pipes is not probable.

   a. Each concrete support shall conform to the details shown on the Drawings. Concrete shall be poured after the pipe is in place with temporary supports. Concrete piers shall conform accurately to the bottom 1/3 to 1/2 of the pipe. Top edges and vertical corners of each concrete support shall have l-inch bevels. Each pipe shall be secured on each concrete support by a wrought iron or steel anchor strap anchored to the concrete with cast-in-place bolts or with expansion bolts. Where directed by the Engineer, vertical reinforcement bars shall be grouted into drilled holes in the concrete floor to prevent overturning or lateral displacement of the concrete support. Unless otherwise approved by the Engineer, maximum support height shall be five (5) feet.

   b. Concrete piers used to support base elbows and tees shall be similar to that specified above. Piers may be square or rectangular.

   c. Each adjustable pipe saddle support shall be screwed or welded to the corresponding size 150 pound companion flanges or slip-on welding flanges respectively. Supporting pipe shall be of Schedule 40 steel pipe construction. Each flange shall be secured to the concrete floor by a minimum of two (2) expansion bolts per flange. Adjustable saddle supports shall be equal to Grinnel Fig. No. 264. Where used under base fittings, a suitable flange shall be substituted for the saddle.

4. Vertical piping shall be supported as follows:

   a. Where pipes change from horizontal to vertical, the pipes shall be supported on the horizontal runs within 2 feet of the change in direction by pipe supports as previously specified herein.

   b. For vertical runs exceeding 15 feet, pipes shall be supported by approved pipe collars, clamps, brackets, or wall rests at all points required to insure a rigid installation.

   c. Where vertical piping passes through a steel floor sleeve, the pipe shall be supported by a friction type pipe clamp which is supported by the pipe sleeve. Pipe clamps shall be equal to Grinnel Fig. 262.

5. Anchor bolts shall be equal to Kwik-Bolt as manufactured by the McCullock Industries, Minneapolis, Minnesota, or Wej-it manufactured by Wej-it Expansion Products, Inc., Bloomfield, Colorado.

6. All rods, hangers, inserts, brackets, and components shall be furnished with galvanized finish.

B. Pipe Hangers and Supports for Plastic Pipe:

1. Single plastic pipes shall be supported by pipe supports as previously specified herein.

2. Multiple, suspended, horizontal plastic pipe runs, where possible, and rubber hose shall be supported by ladder type cable trays such as the Electray Ladder by Husky-Burndy, the Globetray by the Metal Products Division of United States Gypsum, or equal. Ladder shall be of mild steel construction. Rung spacing shall be approximately 18 inches for plastic pipe and 12 inches for rubber hose. Tray width shall be approximately 6-inch for single runs of rubber hose and 12 inches for double runs of rubber hose. 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 equal to Globe Model M-CAC, Husky-Burndy Model SCR or approved equal. Spacing between clamps shall not exceed 9 feet. The cable trays shall provide continuous support along the length of the pipe.

3. Individual clamps, hangers, and supports in contact with plastic pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

C. Pipe Supports for Small Diameter PVC and Steel Pipe:

1. Small diameter Schedule 80 PVC piping 3-inches in diameter and smaller, and steel piping 2-inches in diameter and smaller shall be supported with "SUSPORT" system arrangements as manufactured by Universal Suspension Systems Inc. of Gillette, New Jersey or an equal approved by the Engineer. Clamping halves for the pipe support shall be manufactured of molded polypropylene and shall support and fit closely for 360° around the pipe. To support piping carrying non-corrosive fluids or gases and located in noncorrosive, indoor environments, all hardware for the "SUSPORT" system shall be nickel chrome plated carbon steel. To support piping carrying corrosive fluids or gases, piping located in corrosive environments or piping located outdoors, all hardware for the system shall be manufactured of Type 304 stainless steel.

2. In some cases, to adequately support small diameter PVC or steel piping, a metal frame support structure may be required for support of the "SUSPORT" system specified above. Where required, metal frame support structures shall be constructed using channels, fittings, brackets, hardware and other accessories as manufactured by B-Line Systems, Inc. of Highland, Illinois, or an equal approved by the Engineer. If located in indoor, non-corrosive environments, the materials for the frame structure shall be carbon steel with an epoxy coating applied by a cathodic, electro-deposition process which is equal to "Dura-a-Green" by B-Line Systems, Inc. For corrosive or outdoor environments, the materials for the frame structure be Type 316 stainless steel unless otherwise noted on the Drawings. Hardware used to construct the frame support structure shall be cadmium plated for carbon steel supports or Type 316 stainless steel for stainless steel supports.

3. Pipe supports for small diameter PVC and steel piling shall be located wherever necessary in the opinion of the Engineer to adequately support the pipe, however, they shall have a maximum spacing as specified below for straight pipe runs. Adequate supports shall especially be used adjacent to valves and fittings in pipelines. The following table is based on spacing requirements for Schedule 80 PVC or Standard Weight (Schedule 40) steel pipe carrying a fluid with a Specific Gravity of 1.0 at a temperature not exceeding 120°F. Support spacing for PVC or steel piping carrying fluids with Specific Gravities or temperatures exceeding those stated above shall be approved by the Engineer.

Nominal Pipe Diameter, Inches	Support Spacing, Feet PVC Pipe	Steel Pipe
1/2"	3.5	4.5
3/4"	4.0	5.0
1"	4.5	5.5
1-1/4"	5.0	6.5
1-1/2"	5.0	7.5
2"	5.5	8.0
2-1/2"	5.5	-
3"	6.0	-

2.03 ACCESSORIES (NOT APPLICABLE)

2.04 SPARE PARTS (NOT APPLICABLE)

2.05 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION

A. Prior to prime coating, all pipe hangers and supports shall be thoroughly clean, dry and free from all mill-scale, rust, grease, dirt, paint and other foreign substances to the satisfaction of the Engineer.

B. All submerged pipe supports shall be prime coated with Koppers 654 Epoxy Primer or approved equal. All other pipe supports shall be prime coated with Rustinhibitive Primer No. 621 as manufactured by Koppers Company, Inc., Pittsburgh, Pa., or equal.

C. Finish coating shall be compatible with the prime coating used and shall be applied as specified in Section 09961: High Performance Paints and Coatings.

3.02 INSTALLATION

A. All pipes, horizontal and vertical, shall be rigidly supported from the building structure by approved supports. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or specified herein. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless it is so indicated on the Drawings, or specifically directed or authorized by the Engineer.

B. 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.

C. 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.

D. Pipe supports shall be provided as follows:

1. Cast iron and ductile iron shall be supported at a maximum support spacing of 10 feet, 0-inches with minimum of one support per pipe section at the joints.

2. All vertical pipes shall be supported at each floor or at intervals of at least 15 feet by approved pipe collars, clamps brackets or wall rests, and at all points necessary to insure rigid construction.

E. Effects of thermal expansion and contraction of the pipe shall be accounted for in pipe support selection and installation.

F. Inserts for pipe hangers and supports shall be installed on forms before concrete is poured.

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.

G. Continuous metal inserts shall be embedded flush with the concrete surface.

H. Standard Pipe Supports:

1. Horizontal Suspended Piping:

a. Single Pipes: Adjustable swivel-ring, splint-ring, or clevis hangers.

b. Grouped Pipes: Trapeze hanger systems.

c. Furnish galvanized steel protection shield and oversized hangers for all insulated pipe.

d. Furnish precut sections of rigid insulation with vapor barrier at hangers for all insulated pipe.

2. Horizontal Piping Supported From Walls:

a. Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.

b. Stacked Piping:

1) Wall mounted framing system and clips acceptable for piping smaller than 3-inch minimal diameter.

2) Piping clamps which resist axial movement of pipe through support not acceptable.

c. Wall mounted piping clips not acceptable for insulated piping.

3. Horizontal Piping Supported From Floors:

a. Stanchion Type:

1) Pedestal type; adjustable with stanchion, saddle, and anchoring flange.

2) Use yoke saddles for piping whose centerline elevation is 18 inches or greater above the floor and for all exterior installations.

3) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.

b. Floor Mounted Channel Supports:

1) Use for piping smaller than 3-inch nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.

2) Attach channel framing to floors with anchor bolts.

3) Attach pipe to channel with clips or pipe clamps.

c. Concrete Cradles: Use for piping larger than 3-inch along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.

4. Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.

5. Standard Attachments:

a. To Concrete Ceilings: Concrete inserts.

b. To Steel Beams: I-beam clamp or welded attachments.

c. To Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.

d. To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.

6. Existing Walls and Ceilings: Install as specified for new construction, unless shown otherwise.

3.03 INSPECTION AND TESTING (NOT APPLICABLE)

3.04 START-UP AND INSTRUCTION (NOT APPLICABLE)

END OF SECTION

SECTION 15127

PIPE INSULATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. The work covered by this specification consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to the caustic feed piping exposed to atmospheric conditions, in accordance with applicable project specifications and drawings, subject to the terms and conditions of the contract.

B. Related Work Described Elsewhere:

1. Heat Tracing included in Chemical Feed System Piping: Section 15090.

2. Mechanical piping, valves, pipe hangers, accessories and appurtenances are included under Division 15.

1.02. QUALITY ASSURANCE

A. Insulation materials and accessories furnished and installed hereunder shall, where required, be accompanied by manufacturers' current submittal or data sheets showing compliance with applicable specifications listed below.

1. Thermal insulation materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or end use:

American Society for Testing of Materials Specifications:

a. ASTM C 547, "Standard Specification for Mineral Fiber Pipe Insulation"

b. ASTM C 585, "Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)"

c. ASTM C 1136, "Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation"

B. Insulation materials, including all weather and vapor barrier materials, closures, hangers, supports, fitting covers, and other accessories, shall be furnished and installed in strict accordance with project drawings, plans, and specifications.

C. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

D. Fiberglass pipe insulation for caustic feed piping shall be manufactured by Owens Corning or Engineer approved equal.

1.03 SUBMITTALS

A. Materials and Shop Drawings

1. Submit to the Engineer for approval, as provided in the Section 01340: Shop Drawings, Working Drawings and Samples, operating and maintenance manuals, systems piping and wiring diagrams, and other descriptive material for all equipment to be furnished under this Section.

B. Additional Information

1. In the event that it is impossible to conform with certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.

B. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.

PART 2 - PRODUCTS

2.01 GENERAL

A. Insulation materials furnished should meet the minimum thickness requirements of National Voluntary Consensus Standard 90.1 (1999), "Energy Efficient Design of New Buildings," of the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE). However, if other factors such as condensation control or personnel protection are to be considered, the selection of the thickness of insulation should satisfy the controlling factor.

B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirements of applicable building codes when tested in composite form per one of the following nominally equivalent test methods:

1.	American Society for Testing of Materials	ASTM E 84
2.	Underwriters' Laboratories, Inc.	UL 723, CAN/ULC-S102-M88
3.	National Fire Protection Association	NFPA 255

2.02 MATERIAL AND EQUIPMENT

A. Molded pipe insulation shall be manufactured to meet ASTM C 585 for sizes required in the particular system. It shall be of a type suitable for installation on piping systems as defined in Section 1.01 DESCRIPTION above.

1. Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547. One of the following types shall be used:

a. Insulation shall have operating at temperatures from 0° (F) to 850° (F).

b. Fiberglass Pipe Insulation, with factory applied all-service jacket (ASJ) and two-component adhesive closure system, rated for a maximum service temperature of 850F (454C) shall be used. For large pipe sizes a single adhesive SSL closure may be substituted. Circumferential joints shall be sealed by butt strips having a two-component sealing system. Stapling is not required to complete the closure. When self sealing lap systems are used, sufficient thickness of insulation shall be used to maintain the outer surface temperature of the operating system below +150F (65C). Manufacturer's data regarding thickness constraints in relation to operating temperature shall be followed.

2. Piping exposed to the weather shall be insulated as indicated above except the thickness shall be no less than 1” and will be determined according to the worst weather extremes expected. The insulation shall then be protected with one of the following weatherproof finishes as indicated on contract drawings:

a. Metal jacketing shall be 0.016" (0.4 mm) minimum aluminum or stainless steel with moisture barrier, secured in accordance with the jacket manufacturer's recommendations. Joints shall be applied so they will shed water and shall be sealed completely.

b. UV resistant PVC jacketing may be applied in lieu of metal jacketing provided jacketing manufacturer's limitations with regard to pipe size, surface temperature, and thermal expansion and contraction are followed.

c. Fittings shall be insulated as prescribed above, jacketed with preformed fitting covers matching outer jacketing used on straight pipe sections, with all joints weather sealed.

3. Fittings and valves shall be insulated with pre-formed fiberglass fittings. Thickness shall be equal to adjacent pipe insulation. Finish shall be with pre-formed PVC fitting covers or as otherwise specified on contract drawings.

Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low-density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Rough cut ends shall be coated with suitable weather or vapor resistant mastic as dictated by the system location and service.

4. All piping shall be supported in such a manner that neither the insulation nor the vapor/weather barrier is compromised by the hanger or the effects of the hanger. In all cases, hanger spacing shall be such that the circumferential joint may be made outside the hanger.

a. Piping systems 3" (75 mm) in diameter or less, insulated with insulation, may be supported by placing saddles of the proper length and spacing under the insulation.

b. Where pipe shoes and roller supports are required, insulation shall be inserted in the pipe shoe to minimize pipe heat loss. Where possible, the pipe shoe shall be sized to be flush with the outer pipe insulation diameter.

c. Thermal expansion and contraction of the piping and insulation system can generally be taken care of by utilizing double layers of insulation and staggering both longitudinal and circumferential joints. Where long runs are encountered, expansion joints may be required where single layers of insulation are being used and should be so noted on the contract drawings.

d. On vertical runs, insulation support rings shall be used as indicated on contract drawings.

2.03 ACCESSORY MATERIALS

A. Accessory materials installed as part of insulation work under this section shall include (but not be limited to):

1. Closure Materials - Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes

2. Field-applied jacketing materials - Sheet metal, plastic, canvas, fiber glass cloth, insulating cement, PVC fitting covers

3. Support Materials - Hanger straps, hanger rods, saddles, support rings

B. All accessory materials shall be installed in accordance with project drawings and specifications, manufacturer's instructions.

2.04 SPARE PARTS (Not Applicable)

2.05 QUALITY CONTROL

A. Contractor shall follow Manufacturer's supplier's recommended product quality control specified and required for project.

PART 3 - EXECUTION

3.01 PREPARATION

A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.

B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

D. Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean and dry.

E. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.

F. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.

3.02 INSTALLATION

A. General

1. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.

2. Install insulation on piping subsequent to installation of heat tracing, painting, and acceptance tests.

3. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.

4. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tears or other damage. All staples used on cold pipe insulation shall be coated with suitable sealant to maintain vapor barrier integrity.

B. Fittings

1. Cover valves, fittings, and similar items in each piping system using one of the following:

a. Metal jacket or PVC Fitting Covers insulated with material equal in thickness and composition to adjoining insulation.

C. Penetrations

1. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise specified.

D. Joints

1. Butt pipe insulation against hanger inserts. For hot pipes, it is recommended all joints be staggered when operating temperature is over 400F (204C) double layer. Seal jacketing according to type being used. For cold piping, seal self-sealing laps by firmly rubbing down surface of tape and flap.

2. All pipe insulation ends shall be tapered and sealed, regardless of service.

E. Vertical Piping

1. If specified on contract drawings, all insulated, exposed vertical piping within the building and all insulated piping exposed to the outdoors shall be additionally jacketed with 0.016" thick (0.4 mm) (minimum) aluminum. Vertical piping shall be protected to a height of 8'-0" (2.4 m) above the floor.

3.03 INSPECTION FIELD QUALITY ASSURANCE

A. Upon completion of all insulation work covered by this specification, visually inspect the work and verify that it has been correctly installed. This may be done while work is in progress, to assure compliance with requirements herein to cover and protect insulation materials during installation.

3.04 START-UP AND INTRODUCTION (NOT APPLICABLE)

3.05 PROTECTION

A. Replace damaged insulation, which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

B. The insulation contractor shall advise the general and/or the mechanical contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

END OF SECTION

SECTION 15129

COUPLINGS AND CONNECTORS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: Furnish and install couplings and connectors of the type(s) and size(s) in the location(s) shown on the Drawings and as specified herein. Pipe supports shall be placed where shown on the Drawings. The Contractor may install additional pipe supports and flexible couplings to facilitate piping installation, provided that complete details describing their location, the pipe supports and hydraulic thrust protection are submitted. Thrust protection shall be adequate to sustain the force developed by 150% of the design operating pressures specified.

B. Related Work Described Elsewhere:

1. Mechanical- General Requirements: Section 15000.

2. Pressure Testing of Piping: Section 15044.

C. General Design (Not Applicable)

1.02 QUALITY ASSURANCE

A. Minimum pressure rating equal to that of the pipeline in which they are to be installed.

B. Couplings and connectors, other than those specified herein, are subject to the Engineer's approval.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Submit shop drawings in accordance with the Section 01340: Shop Drawings, Working Drawings, and Samples.

2. Submit manufacturer's catalog data on couplings and connectors. Show manufacturer's model or figure number for each type of coupling or joint for each type of pipe material for which couplings are used.

3. Submit manufacturer's recommended torques to which the coupling bolts shall be tightened for the flexible gasketed sleeve-type compression pipe couplings.

4. Show materials of construction by ASTM reference and grade. Show dimensions.

5. Show number, size and material of construction of the rods and lugs for each thrust harness on the project.

B. Additional Information (NOT APPLICABLE)

C. OPERATING INSTRUCTIONS (NOT APPLICABLE)

1.04 PRODUCT DELIVERY STORAGE AND HANDLING

A. Equipment shall be handled, shipped and stored in accordance with Section 01600: Materials and Equipment.

1.05 WARRANTY AND GUARANTEES

A. Provide equipment warranty in accordance with Section 01740: Warranties and Bonds.

PART 2 - PRODUCTS

2.01 GENERAL

A. All couplings and connectors shall be restrained. Anchors that penetrate the pipe wall for restraint shall not be used.

2.02 MATERIALS AND EQUIPMENT

A. All Couplings and Connectors:

1. Gasket Materials: Composition suitable for exposure to the liquids to be contained within the pipes.

2. Diameters to properly fit the specified types of pipes on which couplings and connectors are to be installed.

B. Sleeve-Type Couplings (when applicable):

1. Exposed couplings (when applicable):

a. Steel middle ring.

b. Two steel or ductile iron follower rings.

c. Two wedge-section gaskets.

d. Wedge style restraints.

e. Sufficient steel bolts to properly compress the gaskets.

f. Acceptable manufacturers.

1) Smith - Blair, Inc. - 470 Series Pipe-Lok.

2) Or equal.

2. Buried Couplings (when applicable):

a. Steel middle ring.

b. Two steel or ductile iron follower rings.

c. Two wedge-section gaskets.

d. Wedge style restraints.

e. Bolts and nuts for buried couplings, shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8 for bolts, and ASTM A 194, Grade 8 for nuts. Bolts and nuts greater than 1 1/8 inches shall be carbon steel, ASTM A 307, Grade B, with cadmium plating, ASTM A 165, Type NS

f. Acceptable manufacturers:

1) Smith - Blair, Inc. - 470 Series Pipe-Lok.

2) Or equal.

C. Split Type (Grooved End) Couplings (when applicable):

1. Constructed from malleable or ductile iron.

2. For use with grooved or shouldered end pipe with minimum wall thickness as required so as not to weaken pipe.

3. Cast in two segments for 3/4-inch through 14-inch pipe sizes, four segments for 15-inch through 24-inch pipe sizes, and six segments for pipe sizes over 24-inch.

4. Coating: Enamel

5. Bolts: Carbon steel

6. Acceptable manufacturers:

a. Victaulic Company of America, Style 77

b. Gustin-Bacon Co.

c. Or equal.

D. Flanged Adapters (when applicable):

1. For joining plain end or grooved end pipe to flanged pipes and fittings.

2. Adapters shall conform in size and bolt hole placement to ANSI standards for steel and/or cast iron flanges 125 or 150 pound standard unless otherwise required for connections.

3. Exposed Sleeve Type (Ferrous Piping):

a. Constructed from steel.

b. Coating: Enamel.

c. Bolts: Carbon steel.

d. Wedge style restraints.

e. Acceptable manufacturers:

1) Smith-Blair Inc. – 911 or 920 Series Flange-Lok.

2) Or Engineer approved equal.

4. Exposed Sleeve Type (Stainless Steel Piping):

a. Construction: Fabricated from Type 316L stainless steel w/ANSI flanges to match the connecting piping.

b. Finish: Pickled & Passivated or Electropolished to match connected stainless-steel piping.

c. Bolts: Type 316 Stainless Steel as specified within Section 15066: Stainless Steel Pipe and Fittings.

d. Acceptable manufacturers:

1) Smith-Blair Inc. – 913 (316 stainless steel option).

2) Engineer approved equal.

5. Buried Sleeve Type:

   a. Constructed from cast iron

   b. Bolts and nuts for buried sleeves shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8 for bolts, and ASTM A 194, Grade 8 for nuts and washers. Bolts and nuts greater than 1 1/8 inches shall be carbon steel, ASTM A 307, Grade B, with cadmium plating, ASTM A 165, Type NS

   c. Acceptable manufacturers:

      1) Dresser Manufacturing Co. - Style 127 locking type for cast iron, ductile iron, asbestos cement and steel pipes with diameters of 3 inches through 12 inches.

      2) Or Engineer approved equal.

6. Split Type (Ferrous Piping):

   a. Constructed from malleable or ductile iron.

   b. For use with grooved or shouldered end pipe.

   c. Coating: Enamel

   d. Acceptable manufacturers:

      1) Victaulic Company of America - Style 741 for pipe diameters of 2 inches through 12 inches

      2) Victaulic Company of America - Style 742 for pipe diameters of 14 inches through 16 inches.

      3) Or Engineer approved equal.

7. Split Type (Stainless Steel Piping):

   a. Construction: Cast Type 316 Stainless Steel, ASTM A 351 Grade CF-8M w/ EPDM gasket material.

   b. For use with grooved or shouldered end pipe

   c. Finish: Smooth Electropolished

   d. Acceptable manufacturers:

1) Victaulic Company of America - Style 77S for pipe diameters of 2 inches through 12 inches with pressures less than 300 psi.

2) Piedmont Pacific Corporation - Style K for pipe diameters of 2 inches through 8 inches with pressures less than 200 psi, Style B for pipe diameters of 2 inches through 4 inches with pressures less than 300 psi.

E. Flexible Expansion Joints:

1 Flexible expansion joints shall be of the molded wide single arch design manufactured of neoprene rubber with polyester and steel reinforcement. Neoprene body shall be supplied with a Hypalon coating. Joints shall be flanged suitable for 150 psi water working pressure and in accordance with ANSI B16.1 dimensions and bolting patterns. Flanged ends shall be furnished with galvanized, split ductile iron retaining rings.

2. Provide limit restraint bolts on all lines. Expansion joints 6 inches and larger in size shall have a minimum of four limit restraint bolts. Restraint bolts and nuts shall be Type 316 stainless steel.

3. Minimum performance for flexible expansion joints shall be as follows:

Axial Size (Inches)	Axial Compression (Inches)	Lateral Elongation (Inches)	Angular Deflection (Inches)	Deflection Degrees
2	7/8	1/2	1	30
4	7/8	1/2	1	30
6	7/8	1/2	1	25
8	1-3/8	3/4	1	25
10	1-3/8	3/4	1	20
12	1-3/8	3/4	1	20

4. Flexible expansion joints shall be Maxi-Joint as manufactured by General Rubber Corporation, Style 1101, Metrasphere as manufactured by the Metraflex Company, Style R Neoprene Body, or an equal approved by the Engineer.

F. Transition Couplings: Transition couplings for connecting different pipes having different outside diameters shall be steel: Dresser Style 62 or 162, Rockwell Series 413, Baker Series 212 or 240, or equal.

2.03 ACCESSORIES

A. Joint Harnesses: Tie bolts or studs shall be as shown in the following table. Bolt or stud material shall conform to ASTM B 193, Grade B7. Nuts shall conform to ASTM A 194, Grade 2H. Lug material shall conform to ASTM A 36, ASTM A 283, Grade B, C, or D, or ASTM A 285, Grade C. Lug dimensions shall be as shown in AWWA Manual M11, Table 19.7.

TIE BOLTS OR STUD REQUIREMENTS FOR FLEXIBLE PIPE COUPLINGS

Tie Bolt or Stud Minimum Requirements

	150 psi		300 psi	
Nominal Pipe Size (Inches)	No. Bolts or Studs	Size (Inches)	No. Bolts or Studs	Size (Inches)
2	2	5/8	2	5/8
3	2	5/8	2	5/8
4	2	5/8	2	4/8
6	2	5/8	2	5/8
8	2	5/8	2	5/8
10	2	5/8	2	5/8
12	2	3/4	2	7/8
14	2	3/4	2	1
16	2	7/8	2	1-1/4
18	2	1	2	1-3/8
20	2	1	2	1-1/2
24	4	1	4	1-1/4
30	4	1-1/8	4	1-1/2
36	4	1-1/4	4	1-3/4
42	4	1-1/2	6	1-5/8
48	6	1-3/8	6	1-7/8
54	6	1-1/2	6	2-1/4
60	6	1-5/8	8	2
66	6	1-3/4	8	2-1/4
72	6	1-7/8	10	2-1/4
84	6	2-1/4	12	2-1/4
96	8	2-1/4	14	2-1/4

2. Select number and size of bolts based on the test pressure shown in Section 15044: Pressure Testing of Piping. For test pressures less than or equal to 150 psi, use the 150-psi design in the table above. For test pressures between 150 and 300 psi, use the 300-psi design in the table above.

3. Provide washer for each lug. Washer material shall be the same as the nuts. Minimum washer thickness shall be 1/8-inch.

B. Bolts and Nuts for Flanges:

1. Bolts and nuts for flanges located indoors and in enclosed vaults and structures shall be carbon steel, ASTM A 307, Grade B.

2. Bolts and nuts for buried and submerged flanges, flanges in open vaults and structures, and flanges located outdoors above ground shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M for bolts, and ASTM A 194, Grade 8M for nuts. Bolts and nuts greater than 1 1/8-inches shall be carbon steel, ASTM A 307, Grade B., with cadmium plating, ASTM A 165, Type NS.

3. Bolts used in flange insulation kits shall conform to ASTM B 193, Grade B7. Nuts shall comply with ASTM A 194, Grade 2H.

4. Provide washers for each unit. Washers shall be of the same material as the nuts.

2.04 SPARE PARTS (Not Applicable)

2.05 QUALITY CONTROL

A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION (Not Applicable)

3.02 INSTALLATION

A. Sleeve Type Couplings (when applicable):

1. Thoroughly clean pipe ends for a distance of 8 inches from the ends prior to installing couplings, and use soapy water as a gasket lubricant.

2. Slip a follower ring and gasket (in that order) over each pipe and place the middle ring centered over the joint.

3. Insert the other length into the middle ring the proper distance.

4. Press the gaskets and followers evenly and firmly into the middle ring flares.

5. Insert the bolts, finger tighten and progressively tighten diametrically opposite nuts uniformly around the adapter with a torque wrench applying the torque recommended by the manufacturer.

6. Insert and tighten the tapered threaded lock pins.

7. Insert the nuts and bolts for the flange, finger tighten and progressively tighten diametrically opposite bolts uniformly around the flange to the torque recommended by the manufacturer.

B. Split Type Flange Adapters (when applicable): Install in the same manner as Split Type Couplings.

C. Buried Couplings, Adapters and Connectors (when applicable): Thoroughly coat all exterior surfaces, including nuts and bolts, after assembly and inspection by the Engineer with a heavy-bodied bituminous mastic as approved by the Engineer.

D. Install thrust rods, supports, and other provisions to properly support pipe weight and axial equipment loads.

3.03 INSPECTION AND TESTING

A. Hydrostatically test flexible pipe couplings, and joints, in place with the pipe being tested. Test in accordance with Section 15044: Pressure Testing of Piping.

3.04 START-UP AND INSTRUCTION (NOT APPLICABLE)

END OF SECTION

DIVISION 16

ELECTRICAL

SECTION 16050

ELECTRICAL - GENERAL PROVISIONS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment and incidentals required for a complete electrical system as hereinafter specified and shown on the Drawings, whether or not specifically shown or called for.

2. The work, apparatus and materials which shall be furnished under these Specifications and accompanying Drawings shall include all items listed hereinafter and/or shown on the Drawings. All materials necessary for the complete installation shall be furnished and installed by the Contractor to provide complete power, generator, lighting systems, instrumentation, wiring and control systems as indicated on the Drawings and/or as specified herein whether or not specifically shown or called for. Certain equipment will be furnished as specified in other Section of this specification that will require conduit and wire to complete the installation as required.

3. The Contractor shall furnish and install the necessary cables, transformers, motor control centers, protective devices (surge protection), conductors, exterior electrical system, etc., to serve motor loads, lighting loads and miscellaneous electrical loads as indicated on the Drawings and/or as specified hereinafter.

4. The work shall include complete testing of all equipment and wiring at the completion of the work and making any minor connection 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.

5. Provide permitting and NETA acceptance testing.

6. Make all field connections to process instrument panels and other control panels furnished under other Divisions of these Specifications.

7. For process instrumentation furnish and install all conduit, wire and interconnections between primary elements, transmitters, local indicators and receivers.

8. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material, equipment, appliances and

all work that may be reasonably implied as being incidental to the work of this Section shall be furnished at no extra cost.

9. Each bidder or his authorized representatives shall, before preparing a bid, visit all areas of the existing building and/or proposed site in which work will take place and be performed to inspect carefully the present installation and conditions. The submission of the bid by this bidder shall be considered evidence that the bidder has visited the Project and noted the locations and conditions under which the work will be performed and that the bidder takes full responsibility for a complete knowledge of all factors governing his work.

10. All necessary temporary power requirements are the responsibility of the Contractor and shall be furnished at no extra cost to the Owner

11. All necessary temporary power, control and instrumentation requirements are the responsibility of the Contractor and shall be furnished at no extra cost to the Owner. Power and controls shall be furnished to all existing equipment at all times.

12. Provide demolition, cutting, patching and repair to match existing conditions.

B. Service and Metering:

1. Permanent electrical power and metering will be provided by the at 227/480 volts, 3-phase, 4 wire, wye, solid grounded, 60 Hertz.

2. Coordinate all electric power work with the Florida Power & Light

3. Furnish and install the secondary and primary service conduit, wire, connectors, to extend the service as directed by the local power utility.

C. Codes, Inspections and Fees:

1. All material and installation shall be in accordance with the latest edition of the National Electrical Code and all applicable national, local and state codes.

2. Pay all fees required for permits, inspections, and connections.

D. Coordination and Short Circuit Study:

1. General:

a. The Contractor shall provide a Power System Study for the electrical power distribution and motor control equipment. The study shall be a totally independent effort to verify adequacy of all of the existing equipment as well as new additions being implemented under these Specifications. The study shall be prepared by a professional engineer, registered in the State of Florida, with demonstrated experience in the

performance of industrial power system analysis. The engineer shall not be an employee of an equipment manufacturer or supplier.

b. The Contractor shall provide data necessary to perform the study. This includes feeder cable sizes, approximate feeder length motor data, generator data, existing protective relay settings and any other information relevant to the study.

c. A summary of the short circuit analysis shall be provided to the Contractor at the time shop drawings for all of the new equipment are submitted for approval.

d. The Contractor shall provide complete sets of switchgear and emergency generator shop drawings for use in the study.

2. Scope:

a. The short circuit study shall be in accordance with ANSI Standards C37.010 and C37.13, shall be performed to check the adequacy, and to verify the correct application of circuit protective devices and other system components specified. The study shall address the case when the system is being powered from the normal source as well as from the on-site generating facilities. Minimum as well as maximum possible fault conditions shall be adequately covered in the study.

b. Fault contribution of all motors shall be considered. The Contractor shall be responsible for obtaining all required data of equipment. All back-up calculations shall become part of the final report. The calculations shall be in sufficient detail to allow easy review.

3. Contents:

a. The study shall include representation of the power company's system, the base quantities selected, impedance source data, calculation methods and tabulations, one-line and impedance diagrams, conclusions and recommendations. Short-circuit momentary duties, shall be calculated on the basis of an assumed bolted three-phase short circuit at each 480 volt. bus, low voltage switchboard bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations through the systems. The short-circuit tabulations shall include significant X to R ratios, asymmetry factors, KVA, and symmetrical fault current.

b. A protective device time current coordination study shall be included with coordination plots of key and/or limiting devices, tabulated data, rating, and/or settings selected. The study shall present an engineering balance 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.

c. Separate plots shall be provided for each mode of "normal" and “standby" operation. Maximum fault values shall be shown in each case. Both power sources shown in one plot will not be accepted.

d. Existing protective device settings in key locations shall be reviewed to ensure selectivity under the new conditions. Recommended changes shall be indicated in the report. The Contractor shall be made aware of the required changes immediately.

e. Generator(s) short circuit decrement curves and thermal limit curves shall be included.

f. Required settings for breakers and relays shall be maximized to provide the most effective protection possible whether the system is fed from the normal or emergency source.

g. Tabulations indicating recommended set points for all protective devices shall be provided. This shall include the normal as well as the emergency source.

4. Motor Current-Time Characteristic Curves:

a. A complete independent set of current-time characteristic curves for all motors indicating coordination between the protective relays and the thermal characteristics of the motor shall be provided.

b. The Contractor shall obtain from the motor supplier, the necessary information to perform the study. Certified curves for "safe time vs. current at 100 percent voltage" and "accelerating time vs. current at 100 percent voltage" shall become part of the final report.

5. Motor Starting Study:

a. A motor starting study for all large electric drives to determine voltage dip or power inrush limitations at selected locations due to starting of motors shall be provided. This applies to both the normal and the emergency mode.

6. Generator Protective Devices:

a. The study shall address all of the protective devices provided for generator protection.

b. Protective relays requiring settings shall include, but not necessarily limited to:

1.) Differential

2.) Overcurrent with voltage restraint c. Ground

3.) Undervoltage

4.) Reverse power

5.) Unbalanced loading and open phase, loss of excitation

7. General Information for Time-Current Curves Presentation:

a. The coordination plots shall include complete titles, representative one-line diagrams, legends, associated power company's relay or system characteristics, significant motor starting characteristics, complete parameters for power, and substation transformers, and complete operating bands for low-voltage circuit breaker trip devices.

b. The coordination plots shall define the types of protective devices selected, together with the proposed coil taps, time-dial settings and pickup settings required.

c. The short-time region shall indicate the medium voltage relay instantaneous elements, the magnetizing in-rush, and ANSI withstand transformer parameters, the low-voltage circuit breaker instantaneous trip devices, fuse manufacturing to tolerance bands, and significant symmetrical and symmetrical fault currents.

d. Each primary protective device required for a delta-to-wye connected transformer shall be selected so that the characteristic or operating band is within the transformer parameters; which, where feasible, shall include a parameter equivalent to 58 percent of the ANSI withstand point to afford protection for secondary line-to-ground faults.

e. Low-voltage power circuit breakers shall be separated from each other and the associated primary protective device, where feasible, by a 16 percent current margin for coordination and protection in the event of secondary line-to-line faults.

f. Protective relays shall be separated, where feasible, by a 0.3 second time margin when the maximum three-phase fault flows, to assure proper selectivity.

F. Interpretation of Drawings:

1. The Drawings are not intended to show exact location of conduit runs.

2. All three-phase circuits shall be run in separate conduits unless otherwise shown on the Drawings.

3. Unless otherwise approved by the Engineer, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.

4. Where circuits are shown as "home-runs," all necessary fittings and boxes shall be provided for a complete raceway installation.

5. The 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 Contractor without additional expense to the Owner. In case interference develops, the Owner's authorized representative is to decide which equipment, piping, etc., must be relocated, regardless of which was installed first.

6. Verify with the Engineer exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

7. The locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. Obtain in the field all 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.

8. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.

9. Circuit layouts shown 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 equipment.

10. The ratings of motors and other electrically operated devices together with the size shown for their branch circuit conductors and conduits are approximate only and are indicative of the probable power requirements insofar as they can be determined in advance of the purchases of the equipment.

11. All connections to equipment shall be made as shown, specified, required, and directed and in accordance with the approved shop drawings, regardless of the number of conductors shown on the Electrical Drawings.

G. Size of Equipment:

1. Investigate each space in the building through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his material in sections sized to permit passing through such restricted areas in the building.

2. The equipment shall be kept upright at all times. When equipment has to be tilted for each of passage through restricted areas during transportation, the manufacturer shall be required to brace the equipment suitably, to insure that the tilting does not impair the functional integrity of the equipment.

H. Component Interconnections:

1. Component equipment furnished under this Specification will not be furnished as integrated systems.

2. Analyze all systems components and their shop drawings; identify all terminals and prepare drawings or wiring tables necessary for component interconnection.

I. Record Drawings:

1. 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, Section 01720.

1.02 SUBMITTALS

A. Material and Shop Drawings:

1. As specified under Section 01340, shop drawings shall be submitted for approval of all materials, equipment, apparatus, and other items as required by the Engineer.

2. Shop drawings shall be submitted for the following equipment:

a. Motor Control Centers

b. Dry Type Transformers

c. Panelboards

d. Lighting Fixtures

e. Disconnect Switches

f. Wire and Cable

g. Supporting Devices

h. Control Panels

i. Variable Frequency Drives

3. The manufacturer’s name and product designation or catalog numbers shall be submitted for the following material:

a. Conduit

b. Receptacles

c. Boxes and Fittings

d. Switches

e. Lamps

f. Control Relays

4. Prior to submittal by the Contractor, all shop drawings shall be checked for accuracy and contract requirements. Shop drawings shall bear the date checked and shall be accompanied by a statement that the shop drawings have been examined for conformity to Specifications and Drawings. This statement shall also list all discrepancies with the Specifications and Drawings. Shop drawings not so checked and noted shall be returned.

5. The Engineer's check shall be only for conformance with the design concept of the project and compliance with the Specifications and Drawings. The responsibility of, or the necessity of, furnishing materials and workmanship required by the Specifications and Drawings which may not be indicated on the shop drawings is included under the work of this Section.

6. The responsibility for all dimensions to be confirmed and correlated at the job site and for coordination of this work with the work of all other trades is also included under the work of this Section.

7. No material shall be ordered or shop work started until the Engineer's approval of shop drawings has been given.

B. Manufacturer's Services

1. Provide manufacturer's services for testing and start-up of the following equipment:

a. 480 Volt Motor Control Centers.

b. Variable Frequency Drives

2. Provide manufacturers of the above listed equipment shall provide an experienced Field Service Engineer to accomplish the following tasks:

a. The equipment shall be visually inspected upon completion of installation and prior to energizing 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.

b. The Field Service Engineers shall provide engineering support during the energizing 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.

c. Upon satisfactory completion of equipment test, they shall provide engineering support of system tests to be performed in accordance with manufacturer's test specifications.

d. Three (3) 4-hour training sessions (one for each system) on operation, and two (2) 4-hour training sessions (one for each system) on maintenance and trouble-shooting procedures shall be provided for the Owner's maintenance personnel. All training shall be conducted at a facility provided by the Owner. The maintenance and trouble-shooting sessions shall be conducted with record "as-built" electrical drawings sufficient for a class of eight personnel.

e. A final report shall be written and submitted to the Contractor within fourteen (14) days from completion of final system testing. The report shall document the inspection and test activity, define any open problems and recommend remedial action.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. The materials used in all systems shall be new, unused and as hereinafter specified. All materials where not specified shall be of the very best of their respective kinds. Samples of materials or manufacturer's specifications shall be submitted for approval as required by the Engineer.

B. Materials and equipment used shall be Underwriters Laboratories, Inc., listed.

C. 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 any apparatus has been damaged, 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.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide and place all sleeves for conduits penetrating floors, walls, partition, etc. Locate all necessary slots for electrical work and form before concrete is poured.

B. All cutting and patching shall be done in a thoroughly workmanlike manner.

3.02 INSPECTION AND TESTING

A. Test all systems and repair or replace all defective work. Make all necessary adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

END OF SECTION

SECTION 16070

SUPPORTING DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section Includes:
   1. Requirements for furnishing, installing, cleaning, and protecting hanger and support systems for electrical wiring, conduit boxes, and equipment.

B. Related Section:
   1. Section 01730 - Operating and Maintenance Data.
   2. Section 16050– Basic Electrical Requirements

1.02 REFERENCES

A. American Iron and Steel Institute (AISI):
   1. AISI Standard Steels (Handbook).

B. American Society for Testing Materials (ASTM):
   1. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
   2. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc- Coated - Welded and Seamless.
   3. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   5. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi, Minimum Tensile Strength.
   6. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   7. ASTM A 563 - Standard Specification for Carbon and Alloy Steel Nuts.
   8. ASTM A 575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M- Grades.
   9. ASTM A 576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
   10. ASTM A 635/A 635M - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled.
   11. ASTM A 1011/A 1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   12. ASTM B 633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   13. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

C. American Welding Society (AWS):
   1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

D. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts maximum).

E. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC).
   2. NFPA 258 - Standard Research Test Method for Determining Smoke Generation of Solid Materials.

F. Society of Automotive Engineers International (SAE):
   1. SAE J 429 - Mechanical and Material Requirements for Externally Threaded Fasterners.

G. The Society for Protective Coatings (SSPC):
   1. SSPC Painting Manual.
      a. SSPC-SP 2 - Hand Tool Cleaning.
      b. SSPC-Paint 15 - Paint Specification No. 15, Steel Joist Shop Paint, Type I, Red Oxide Paint, Type II, Asphalt Coating.
      c. SSPC-Paint 20 - Paint Specification No. 20, Zinc-Rich Primers (Type I, "Inorganic," and type II, "Organic").

H. Underwriters Laboratory, Inc. (UL):
   1. UL 568 - Nonmetallic Cable Tray Systems.
   2. UL 635 - Standard for Insulating Bushings.
   3. UL 870 - Standard for Wireways, Auxilliary Gutters, and Associated Fittings.
   4. UL 884 - Standard for Underfloor Raceways and Fittings.
   5. UL 1479 - Standard for Fire Tests of Through-Penetration Firestops.
   6. UL 2239 - Hardware for the Support of Conduit, Tubing, and Cable.

I. U. S. General Services Administration (GSA)
   1. Federal Specifications:
      a. A-A-1922A - Shield, Expansion (Caulking Anchors, Single Lead).
      b. FF-S-107C(2) - Screws, Tapping and Drive.

1.03 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the requirements of Section 01340, Shop Drawings, Working Drawings and Samples, and Section 16050, Basic Electrical Requirements.
   1. Product Data:
      a. Provide product data and catalog cuts for the products provided under this Section.
   2. Shop Drawings:
      a. Provide Shop Drawings.
      b. Provide Shop Drawings of hanging supports for conduit.

3. Quality Assurance/Control Submittals:
    a. Design Data:
        1) Provide structural calculations for the following items:
            a) Equipment backboards and support structures not directly fastened to the walls.
            b) Hanging supports for conduit.
        2) Detailed drawings of proposed departures from the original design.
    b. Certificates:
        1) Testing Agency/Quality Verification:
            a) With the product data for electrical hangers and supports, provide evidence of quality verification, listing, and labeling by the Electrical Testing Agency (ETA); either by a printed mark on the data, or by a separate listing card.
            b) If an item does not have ETA quality assurance verification, provide a written quality assurance verification statement from the product manufacturer indicating why the item does not have the specified quality assurance verification.
                (1) Such quality assurance verification statements are subject to approval by the Owner and the Engineer.
        2) Manufacturers' Certificate of Compliance.
    c. Qualification Statements:
        1) Manufacturers' qualifications.

1.04 QUALITY ASSURANCE

A. Qualifications;
    1. Electrical Testing Agency (ETA) Qualifications:
        a. Use the Electrical Testing Agency (ETA) qualified as specified in Section 16050, Basic Electrical Requirements.
    2. Manufacturers' Qualifications:
        a. Provide electrical support framing made by manufacturers that have been manufacturing support framing for a minimum of 5 years, and who carefully controls their operations to ensure that excellent product engineering, quality, safety, and reliability are achieved.
        b. Submit the manufacturer's qualifications to the Engineer for approval.

B. Certifications:
    1. Electrical Testing Laboratory (ETL) Certification:
        a. Provide products that are listed and labeled by Underwriters Laboratory, Inc. (UL) or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products.
    2. Manufacturers Certificate of Compliance:
        a. Submit a manufacturer's Certificate of Compliance certifying that

both the galvanizing and the products meet the requirements of the ASTM standards.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packaging, Shipping, Handling, and Unloading:
   1. Deliver, store, and handle the hangers and supports in accordance with Section 16050, Basic Electrical Requirements, and as specified herein.
   2. Deliver material to Site in the original factory packaging.

B. Storage and Protection:
   1. Shelter and store the components under cover, and supported off the ground and floors on blocking.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Welding materials:
   1. Provide welding materials complying with the requirements of AWS D1.1/D1.1M for the type of material being welded.

2.02 MANUFACTURED UNITS

A. Metal U-Channel Electrical Support Framing Systems and Fittings:
   1. Stainless Steel U-Channel Support Framing Systems:
      a. Provide U-channel supports, fittings, threaded rod, and hardware fabricated from Type 316 stainless steel.
   2. PVC-Coated Steel U-Channel Support Framing Systems:
      a. Provide U-channel supports, fittings, threaded rod, and hardware fabricated from PVC-coated carbon steel.

B. Conduit Supports:
   1. Stamped Steel Conduit Supports:
      a. Provide one-hole style galvanized stamped steel fasteners with pipe straps similar to those as manufactured by Thomas & Betts.
      b. Provide support devices consisting of threaded rods, channel supports, and conduit straps/fasteners.
   2. Special Finishes:
      a. Where PVC-coated RGS conduits are to be installed, provide stainless steel conduit supports including the threaded rods, channel supports, and conduit straps/fasteners.
   3. Manufacturers:
      a. Thomas & Betts.
      b. Approved equal.

C. Cable Supports:
   1. Provide voltage rated cable supports fabricated from Type 316 stainless

steel with a threaded collar.

2. Provide tapered wedging cable plugs fabricated from hard fiber, impregnated hardwood, or canvas bakelite for the cable supports.
3. Manufacturers:
   a. Emerson, O-Z/Gedney, Inc., Type "M"
   b. Approved equal.

D. Bolts, Nuts, and Washers:
   1. For bolts, nuts, and washers smaller than 1/4-inch trade size, provide 316 stainless steel fasteners complying with the requirements of ASTM A 325.
   2. For fastening galvanized components, provide stainless steelbolts, nuts, and washers galvanized in accordance with the requirements of ASTM A 325.

E. Anchors and Fasteners:
   1. Drive (Deep-Pitch) Screws:
      a. Provide Type 316 stainless steel self-tapping type drive (deep-pitch) screws that comply with the requirements of FF-S-107C(2).
   2. Drilled-In Anchors and Fasteners:
      a. Provide drilled-in anchors and fasteners that comply with the requirements of FF-S-107C(2).
      b. Masonry Anchors:
         1) Provide masonry anchors designed to accept both machine bolts and threaded rods as fasteners.
            a) Provide SAE J 429 Grade 2 machine bolt fasteners fabricated from AISI Type 316 stainless steel.
            b) Provide nuts and washers conforming to the requirements of ASTM A 563.
         2) Provide masonry anchors consisting of an expansion shield and expander nut contained inside the shield.
            a) Expander Nuts:
               (1) Fabricate square expander nuts with their sides tapered inward from the bottom to the top.
               (2) Design the expander nuts to simultaneously climb the bolt or rod thread and expand the shield as soon as the threaded expander nut reaches and bears against the shield bottom when being tightened.
            b) Expansion Shields:
               (1) Provide expansion shield bodies consisting of four legs, the inside of each tapered toward the shield bottom, or nut end.
               (2) The end of one leg shall be elongated and turned across shield bottom. Outer surface of shield body shall be ribbed for grip-action.
         3) Masonry Anchor Material:
            a) Provide die cast Zamac No. 3 zinc alloy having a 43,000 psi minimum tensile strength.
         4) Manufacturers:

a) U.S.E. Diamond, Inc., FORWAY System.

c. Concrete Anchors:

1) Stainless Steel Anchor/Fastener:

a) Provide one-piece AISI Type 303 or 304 stainless steel studs (bolts) with integral expansion wedges, AISI Type 316 stainless steel nuts, and AISI Type 316 stainless steel washers.

b) Provide stainless steel anchor/fasteners complying with the physical requirements of FF-S-325 for Group II, Type 4, Class 1.

2) Acceptable Manufacturers:

a) MKT, SUP-R-STUD.

b) Hilti Fastening Systems; KWIK-BOLT.

c) Phillips; RED HEAD Wedge-Anchor.

3. Hammer drive-type explosive charge drive-type anchors and fastener systems are unacceptable.

4. Lead shields, plastic-inserts, fiber-inserts, and drilled-in plastic sleeve/nail drive systems are unacceptable.

2.03 ACCESSORIES

A. Wall Seals:

1. Provide a hydrostatic seal to fill the annular space between conduit and through structure openings.

2. Manufacturer:

a. PSI-ThunderLine/Link-Seal Corp., Link-Seal®.

B. Fire Seals:

1. Where conduit penetrates fire-rated walls, floors, partitions, and ceiling, provide approved fire seals to ensure that the fire rating is maintained.

2. Provide a fire seal system which is UL-listed for the application.

a. Provide fire seal compound or a mechanical seal for fire rating of 2 hours or less.

3. Manufacturers:

a. Compound Fire Seals:

1) Dow Corning Corporation.

2) 3M.

b. Mechanical Fire Seals:

1) PSI-ThunderLine/Link-Seal Corp.

c. Through-Wall Barrier Fire Seals:

1) Cooper Crouse-Hinds.

2.04 FABRICATION

A. Fit and shop assemble items in the largest sections practical for delivery to the Site.

2.05 FINISHES

A. Prime paint non-galvanized steel items.
   1. Prepare surfaces to be primed in accordance with the requirements of SSPC-SP 2.
      a. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
   2. Prime Painting: Apply one coat of primer.

B. Touch-Up Primer:
   1. For un-galvanized metal surfaces: Provide primer complying with the requirements of SSPC-Paint 15 for Type I, Red Iron Oxide.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Field Measurement:
   1. Although the Contract Drawings are generally indicative of the Work, take field measurements to verify actual conditions.
      a. Due to the small scale of the Contract Drawings it is not possible to indicate all offsets, fittings, and apparatus required or the minor structural obstructions that may be encountered during the Work.
   2. Carefully investigate the structural and finish conditions, and other construction work, at the Site which may affect the work of this Section.

3.02 PREPARATION

A. After carefully investigating structural and finish conditions and other in-place construction work, produce detailed Shop Drawings showing proposed departures from the original design due to field conditions or other causes.
   1. Layout the electrical work according to accepted standard electrical trade practice to suit actual field measurements.
   2. Arrange the electrical work to consider existing conditions and to preserve access to other equipment, rooms, areas, and similar features of the construction.
   3. Provide plan and profile views of duct banks, and show equipment backboards and support structures not directly fastened to the walls on the Shop Drawings.
   4. Indicate the location and details of conflicting utility construction and slopes on the Shop Drawings.
   5. Submit the Shop Drawings to the Engineer for approval prior to performing the Work of this Section.

B. Obtain roughing-in dimensions of electrically operated equipment, including equipment being installed by both electrical and other construction trades.
   1. Set conduit and boxes only after receiving approved dimensions and checking such equipment locations.

2. Arrange electrical Work accordingly and furnish such fittings and apparatus as required to accommodate such conditions and to preserve access to other equipment, rooms, areas, and similar spaces.

3.03 INSTALLATION

A. Install electrical Work in conformance to the requirements of NFPA 70 for wiring methods general requirements, and to other applicable Articles of the NEC governing methods of wiring.

B. Installing Anchors and Fasteners:
   1. For anchoring or fastening applications in masonry and hollow-core precast concrete structural elements, provide masonry anchors as specified herein.
   2. For anchoring or fastening applications in cast-in-place concrete and solid precast concrete structural elements, provide concrete anchors as specified herein.
   3. Threaded Bolts:
      a. Draw threaded bolted connections up tight using 316 stainless steel lock washers to prevent the bolt or nut from loosening.
   4. Drilled-In Expansion Anchors:
      a. Install expansion anchors in strict accordance with manufacturer's instructions and the following.
         1) Drill holes to the required diameter and depth in accordance with anchor manufacturer's instructions for the size of anchor being installed.
         2) Minimum Embedment:
            a) Embed expansion anchors to four and one-half bolt diameters minimum unless otherwise indicated on the Contract Drawings.

C. Installation of U-Channel Support Framing Systems in accordance with Table 16070-1 below:

Table 16070-1 U-Channel Support Framing Selection

Condition 1	Condition 2	Type
Aboveground	Outside vertical support within 6” of concrete	PVC Coated Steel or Stainless Steel
	Outside other locations	Stainless Steel or PVC Coated Steel
	Interior NEMA 1/12	Stainless Steel, PVC Coated Steel
	Interior NEMA 4X	Stainless Steel, PVC Coated Steel

D. Installing Conduit Supports:

1. For exterior locations provide malleable iron conduit supports.
2. For interior locations, provide stamped steel conduit supports.

E. Panelboard/Enclosure Feed Risers:
   1. Furnish and install cable supports in feeder risers as required by the underwriters.

F. In areas designated as wet, NEMA 3, NEMA 3R, NEMA 4X, NEMA 12, or NEMA 13 as defined in NEMA 250; secure equipment and conduit to no fewer than two 7/8-inch minimum depth, non-metallic channels mounted vertically on the walls.

G. Field Fabrication:
   1. Fabricated Items:
      a. Fabricate backboards, backboard supports, equipment supports, conduit supports, and the other items as detailed on the Contract Drawings.
      b. Fabricate backboard posts as detailed on the Contract Drawings from concrete filled steel pipe with a crowned cap; and apply a prime paint finish.
      c. Supply components required for the anchorage of fabrications.
         1) Except where specifically noted otherwise, fabricate anchors and related components from the same material as the fabrication and apply the same finish.
   2. Tightly fit and secure joints.
      a. Make exposed joints butt tight, flush, and hairline.
      b. Weld fabricated assemblies in accordance with AWS D1.1/D1.1M.
         1) Continuously seal joined members using intermittent welds and plastic filler.
         2) Dress welds smooth and free of sharp edges and corners.
      c. Grind exposed joints flush and smooth with the adjacent finish surface.
   3. Ease exposed edges to a small uniform radius.
      a. Cut all backboard corners to a 1-inch radius.
   4. For the attachment of work and for bolted connections, accurately drill or punch holes for the fasteners as required.
      a. Burned holes are unacceptable.
      b. Provide holes no more than 3/32-inch larger than the fasteners.
   5. Exposed Mechanical Fastenings:
      a. Except where specifically noted otherwise in the Contract Documents, provide flush countersunk screws or bolts; unobtrusively located, and consistent with the design of the component.
   6. Fabrication Tolerances:
      a. Squareness: 1/8 inch (3 mm), maximum difference in diagonal measurements.
      b. Maximum offset between faces: 1/16 inch (1.5 mm).
      c. Maximum misalignment of adjacent members: 1/16 inch (1.5 mm).
      d. Maximum bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
      e. Maximum deviation from plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

3.04 REPAIR/RESTORATION

A. Coatings:
   1. Repair damage to coatings.
      a. Touch up damaged coating surfaces using the specified primer for primed steel surfaces.

3.05 FIELD QUALITY CONTROL

A. Inspection:
   1. Verify the adequacy of coatings.
   2. Inspect the items provided under this Section for adherence to the fabrication tolerances specified above, and correct any discrepancies:

3.06 PROTECTION

A. Protect the items provided under this Section from damage during the work of other trades.

END OF SECTION

SECTION 16120

WIRES AND CABLES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish, install and test all wire, cable and appurtenances as shown on the Drawings and as hereinafter specified.

B. General Design:

1. Wire for lighting, and receptacle circuits in the administration building shall be type THHN/W solid.

2. Wire for all power feeder and motor circuits outside of the administration building shall be type XHHW, stranded.

3. Single conductor wire for control, indication and metering shall be type XHHW No. 14 AWG, stranded.

4. Multi-conductor control cable shall be No. 14 AWG, stranded tinned copper.

5. Wire for process instrumentation shall be No. 16 AWG, stranded tinned copper.

6. Except for control and signal leads, no conductor smaller than No. 12 AWG shall be used.

1.02 QUALITY ASSURANCE

A. Standards:

1. Insulated Cable Engineers Association (ICEA).

2. Underwriters Laboratories, Inc. (U.L.)

3. American Society for Testing and Materials (ASTM)

B. Manufacturers:

1. 600 volt wire and cable.

a. Hi-Tech Cable Corp.

b. Collyer Insulated Wire Co.

c. Okonite Co.

d. Rome Cable Co.

e. American Insulated Wire Corp.

f. Triangle PWC, Inc.. Or equal

2. Instrumentation and Control Cable:

a. American Insulated Wire Corp.

b. Rome Cable Corp.

c. Okonite Co.

d. Eaton Corp. "Polyset".

e. Triangle PWC, Inc.

f. Or Equal.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. The requirements of Section 01340 shall be met.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All conductors shall be carefully handled to avoid kinks or damage to the insulation.

B. All conductors stored outdoors shall be covered.

PART 2 - PRODUCTS

2.01 GENERAL

A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper conductors.

B. All conductors shall be stranded except lighting and receptacle circuits.

2.02 MATERIALS

A. 600 Volt Wire and Cable:

1. Type XHHW shall be cross-linked polyethylene (XLP).

B. Instrumentation and Control Cable:

1. Process instrumentation wire shall be twisted pair, 600 volt, cross linked polyethylene insulated, aluminum tape shielded, polyvinyl chloride jacketed, type "XLP". Multi-conductor cables with individually shielded twisted pairs shall be installed where indicated.

2. Multi-conductor control cable shall be stranded, 600 volt, cross-linked polyethylene insulated with PVC jacket, type "XLP".

C. Terminations and Splices:

1. Unless otherwise indicated on the plans, no splices may be made in the cables without prior approval of the Engineer. Where splicing is approved, the splicing material shall be as recommended and approved by the cable manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All conductors shall be carefully handled to avoid kinks or damage to insulation.

B. Lubrications shall be used to facilitate wire pulling. Lubricants shall be U.L. listed for use with the insulation specified.

C. Shielded instrumentation wire shall be installed from terminal to terminal with no splicing at any intermediate point.

D. Shielded instrumentation wire shall be installed in rigid steel conduit and pull boxes that contain only shielded instrumentation wire. Instrumentation cables shall be separated from control cables in manholes.

E. Shielding on instrumentation wire shall be grounded at one end only as directed by the supplier of the instrument.

F. Wire and cable connections to terminals, splices, and taps shall be made with compression connectors. Connections of insulated conductors shall be insulated and covered. All connections shall be made using materials and installation methods in accordance with instructions and recommendations of the manufacturer of the particular item of wire and cable. The conductivity of all completed connections shall not be 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.

G. 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 as approved by the Engineer.

H. Installed, unapproved wire shall be removed and replaced at no additional cost to the Owner.

I. Steel fish tapes and/or steel pulling cables shall not be used in PVC raceway systems.

J. Remove debris and moisture from the conduits, boxes, and cabinets prior to cable installation and mandrel with device of one size smaller than conduit and mandrel with wire brush one size larger than conduit.

K. All control and signal wiring shall be identified with snap-on or slip-on PVC wire markers, machine printed and numbered.

3.02 TESTS

A. All 600-volt wire insulation shall be tested with a megohm meter after installation. Tests shall be made at not less than 1000-VDC. A cable test data form shall be provided for Engineer review.

B. All service conductors shall be tested as in Paragraph A above. These tests shall be witnessed by the Engineer.

END OF SECTION

SECTION 16130

RACEWAYS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish and install complete raceway systems as shown on the Drawings and as specified herein.

B. The complete raceway system shall be Schedule 40 PVC below grade, Schedule 80 PVC above grade, non-metallic conduit and fittings, except for raceway systems for shielded instrumentation wiring. Raceway systems for process shielded instrumentation, telephone, data and VFD motor lead wiring shall be installed in rigid aluminum conduit. Raceway systems for interior administration area in air-conditioning plenums shall be EMT steel conduit.

1.02 QUALITY ASSURANCE

A. Qualifications:

1. The equipment shall be products of manufacturers who are fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The system components shall be designed, constructed, delivered and installed in accordance with the best practices and methods.

B. Standards:

1. Underwriters Laboratories, Inc. (U.L.).

2. American Society for Testing and Materials, (ASTM).

3. Federal Specifications.

C. Manufacturers:

1. Non-Metallic Raceways.

a. Carlon.

b. Triangle Pipe and Tube Co.

c. Phillips Petroleum Co.

d. Indian Head Company.

e. Or equal.

2. Metallic Raceways:

a. Youngstown Sheet and Tube Co.

b. Allied Tube and Conduit Corp.

c. Wheeling-Pittsburg Steel Corp.

d. Or equal.

1.03 SUBMITTALS

A. Material and Shop Drawings:

1. Copies of all materials required to establish compliance with these specifications shall be submitted in accordance with the provisions of the General Conditions. Submittals shall include at least the following:

a. Certified shop drawings with performance data and physical characteristics.

b. Descriptive literature, bulletins, and/or catalogs of each item of equipment.

c. All information required by Section 01340.

d. A complete total bill of materials for all equipment.

2. In the event that it is impossible to conform with certain details of the specifications, describe completely all non-conforming aspects of the Shop Drawing transmittal.

PART 2 - PRODUCTS

2.01 GENERAL

A. The specifications are intended to give a general description of what is required, but do not cover all details which may vary in accordance with the exact requirements of the equipment as offered. They are, however, intended to cover the furnishing, delivery, installation and field testing of all materials, equipment and apparatus as required. Any additional auxiliary equipment necessary for the proper operation of the proposed installation not mentioned in these specifications, or shown on the Drawings shall be furnished and installed.

B. The material covered by these specifications is intended to be standard equipment of proven ability and as manufactured by reputable concerns having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in

accordance with best practice and methods and shall operate satisfactorily when installed as shown on the Drawings.

2.02 MATERIALS AND EQUIPMENT

A. Metallic Conduit:

1. ALUM conduit shall contain less than 0.1 percent copper and conform to Federal Specification WW-C-540C.

B. Non-Metallic Conduit and Fittings:

1. PVC conduit shall be schedule 40 composed of High Impact PVC (polyvinyl) chloride (C-200 Compound), and shall conform to industry standards, and be UL listed in accordance with Article 347 of National Electrical Code for underground and exposed use. Materials must have tensile strength of 55 PSI, at 70 degrees F, flexural strength of 11,000 PSI, compression strength of 8600 PSI. Manufacturer shall have five years' extruding PVC experience.

2. Liquidtight Flexible Conduit and Fittings shall be for use per Article 351 of the NEC. PVC compounds shall not include fillers. Fittings shall be manufactured from high impact PVC.

C. Liquidtight, Flexible Non-Metallic Conduit, Couplings and Fittings:

1. Liquidtight, flexible non-metallic conduit shall be all PVC conduit and manufactured by Thomas and Betts Co., K-Flex, Inc., or equal.

2. Fittings used with Liquidtight flexible conduit shall be of the non-metallic type as manufactured by the Thomas and Betts Co., Xtraflex System, K-Flex, Inc., or equal.

D. Flexible Couplings:

1. Flexible Couplings shall be as manufactured by the Thomas and Betts Co., K-Flex, Inc., or equal.

E. Conduit hubs shall be as manufactured by Myers Electric Products, Inc., Raco,, Div., Appleton Electric Co., or equal.

F. Conduit wall seals shall be Type WSK as manufactured by the O.Z. Electrical Mfg. O., or equal.

G. Combination expansion-deflection fittings shall be Type XD as manufactured by the Crouse-Hinds Co., or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendation, in the location shown on the Drawings.

B. No conduit smaller than 1/2-inch electrical trade size shall be used, nor any have more than three 90 degree bends in any one run. Pull boxes shall be provided as required or directed. Minimum size floor conduit shall be 3/4-inch.

C. 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.

D. The ends of all conduit shall be tightly plugged to exclude dust and moisture while the buildings are under construction.

E. Conduit supports shall be spaced at intervals of 4 feet or less, as required to obtain rigid construction. Conduit straps shall be type as manufactured by "CLIC".

F. Single conduits shall be supported by means of one-hole non-metallic pipe clamps in combination with one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on trapeze type hangers with fiberglass horizontal members and fiberglass treaded hanger rods. The rods shall be not less than 3/8-inch diameter.

G. Conduit hangers shall be attached to structural steel by means of non-metallic beam or channel clamps. Where attached to concrete surfaces, concrete inserts of the spot type shall be provided.

H. All conduits on exposed work 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.

I. No broken run shall exceed 500 feet in length. This length shall be reduced by 75 feet for each 90 degree elbow.

J. Conduit terminating in boxes shall have sealing double lock-nuts and insulating bushings.

K. Conduit terminating in gasketed enclosures shall be terminated with sealing conduit hubs.

L. Conduit wall seals shall be used for all conduits penetrating walls below grade or other locations shown on the Drawings.

M. Liquidtight flexible metal conduit shall be used for all motor terminations and other outdoor equipment where vibration is present.

N. Flexible couplings shall be used in hazardous locations for all motor termination and other equipment where vibration is present.

O. Expansion fittings shall be installed in the following cases: In each conduit run wherever it crosses an expansion joint in the concrete building structure; in each conduit run which is mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other; in straight conduit runs above ground which is more than one hundred feet long and interval between expansion fittings in such a run shall not be greater than 100 feet.

P. PVC joints shall be solvent welded. Threads will not be permitted on PVC conduit and fittings. Installation of PVC conduit shall be in accordance with manufacturer's recommendations. PVC conduit shall not be used to support fixture or equipment. Field bends shall be made with approved hotbox. Heating with flame and hand-held dryers are prohibited.

Q. Conduit installations on roofs shall be kept to a bare minimum. Conduit shall be supported above roof at least 6 inches using approved conduit supporting devices. Supports to be fastened to roof using roofing adhesive as approved by roofing contractor.

R. Cables in vertical raceways shall be supported as per NEC Article 300-19. Provide and install supporting devices for cables, including any necessary accessible pullbox as required regardless if shown on drawings or not. Provide and install access panels as required. Coordinate location of pull box and access panel with the Engineer prior to installation. This includes empty raceways for future use.

S. Provide and install pullboxes, junction boxes, fire barrier at fire rated walls, etc., as required by NEC Article 300, whether shown on drawings or not.

T. Paint all field cut thread on rigid steel conduit with zinc rich sealant. Paint all field cuts on metallic channel or unistrut.

U. Raceways which do not have conductors furnished under this division of specification shall be left with an approved nylon pullcord in the raceway.

V. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on drawings. Grounding conductors run with feeders shall be bonded to portions of conduit that are metal by approved ground bushings.

W. Paint all aluminum conduits below grade and in contact with concrete per the manufacturer’s recommendations.

END OF SECTION

SECTION 16135

CABINETS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Furnish and install all junction boxes, pull boxes, service entrance boxes and for a complete raceway system as shown on the Drawings and as specified herein.

B. Related Work Described Elsewhere

1. Raceways: Section 16130

2. Supporting Devices: Section 16070

C. General Design

1. Unless otherwise hereinafter specified or shown on the Drawings, all boxes and fasteners shall be type NEMA 4X, 316-stainless steel.

2. All boxes in air conditioning plenums above ceilings shall be pressed steel.

3. All boxes that do not receive devices are to have blank plates installed matching wiring device plates.

1.02 QUALITY ASSURANCE

A. Standards

1. Underwriters Laboratories, Inc. (U.L.)

2. Federal Specifications

3. American Society for Testing and Material, (ASTM)

B. Manufacturers

1. Hoffman, Type CHNFSS

2. Or Equal

1.03 SUBMITTALS

A. Materials and Shop Drawings

1. See Section 16050 – Basic Electrical Requirements.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Boxes and fittings shall be stored indoors protected from damage.

1.05 WARRANTY AND GUARANTEES

A. All boxes and fittings shall be warranted against defects or failure for a period of one year from date of acceptance.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Boxes shall be constructed as follows:

1. 14-gauge 316L stainless steel
2. Continuously welded and ground smooth, no holes or knockouts.
3. Seamless foam in-place gasket, watertight, dust-tight.
4. Stainless steel screws and clamps.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All boxes shall be supported away from surfaces.

B. All boxes shall be sized per the National Electrical Code (NEC)

C. All conduit entries into boxes shall not lower or change the NEMA rating of the box.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish and install wiring devices and all necessary accessories and appurtenances required as hereinafter specified and shown on the Drawings.

2. Wiring devices shall include the following:

a. Wall Switches

b. Device Plates

c. Plugs

d. Receptacles

e. Lighting Control Time Clocks

f. Clocks

g. Lighting Contactors

h. Control Stations

i. Dimmer Controls

j. Ground Fault Interrupter Receptacles

B. Related Work Described Elsewhere:

1. Basic Electrical Requirements: Section 16050.

2. Raceway: Section 16130.

1.02 QUALITY ASSURANCE

A. Standards:

1. Underwriters Laboratories Inc. (UL).

2. National Electric Manufacturers Association (NEMA).

3. National Electrical Code (NEC).

B. Manufacturers:

1. Wall switches, device plates, plugs, and receptacles as follows:

a. Arrow-Hart

b. Bryant

c. Hubbell

d. Leviton

e. or Equal

2. Clocks:

a. Simplex

b. or Equal

3. Lighting Contactors:

a. Square-D

b. General Electric

c. Allen Bradley

d. or Equal

4. Dimmer Controls:

a. Leviton

b. Prescolite

c. or Equal

5. Control Stations:

a. Hoffman Engineering Co.

b. Square-D

c. Crouse-Hinds

d. Or equal

1.03 SUBMITTALS

A. Material and Shop Drawings:

1. Submit material list and catalog cut-sheets for all items covered under this section. Indicate type, ratings, material, color, and manufacturer.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All devices covered under this Section shall be stored indoors, protected from damage.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Switches:

1. Wall switches shall be of the indicating, toggle action, flush mounting quiet type. All switches shall conform to Federal Specification W-S-896-D.

2. Wall switches shall be of the following types and manufacturer or equal. Any 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.

a. Single pole - Arrow-Hart, Catalog No. 1991.

b. Double pole - Arrow-Hart, Catalog No. 1992.

c. Three way - Arrow-Hart, Catalog No. 1993.

d. Four way - Arrow-Hart, Catalog No. 1994.

e. Single pole, key operated - Arrow-Hart Catalog No. 1l991-L.

f. Momentary contact, 2 circuit, center off - Arrow-Hart, Catalog No. 1895.

g. Weatherproof cover for Arrow-Hart 2900 series tap action switches - Arrow-Hart Catalog No. 2881-G.

B. Receptacles:

1. Wall receptacles shall be of the following types and manufacturer or equal.

a. Single, 20A, 125V, 1P, 3W; Arrow-Hart, Catalog No 5351.

b. Duplex, 20A, 125V, 2P, 3W; Arrow-Hart, Catalog No. 5352.

c. Weatherproof, 20A, 125V, 2P, 3W; Arrow-Hart, Catalog No. 5351 and WLRD-1 cover.

d. Corrosion-resistant, duplex, 20A, 1 25V, 2P, 3W; Arrow-Hart, Catalog No. 5351 and WLRD-l cover.

e. 60A, 480V, 3P, 2W; weatherproof receptacle shall be Crouse-Hinds Catalog No. ARE6324 with Crouse-Hinds Catalog No. APJ 6385 plug.

f. Ground fault interrupter, duplex, 20A, 125V, 3P, 2W; Arrow-Hart Catalog No. GF5342.

g. Stainless steel indoor mounting plate for G.F.I. receptacle; Arrow-Hart Catalog No. 97061.

h. Weatherproof cover for G.F.I. receptacle in FS box; Arrow-Hart Catalog No. 4501-FS.

i. Clock hanger, 15A, 125V, 2P, 3W; Arrow-Hart Catalog No. 452.

j. Single, 20A, 125V, 2P, 3W; Arrow-Hart Catalog No. 8510BL; cover: Arrow-Hart Catalog No. 9301C indoor, 7420C weatherproof.

k. Single, 30A, 125V, 2P, 3W; Arrow-Hart Catalog No. 5716N; cover: Arrow-Hart Catalog No. 9301C indoor, 7420C weatherproof.

l. Clothes dryer, 30A, 125/250V, 3P, 3W; Arrow-Hart Catalog No. 9344N. Matching cord set shall also be included.

C. Device Plates:

1. Plates for flush mounted devices shall be of the required number of gangs for the application involved and shall be 302 (18-8) high nickel stainless steel of the same manufacturer as the device.

D. Lighting Contactor:

1. Lighting contactors shall be of the electrically operated, electrically held type in NEMA 1 enclosures of the number of poles as called for on the Drawings.

2. Contactors shall be rated for 25A-600 volt contacts and be similar and equal to Automatic Switch Company bulletin 1255-166 RC.

E. Lighting Control Time Switches:

1. Time switches for the control of lighting shall have astronomic dials, reserve power and be similar and equal to the following types:

a. Where time switch is indicated to be for momentary contact operation it shall be similar and equal to Tork Time Controls Catalog No. 1847ZL-(277V).

b. Where time switch is indicated for SPST maintained control it shall be similar and equal to Tork Time Controls Catalog No. 7100ZL (120V).

c. Where time switch is indicated for DPST maintained control it shall be similar and equal to Tork Time Controls Catalog No. 7200ZL (120V).

d. Where time switch is indicated for roadway or equipment, lighting shall be similar or equal to Tork Time Controls 900 series.

F. Clocks:

1. Clocks shall have round dials, 120 volt synchronous motors, surface mounting and be similar and equal to Simplex Time Recorder Company Catalog Nos. 3009D-15 (9-inch), 3012D-15 (12-inch) and 3015D-15 (15-inch).

G. Control Stations:

1. Control stations for start/stop pushbutton and hand-off-automatic selector switches shall be corrosion resistant, dust-tight, watertight and weatherproof, NEMA 4X, 600 VAC, UL Standard 508 as manufactured by Crouse-Hinds Series NCS or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Receptacles in process areas and shops shall be mounted 36 inches above the floor unless otherwise noted on the Drawings.

B. Receptacles in office and other like areas shall be mounted 18 inches above the floor unless otherwise noted on the Drawings.

C. Use bolt, screws, nuts and other threaded devices having standard threads and heads so they may be installed and replaced without special tools.

D. Check light switch locations before rough-in to avoid installing a switch behind the door swing.

E. The Engineer and Owner reserve the right to change any switch or receptacle location within the same room, without added cost prior to rough-in.

F. Locate outlets intended for the supply of specific items such as water coolers, copying machines, fans, etc., as recommended by the item manufacturer.

END OF SECTION

SECTION 16150

MOTORS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish and install the motors as hereinafter specified and as called for in other sections of these Specifications.

B. Related Work Described Elsewhere:

1. Equipment: Division 11.

1.02 QUALIFICATIONS

A. Qualifications:

1. Motors shall be sufficient in size for the duty to be performed and shall not exceed their full-rated load when the driven equipment is operating at specified capacity. Unless otherwise noted, motors driving pumps shall not be overloaded at any head or discharge condition of the pump.

2. The equipment shall be products of manufacturers who are fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The system components shall be designed, constructed, delivered and installed in accordance with the best practices and methods.

1.03 SUBMITTALS

A. The motor manufacturer shall submit to the Engineer as provided in Section 01340: Shop Drawings, Working Drawings and Samples: certified dimension prints showing nameplate data and outline dimensions.

B. 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 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 Contractor at no expense to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. The specifications are intended to give a general description of what is required, but do not cover all details which may vary in accordance with the exact requirements of the equipment as offered. They are, however, intended to cover the furnishing, delivery, installation and field testing of all materials, equipment and apparatus as required. Any additional auxiliary equipment necessary for the proper operation of the proposed installation not mentioned in these specifications, or shown on the Drawings shall be furnished and installed.

B. The material covered by these specifications is intended to be standard equipment of proven ability and as manufactured by reputable concerns having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with best practice and methods and shall operate satisfactorily when installed as shown on the Drawings.

2.02 MATERIALS AND EQUIPMENT

A. Rating:

1. Unless otherwise noted, motors 200 horsepower and below shall be of the low voltage type. Unless otherwise noted, all motors 1/2 through 200 horsepower shall be rated 230/460 volt, 3-phase, 60 Hertz A.C., premium efficient, and motors: below 1/2 horsepower shall be rated 115/230 volt, 1-phase, 60/Hertz A.C.

2. Motor connected to variable frequency drives shall be rated as inverter duty by the motor manufacturer. The motor manufacturer shall submit in writing that the motor is suitable for the drive.

B. All dripproof and weather protected Type 1 (WP1) motors shall have epoxy encapsulated windings. Small motors not readily available with encapsulated windings may be standard type, except non-encapsulated motors exposed to the outside atmosphere shall be totally enclosed.

C. All motors shall include space heaters to prevent condensation on the motor windings when the motor is not operating. The space heaters shall be sized by the motor manufacturer; maximum 200 watts; 120 volts.

D. 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.

E. Low Voltage, Three-Phase Motors:

1. Motors shall be of the squirrel-cage or wound rotor induction type as noted. 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 herein. All motors shall be built in accordance with current NEMA, IEEE, ANSI and AFMBA standards where applicable. Motors shall be of the type and quality described by the 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 600 percent full load current), and low slip.

3. Motors shall be of drip proof or weather protected Type 1 or totally enclosed fan cooled construction as called for on the Drawings or specified in other sections of these specifications, with 1.15 service factor.

4. Motors shall be suitable for operation in moist air with hydrogen sulfide gas present

5. The output shaft shall be suitable for direct connection or belt drive as required.

6. Motors shall have a Class B non-hygroscopic insulation system. Class F insulation may be used but shall be limited to Class B temperature rise.

7. 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.

8. All fittings, bolts, nuts, screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads.

9. All machine surfaces shall be coated with rust inhibitor for each disassembly.

10. Motor terminal boxes for motor 100 horsepower or greater shall be cast iron diagonally split, one size larger than the manufacturer's standard, pipe tapped for conduit and shall be attached to the motor frame with cadmium plated hex head cap screws. The box shall be arranged for rotation so that conduit entry from either sides, or bottom is possible. Gaskets shall be supplied between the box and the motor frame and between halves of the box. Cover shall be installed with cadmium plated hex head cap screws. The box shall come completely assembled to the motor. Motor leads in the conduit box shall have the same insulation class as the windings, shall be sized in accordance with EASA suggested minimum ampacity values using 105 degree C insulated lead wire. The wiring shall be clearly identified every inch or the lead shall have a metal band in accordance with ANSI C6.1, latest revision. Nameplates shall be supplied stating the above data and permanently attached to the motor.

Where the leads exit the motor frame, they shall pass through a tight fitting neoprene rubber seal to prevent foreign material or air passage and to hold the leads in a centered position. Motors shall be provided with a compression type grounding lug, mounted in the conduit box by drilling and tapping into the motor frame or by a double ended cap screw of silicon bronze.

11. Totally enclosed motors shall be provided with condensate drain hole and epoxy coated motor windings to protect against moisture.

12. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all frames 254T and larger. Enclosures will have stainless steel screen and motors shall be protected for corrosion, fungus and insects.

13. Low voltage, three-phase motors shall be manufactured by, Baldor, Marathon or Relience Electric.

14. 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 reinforced, lightweight die-cast aluminum. 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 lubrication.

15. Integral Horsepower:

    a. Motor frames and end shield 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 shall 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 or 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.

F. Inverter Duty Motors:

1. In addition to the requirements of 16150-2.02 A.B.C. D and E., motors intended for use with variable frequency drives shall be inverter duty motors specifically designed for inverter operation, and shall be applied in accordance with NEMA, ANSI, IEEE, AFBMA AND NEC for the duty imposed by the driven and drive equipment. Inverter duty motors shall be specifically certified by the motor manufacturer to be compatible with the variable frequency drive to be used with the motor. Inverter duty motors shall be designed to operate over a frequency range of 0 to 66 Hertz. Motor insulation for all motors operating with variable frequency drives shall be Class H with Class F temperature rise when operated with the inverter continuously at all speed and load conditions throughout the specified operating range. Insulation systems shall be capable of withstanding a change in voltage (dV/dT) of 1600 peak volts and rise time greater than 0.1 microseconds without damage per NEMA MG-1 Section IV, Part 31.40.4.2. Motors rated less than 200 horsepower shall be protected with two normally closed thermal protectors in the stator winding and shall be set to open when the temperature reaches 155 degrees C. Motors rated 200 horsepower and greater shall have platinum RTD overtemperature protection

The motor frame shall be cast iron. Inverter Duty motors shall be Baldor Inverter Drive Motors, Reliance Electric.

2. Motors shall be suitable for operation in moist air with hydrogen sulfide gas present

3. Conduit boxes shall be gasketed. Lead wires between motor frame and conduit box shall be gasketed.

4. Totally enclosed motors shall be provided with condensate drain hole and epoxy coated motor windings to protect against moisture.

5. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all frames 254T and larger. Enclosures will have stainless steel screen and motors shall be protected for corrosion, fungus and insects.

G. 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 called for on the Drawings. Motors shall be rated 115/230 volts, 60 Hertz, single phase, open, drip proof, or totally enclosed fan cooled as called for on the Drawings or other sections of these 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 protecting 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 a means of a short section (18 inch maximum) of flexible conduit unless otherwise indicated. For motor connections of No. 6 AWG and smaller wire size, the Contractor shall furnish flexible conduit with an approved grounding conductor inside the flexible section. For motor connections of No. 4 AWG or larger wire size, the Contractor shall install a grounding conductor in the conduit and terminate at the motor control center with an approved grounding clamp.

3.02 INSPECTION AND TESTING

A. The following tests shall be performed on all motors after installation but before putting motors into service.

1. 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. The following table gives minimum acceptance insulation resistance in megohms at various temperatures and for various voltages with readings being taken after one minute of megger test run.

Winding Temp (F°)	115V.	230V.	460V.
37	60	108	210
50	32	60	120
68	13	26	50
86	5.6	11	21
104	2.4	4.5	8.8
122	1	2	3.7
140	.50	.85	1.6

2. The Contractor shall check all motors for correct clearances and alignment and for current lubrication, and shall lubricate if required in accordance with manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections if necessary.

END OF SECTION

SECTION 16151

VARIABLE SPEED DRIVE UNITS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Furnish and install variable speed drives including all appurtenances required as shown on the drawing and specified herein.

2. All equipment and accessories shall have approved manufacturer's shop drawings prior to installation and shall be tested in conformance with these Performance Specifications prior to acceptance and final payment by the Owner.

B. Related Work Described Elsewhere

1. Equipment: Division 11.

2. Process Instrumentation and Controls Products: Section 13615.

1.02 QUALITY ASSURANCE

A. Variable speed drives shall be sufficient size for the duty to be performed and shall not exceed their full-rated capacity when the driven equipment is operating as specified. Variable speed drives driving pumps shall not be overloaded under any operating condition of the pump.

B. Standards

1. National Electrical Manufacturers Association (NEMA).

2. Institute of Electrical and Electronics Engineers, Inc. (IEEE).

3. American National Standards Institute (ANSI).

4. National Electric Code (NEC).

C. The variable frequency control shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10% total harmonic voltage distortion and commutation VFD's shall meet the requirements as outlined in the latest edition of IEEE-519 for total harmonic voltage and current distortion. Individual or simultaneous operation of the VFD's shall not add more than 5% total harmonic voltage distortion to the normal bus, nor more than 10%

while operating from standby generator. The point of common coupling shall be the secondary side of the service transformer. The short circuit current at point of common coupling under utility operation is estimated at 90,105 syn. amps. Standby generator rating will be 1000KW with a minimum 0.12702 per unit X"D subtransient direct axis reactance. A maximum of four (4) VFD's will operate simultaneously from the generator. Maximum allowable total and individual harmonic current distortion limits for each VFD shall not exceed limits as set forth by IEEE 519 latest edition. If harmonic filters are required to meet these requirements, it is the responsibility of the VFD manufacturer to provide filters and labor to install and wire the filters. It is the responsibility of the VFD manufacturer to design and manufacturer any required filters.

D. The controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:

1. Power transistors, SCR,s and diodes shall be tested to ensure correct function and highest reliability.

2. All printed circuit boards shall be tested at 50 degree C for 50 hours. The VFD manufacturer shall provide certification that the tests have been completed.

3. Every controller will be functionally tested with a motor to ensure that if the drive is started up according to the instruction manual provided, the unit will run properly.

4. The VFD systems shall be fabricated by the same VFD manufacturer, items must not be fabricated in whole or in part by parties other than the VFD manufacturer. Third party distributor or packager modifications to a standard product will not be allowed.

5. The VFD shall be fully designed and manufactured in the United States of America.

E. Approved Manufacturers:

1. The AC Drive shall be Yaskawa model iQpump 1000 by ICON Technologies or approved equal.

1.03 DRIVE MANUFACTURER'S RESPONSIBILITIES

A. The VFD manufacturer shall be responsible for the installation, testing and start-up of each drive.

B. The VFD manufacturer shall be responsible for the coordination of the drive with their respective motor(s) specified in other Section(s) of this specification.

C. The VFD manufacturer shall be, at no additional cost to the Owner, responsible for mitigating any harmonic, and/or all RF and/or EMI and/or any electrical type noise

created by the drive which adversely affect the proper operation of any and all electronic and/or electrical power and/or mechanical devices on this project. The VFD manufacturer shall repair all damages due the drive misapplication.

D. The VFD manufacturer shall provide input and/or output filters and/or other accessories on each drive to mitigate the transient to a limit which is not detrimental to the motor winding regardless of the motor lead length and/or type of conduit and wire.

E. The VFD manufacturer shall be responsible for all additional materials and labor related to the installation of the drive that is above and beyond the scope of work as shown on these drawings and specification.

F. The VFD manufacturer shall be responsible for interfacing with the plant SCADA system. The interface shall transmit real-time data, configuration and fault data as a minimum.

1.04 SUBMITTALS

A. Refer to Section 01340: Shop Drawings, Working Drawings and Samples; and Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

1.05 DOCUMENTATION

A. Refer to Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

B. The equipment shall be maintained in an upright position at all times. Lifting shall be only at the floor sills or the top mounted lifting angles.

C. The equipment shall be protected against damage at all times. Any damage to the paint shall be carefully repaired using touch-up paint furnished by the VFD Manufacturer.

D. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.06 WARRANTY AND GUARANTEES

A. Refer to Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

PART 2 - PRODUCTS

2.01 18-PULSE VARIABLE FREQUENCY ADJUSTABLE SPEED DRIVES (VARIABLE TORQUE, PWM)

A. General:

1. The variable frequency drive (VFD) motor controller shall convert 460 Volt, three-phase, 60 Hertz utility power to adjustable voltage (0-460V) and frequency (0-60 Hz.) three-phase, AC power for stepless motor speed control with a capability of 10:1 speed range. All general options and modifications shall mount within the standard adjustable frequency controller enclosure.

2. The adjustable frequency controller shall be a space vector sine-coded Pulse-Width Modulated (PWM) design. Modulation methods which incorporate "gear-changing" techniques are not acceptable. Distributor or packager modifications to a third-party standard product will not be allowed. All drives shall be manufactured by a single manufacturer, and shall be of the same technology.

3. The controller(s) shall be suitable for use with any standard configuration squirrel-cage induction motor(s) having a 1.05 or better service factor, or with existing standard squirrel-cage induction motor(s) with nameplate data as shown on the plans. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage and RPM) in the field.

4. The Contractor shall be responsible for the erection, installation and start up on the equipment covered by this Specification.

5. Complete drawings shall be furnished for approval before proceeding with manufacture and shall consist of master wiring diagrams, elementary or control schematics including coordination with other electrical control devices operating in conjunction with the Adjustable Frequency Drive, and suitable outline drawings with sufficient details for locating conduit stub-ups and field wiring.

6. The Adjustable Frequency Drive manufacturer shall maintain and staff engineering service and repair shops throughout the United States, including the State of Florida, trained to do start up service, emergency service calls, repair work, service contracts and training of customer personnel.

B. Construction

1. Each Adjustable Frequency Drives shall consist of a 460V, 3 phase rectifier and adjustable frequency inverter with features, functions and options as specified.

2. The controller shall produce an adjustable AC voltage/frequency output. It shall have an output voltage regulator to maintain correct output V/Hz. despite incoming voltage variations.

3. The controller shall have a continuous output current rating of 100% of motor nameplate current.

4. The VFD shall be of the Pulse-Width Modulated type and shall employ a 12 pulse dual full-wave diode bridge converters to convert incoming fixed voltage/frequency to a fixed DC voltage, all components for 12-pulse converters

must be integral to VFD enclosure and require no additional installation costs. The Pulse Width Modulation strategy shall be of the space vector type implemented in a microprocessor which generates a sine-coded output voltage.

5. The inverter output shall be generated by Darlington power transistors which shall be controlled by six identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

6. The Adjustable Frequency Drives shall be rated for the HP, full load amperes and rpm of the motor. They shall be designed to provide continuous speed adjustrnent of three-phase motors. The Adjustable Frequency output voltage shall provide constant volts-per-Hertz excitation to the motor terminals up to 60 Hertz.

7. Controllers shall be rated for an ambient temperature of 0°C. to 40°C., an altitude of up to 3,300 feet above sea level and humidity of 0 to 95% non-condensing.

8. Controller enclosures shall be NEMA Type I floor-mounted, force ventilated above 25 HP. The inverters shall have complete front accessibility with easily removable assemblies.

9. The door of each power unit shall include a "POWER ON light, a VFD fault light, a VFD run light, stop push-button, start push-button, a fault reset push-button, a "HAND-OFF-AUTOMATIC" selector switch, and a manual speed control potentiometer.

10. The VFD shall be software programmable to provide automatic restart after any individual trip condition resulting from either overcurrent, overvoltage, undervoltage, or overtemperature. For safety, the drive shall shut down and require manual reset and restart if the automatic reset/restart function is not successful within a maximum of three attempts within a short time period.

11. A speed droop feature shall be included which reduces the speed of the drive on transient overloads. The drive is to return to set speed after transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive is to automatically compensate to prevent drive trip.

12. Automatic restart after drive trip or utility failure. Software selectable if not desired.

13. Process signal inverter. Software selectable to allow speed of drive to vary inversely with input signal.

14. Proportional and integral setpoint process controller with menu driven selection and programming via door-mounted keypad.

15. Pick up a spinning load. The VFD shall be able to determine the motor speed and resume control of a motor which is spinning in either direction without tripping.

16. A door-mounted membrane keypad with integral 2-line, 24-character LCD display shall be furnished, capable of controlling the VFD and setting drive parameters, and shall include the following features:

17. The digital display must present all diagnostic message and parameter values in English engineering units when accessed, without the use of codes.

18. The keypad module shall contain a "self-test" software program which can be activated to verify proper keypad operations.

19. The digital keypad shall allow the operator to enter exact numerical settings in English engineering units. A plain English user menu shall be provided in software as a guide to parameter setting, (rather than codes). Drive parameters shall be factory set in EEPROM and re-settable in the field through the keypad. Six (6) levels of password security shall be available to protect drive parameters from unauthorized personnel. The EEPROM stored drive variables must be able to be transferred to new boards to reprogram spare boards.

    a. Normally the digital display shall simultaneously display:

        1. Speed demand in percent
        2. Output current in amperes
        3. Frequency in hertz
        4. Control Mode: Manual/Automatic
        5. Total three-phase KW or output volts

20. The controller shall include the following protective features:

    a. Single phase fault or 3-phase short circuit on VFD output terminals without damage to any power component.

    b. Static instantaneous overcurrent and overvoltage trip with inverse overcurrent protection.

    c. Static overspeed (overfrequency) protection.

    d. Line or fuse loss and undervoltage protection.

    e. Power unit overtemperature protection.

    f. Electronic motor overload protection.

g. Responsive action to motor winding temperature detectors or thermostatic switches.

h. LED monitor lamps for each inverter stage.

i. LED status indicators on regulator, printed circuit board face plates.

j. Isolated operator controls.

k. Input line fuses.

l. Be insensitive to incoming power phase sequence.

m. Have desaturation circuit to drive inverter section transistor base current to zero in event of controller fault.

n. Have DC bus discharge circuit for protection of operator and service personnel with an indicator lamp.

21. The following system configuring settings shall be provided, without exception, field adjustable through the keypad/display unit or via the serial communication port only.

a. Motor Nameplate Data

1. Motor frequency
2. Number of poles
3. Full load speed
4. Motor volts
5. Motor full load amps
6. Motor KW
7. Current min.
8. Current max.

b. VFD Limits

1. Independent accel/decel rates
2. No load boost
3. Vmin, Vmax, V/Hz.
4. Full load boost
5. Overload trip curve select (Inverse or Constant)
6. Min./max. speed (frequency)
7. Auto reset for load or voltage trip select
8. Slip compensation
9. Catch-A Spinning-Load select
10. Overload trip time set

c. VFD Parameters

1. Voltage loop gain
2. Voltage loop stability
3. Current loop stability

d. Controller Adjustments

1. PID control enable/disable
2. Setpoint select
3. Proportional band select
4. Reset time select
5. Rate time select
6. Input signal scaling
7. Input signal select (4-20mA/0-5 Volts)
8. Auto start functions: On/Off, Delay On/off, Level Select On/Off
9. Speed Profile: Entry, Exit, Point Select
10. Min., Max. Speed Select

22. The VFD shall include a comprehensive microprocessor based digital diagnostic system which monitors its own control functions and displays faults and operating conditions. microprocessor systems must be products of the same manufacturer as the VFD.

23. A "FAULT LOG" shall record, store, display and print upon demand, the following for the 50 most recent events:

a. VFD mode (Auto/Manual)
b. Elapsed time (since previous fault)
c. Type of fault
d. Reset mode (Auto/Manual)

24. A "HISTORIC LOG" shall record, store, display and print upon demand, the following control variables at 2.7 m/Sec. intervals for the 50 intervals immediately preceding a fault trip:

a. VFD mode (manual/auto/inhibited/tripped/etc.)
b. Speed demand
c. VFD output frequency
d. Demand (output) Amps
e. Feedback (motor) Amps
f. VFD output volts
g. Type of fault:
   (A) Br Over Current
   (B) Br Under Voltage
   (C) Br Phase Rotation

(D) Br Fuse Failure
(E) Sustained Overload
(F) Manual Trip Test
(G) Drive inhibit (on/off)
(H) Power Supply Fail
(I) Output Over Voltage
(J) Over Temperature
(K) Thermistor Trip
(L) Ground Fault

25. The fault log record shall be accessible via a RS232 serial link as well as line by line on the keypad display. A portable battery powered thermal printer with RS-232C serial interface and connecting cable shall be furnished. The printer shall have a dot matrix format with a print speed of 37 CPS and a 1500 line print

26. The following factory installed modifications shall be furnished with the controller:

a. Input circuit breaker, interlocked with the enclosure door, with through-the-door handle to provide positive disconnect of incoming AC power. The circuit breaker shall be rated for AIC.

b. Door-mounted meters to be provided on all units as follows:

1. Analog or digital ammeter (0% - 110%).
2. Analog or digital speed/frequency meter (0 - 110% speed as well as Hz.)
3. Analog or digital voltmeter (0 - 600 VAC).
4. Analog or digital KW meter(0 - 110%).
5. 5-digit elapsed time meter.

c. The drive is to be provided with isolated 4-20mA DC output signals proportional to speed and current for remote monitoring of the VFD.

d. Relay output auxiliary contacts to indicate the position of all selector switches, drive failures and drive status.

f. Provide 120VAC and logic for motor space heater control and generator lockout.

g. The drive is to be provided DeviceNet, Modbus serial data communication compatible with the plant SCADA system.

PART 3 - EXECUTION

3.01. SYSTEM OPERATION

1. With the H-O-A switch in the "HAND" position, the drive shall be controlled by the manual speed potentiometer located remotely near the motor or on the drive door.

2. With the H-O-A switch in "AUTOMATIC", the drive shall start when and its speed shall be controlled by a 4-20mA signal from the local control panel.

3. With the H-O-A switch in the "OFF" position, the run circuit will be open and the VFD will not operate.

3.02 INSTALLATION

A. Field wiring shall be per manufacturer's recommendation.

B. The manufacturer shall include in his bid one (1) normal work day per drive of a qualified service engineer's time. This time will be used to ensure proper connection and functioning of the equipment prior to startup and to train Owner personnel in the use of the equipment.

C. The manufacturer shall provide one spare for each type of plug-in type PC card. These spares will be color-coded or otherwise keyed to its original counterpart. In addition to the cards, the manufacturer shall provide two spares per drive all expendable items such as fuses, pilot lamps, etc.

3.03 INSPECTION AND TESTING

A. The drive manufacturer shall test the drive controller with a motor load prior to shipment.

B. The drive manufacturer shall furnish a certified field test report demonstrating installed compliance for voltage and current distortion at the required point of common coupling under both utility power and generator power. The test shall report shall be sealed by a Florida Registered Professional Electrical Engineer. The test report shall be performed by measuring actual power system harmonic content and be performed by an independent testing agent approved by NETA. The test shall measure harmonic content while all variable frequency drives are on-line and at full speed.

C. A copy of all tests and checks performed in the field, complete with meter readings and recordings, where applicable, shall be submitted to the Owner.

END OF SECTION

SECTION 16402

UNDERGROUND SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Furnish and install a complete underground system of ducts, manholes and handholes all as hereinafter specified and shown on the Drawings.

B. Related Work Described Elsewhere

1. Excavation and backfilling is included in Division 2.

2. All concrete and reinforcing steel shall be included under Division 3.

3. Conduit for ducts shall be as specified under Section 16130.

4. Ground rods and other grounding materials and methods shall be as specified under other sections of Division 16.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Ducts shall be polyvinyl chloride.

B. Cable racks, supports, pulling-in irons, manhole steps, and hardware shall be galvanized steel manufactured by Cope or equal.

C. Precast 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., or equal.

D. Handhole covers and frames shall be as shown on the Drawings.

E. Fireproofing tape shall be Irvington No. 7700 or be an approved equal product.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Ducts shall be installed to drain away from buildings; ducts between manholes or handholes shall drain toward the manholes or handholes. Duct slopes shall not be less than 3 inches per 100 feet.

B. Duct banks shall be reinforced as shown on the Drawings.

C. Duct lines shall be laid in trenches on a clean backfill bedding not less than 6 inches thick and well graded.

D. Plastic spacers shall be used to hold ducts in place. Spacers shall provide not less than 2-inch clearance between ducts.

E. The minimum cover for duct lines shall be 24 inches unless otherwise permitted by the Engineer.

F. Duct entrances to buildings and structures shall be made with steel conduit not less than 10 feet long.

G. PVC duct termination at manholes shall be with PVC end bells. Steel conduits shall be terminated with insulated, grounding-type bushings.

H. Where bends in ducts are required, long radius elbows, sweeps and offsets shall be used.

I. All ducts shall be rodded and 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 duct.

J. Spare ducts shall be plugged and sealed watertight at all manholes, buildings and structures.

K. Ducts in use shall be sealed watertight at all manholes, buildings and structures.

L. Pulling-in irons shall be installed opposite all duct entrances to manholes, equal to Cope Catalog No. 311-9.

M. Cable racks shall be similar and equal to Cope Catalog 324-T, cut to length for one, two, three or four vertical tiers of cables. Racks shall be mounted with 1/2-inch by 4-inch expansion bolts on manhole walls. Arms similar and equal to Cope Catalog No. 325-T4, 325-T75 and/or 325-T10 for one, two and/or three cables, respectively, shall be furnished and installed with Catalog No. 326-T22 porcelain insulators for support of cables. Lock clips shall be furnished and installed to secure hooks in position.

N. Cables shall be trained in manholes and supported on racks and hooks at intervals not greater than 3 feet - O 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.

O. Fireproofing shall be furnished for all 5-KV cables in manholes. Each individual 5-KV cable shall be wrapped with an arc-proofing tape. The tape shall be applied in accordance with the manufacturer's recommendations. The wrapping shall extend into the end bells.

P. Rigid steel conduit shall be used for risers. For fiber runs, a fiber to rigid steel conduit adapter shall be used at the lower end of the elbow and the elbow and all exposed conduit shall be of galvanized rigid steel conduit.

Q. All risers from underground shall be given a heavy coat of bitumastic paint from a point 1’-0” below grade to a point not less than 6 inches above grade or surface of slab.

R. All joints shall be made so as to prevent the passage of concrete inside the conduit to form obstructions or cause cable abrasions.

S. 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 I foot above the floor and center line of the highest conduit entering will be not less than 1 foot below the roof slab.

T. 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.

U. A #6 bare copper wire (stranded) shall be installed in each 4-inch PVC conduit.

V. A 5/8-inch by l0-foot copper clad ground rod shall be driven in the bottom of each manhole. All bond wires and galvanized steel conduits shall be bonded to the ground rod.

END OF SECTION

SECTION 16410

SAFETY SWITCHES

PART I- GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish and install all motor and circuit disconnects as hereinafter specified and as shown on the drawing.

B. General Design:

1. All safety switches shall be heavy duty and have stainless steel NEMA 4X enclosures.

2. All switches shall have metal nameplates, front cover mounted, that contain a permanent load, switch-type, catalog number and HP ratings, handle whose position is easily recognizable and is padlockable in the "off" position, visible blades, reinforced fuse clips, non-teasible, positive, quick make-quick break mechanism, switch assembly plus operating handle as an integral part of the enclosure base.

3. Switches shall have defeatable door interlocks that prevent the door from opening when the operating handle is in the "on" position. All switches shall have line terminal shields.

4. All current carrying parts shall be copper.

5. Auxiliary contacts rated 10 ampere at 240 volts shall be provided.

1.02 QUALITY ASSURANCE

A. Standards:

1. National Electrical Manufacturer's Association (NEMA).

2. Underwriter's Laboratories (UL).

3. Federal Specifications.

4. National Electrical Code (NEC).

B. Manufacturer:

1. Switches shall be as manufactured by Square D, Cutler-Hammer, or Siemens.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. See Section 16050 – Basic Electrical Requirements.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All switches shall be stored indoors protected from damage.

1.05 WARRANTY AND GUARANTEES

A. All switches shall be warranted against defect, rusting or failure for a period of one year from date of acceptance.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Where a six (6) pole weatherproof disconnect are called for on the drawings; the Contractor shall provide two (2) 600 Volt, 3-pole non-fusible switch in a single NEMA 4X stainless steel enclosure with a single operating handle mechanically interlocked to both disconnects.

B. All parts exposed to the weather or in hose down areas shall be stainless steel.

C. Short circuit rating - 10,000 RMS symmetrical amperes for non-fused switches.

D. Line and load lugs shall be front removable and suitable for copper, 60/75 degree C wire through 200A sizes, 75 degree C wire for 400-800A sizes.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All switches shall be mounted as shown on the drawings.

B. Location of disconnect switches shall be per the N.E.C. and shall be verified with the Engineer before installation.

C. All mounting appurtenances shall be fiberglass or stainless steel including fasteners.

END OF SECTION

SECTION 16421

MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish, install and test the motor control centers as hereinafter specified and as shown on the Drawings.

1.02 QUALITY ASSURANCE

A. Standards:

1. The motor control centers shall be the product of a manufacturer who shall also be the manufacturer of all the circuit breakers, fused switches and motor starters included in the motor control centers.

2. All units and sections shall be U.L. labeled when possible. Motor control centers containing service entrance equipment shall be U.L. labeled "Suitable For Use As Service Equipment".

3. Motor control centers shall be built and tested in accordance with:

a. National Electrical Manufacturers (NEMA).

b. American National Standards Institute (ANSI).

c. Underwriters Laboratories, Inc. (U.L.).

4. The Motor Control Centers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA, ANSI and UL 845

B. Equipment Manufacturer:

1. The motor control center shall be as manufactured by Square D Model 6 OMNI, Allen-Bradley, or Cutler-Hammer IT.

1.03 SUBMITTALS

A. Complete master wiring diagrams and elementary or control schematics, including coordination with other electrical control devices operating in conjunction with the motor control centers and suitable outline drawings shall be furnished for approval before proceeding with manufacture. Due to the complexity of the control functions, 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.

B. Submittals shall include a bill-of-material listing conductor material and insulation type as well as other hardware and equipment to be furnished.

C. Where it is not explicitly shown and completely obvious from the outline drawings, the following items shall be verified in a written statement accompanying the shop drawings:

1. Type of terminal blocks used and that the removal of plug-in compartments can be performed without disconnecting or removing wires.

2. Tin plating of bus.

3. Insulation and isolation of vertical bus.

4. U.L. approval.

5. The following information shall be submitted to the Engineer:

a. Master drawing index
b. Front view elevation
c. Floor plan
d. Top view
e. Single line
f. Unit wiring diagrams depicting remote devices
g. Nameplate schedule
h. Starter and component schedule
i. Conduit entry/exit locations
j. Assembly ratings including:
k. Short-circuit rating
l. Voltage
m. Continuous current
n. Major component ratings including:
o. Voltage
p. Continuous current
q. Interrupting ratings
r. Cable terminal sizes
s. Product data sheets.
t. Busway connection
u. Connection details between close-coupled assemblies

v. Composite floor plan of close-coupled assemblies
w. Key interlock scheme drawing and sequence of operations.

6. Submittals – for construction

a. Final as-built drawings and information for items listed above
b. Unit wiring diagrams
c. Certified production test reports
d. Installation information
e. The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process.

PART 2 - PRODUCTS

2.01 RATING

A. The motor control centers shall be designed for 480 volt, 3 phase, 3 wire, 60 Hz service and shall have short-circuit rating of not less than 65,000 amperes RMS, symmetrical.

2.02 CONSTRUCTION

A. Structures shall be totally enclosed deadfront, free-standing assemblies. They shall be 90 inches high and 21 inches deep for front-mounted units. Structures shall contain a horizontal wireway at the top, isolated from the horizontal bus via metal barriers and shall be readily accessible through a hinged cover. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.

B. Compartments for mounting control units shall be incrementally arranged such that not more than eleven (11) size 1 starters for front-mounted only can be mounted within each vertical structure. Unit guide rails shall be provided.

C. A vertical wireway with minimum of 70 square inches of cross-sectional area shall be adjacent to each vertical unit and shall be covered by a hinged door. Wireways shall contain cable supports.

D. All full voltage starter units through NEMA Size 5 and feeders through 400 amp shall be of the drawout type. Drawout provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Draw-out units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend into the unit compartment. Interior of all units shall be painted white for increased visibility. Units shall be equipped with side-mounted, positive latch pull-apart type control terminal blocks rated 300 volts. Knockouts shall be provided for the addition of future terminal blocks. All control wire to be 16 gauge minimum.

E. All drawout units shall be secured by a quarter turn indicating type fastening device located at the top left of the unit. Each unit compartment shall be provided with an individual front door.

F. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access unless the disconnect is in the OFF position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. A second interlock shall be provided to prevent removal or re-insertion of the unit while in the ON position. Padlocking facilities shall be provided to positively lock the disconnect in the OFF position with from one (1) to three (3) padlocks with the door open or closed. In addition, means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.

2.03 BUS

A. Each structure shall contain a main horizontal copper tin-plated bus, with minimum ampacity of 600 amperes or rated amperes as shown on the drawings. The horizontal bus shall be rated at 50 degrees C temperature rise over a 40 degree C ambient in compliance with UL standards. Vertical bus feeding unit compartments shall be tin plated copper and shall be securely bolted to the horizontal main bus. All joints shall be front- accessible for ease of maintenance. The vertical bus shall have a minimum rating of 300 amperes for front-mounted units and 600 amperes for back-to-back mounted units. All vertical bus shall be fully rated, reduced rated via center feeding is not acceptable.

B. The vertical bus shall be completely isolated and insulated by means of a labyrinth design barrier. It shall effectively isolate the vertical buses to prevent any fault-generated gases from passing from one phase to another. The vertical bus shall include a shutter mechanism to provide complete isolation of the vertical bus when a unit is removed.

C. Buses shall be braced for 65,000 amperes RMS symmetrical.

D. Each structure shall contain tin plated vertical ground bus rated 300 amps. The vertical ground bus shall be directly connected to the horizontal ground bus via a tin plated copper connector. Units shall connect to the vertical bus via a tin plated copper stab.

E. Each structure shall contain a tin plated DC bus to distribute control voltage from the Control Power Supply unit to the Motor Control units.

2.03 BUS

A. Wiring shall be NEMA Class II, Type B.

B. Wiring shall be in accordance with the Open DeviceNet Vendors Association (ODVA) specification. Truck cable shall be provided in the upper wireway, with T connectors for each MCC section. Drop cables and T connectors shall be used in the vertical wireway to connect each DeviceNet device.

2.04 MOTOR CONTROLLERS

A. Combination starter units shall be full-voltage non-reversing, unless otherwise shown, and shall utilize motor circuit protectors (MCP).

1. Each combination unit shall be rated 65,000 AIC symmetrical at 480V. The MCP shall provide adjustable magnetic protection, which has an adjustment range that can be set to1700% motor nameplate full load current to comply with NEC requirements. All MCP combination starter units shall have a “tripped” position on the unit disconnect and a push-to-test button on the MCP. Motor circuit protectors shall include transient override feature for motor inrush current. MCP shall be used to provide Type 2 coordination to 65,000 amperes.

B. Motor starters shall be DeviceNet compatible, electrically operated, electrically held, three-pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of four (4) NO or four (4) NC auxiliary contacts. The overload protection shall consist of one (1) current sensor located in each phase monitored by the microprocessor that yields a time-current curve closely paralleling that of motor heating damage boundary, accurate to 2%. Running overload protection shall be selectable for the specific motor full load amperes within the overload range. The overload shall be programmable to provide selectable overload trip class of 20 without the use of an external programming device.

1. Motor starters shall monitor current in each phase to provide phase loss and phase unbalance protection, such that if the unbalance on any of two phases is greater than 30% of the FLA selected trip rating, a phase loss/unbalance trip occurs. Provide phase loss/unbalance protection which requires no time delay for reset. Phase unbalance protection shall have the capability of enabled or disabled with out the use of an external programming device.

2.. Microprocessor shall apply power to the coil such that a guaranteed maximum of two (2) milliseconds of main contact bounce occurs on contactor closure.

3. Microprocessor shall continuously measure coil circuit voltage and current so as to maintain constant coil power at a level to maintain main contact closure and minimize coil power consumption.

4. Provide control modules to perform the indicated input/output control functions shown on the drawings. Module to incorporate faceplates having membrane type pushbuttons and LEDs. All pushbutton and LED functions to be furnished with clearly written identification. Modules to be provided with the ability to replace conventional start, stop, hand, auto, and control functions, and when utilized in starter applications, overload reset function. Modules to be provided with the ability to replace conventional indicating light status of run, off, selector switch pushbutton position, and when utilized in starter applications, overload alarm, overload trip, and circuit breaker trip.

5. Each starter unit shall have an addressable communication module capable of transmitting control and diagnostic data over an open DeviceNet network to either a personal computer or PLC. Each starter shall be a single node on the DeviceNet network. The addition of the DeviceNet communication module shall not increase the

size of the starter unit. The starter unit shall be capable of transmitting the following data.

a. Starter Status (ON, OFF, TRIPPED, NO RESPONSE)
b. ON-OFF reset control functions
c. Circuit Breaker status (ON, OFF, TRIPPED)
d. Control voltage Trip Class
e. Overload protection settings
f. Trip current magnitude as a % of FLA
g. Average motor current Trip Warning
h. Hand/Manual/Local control
i. Cause of trip indication
    1) Phase loss
    2) Phase unbalance
    3) Thermal trip

C. Each starter shall be equipped with a control power stab with fuseless over current protection, two (2) 24 V DC LED type indicating lights (Run and Stop), HOA selector switch, and two (2) NO contacts, unless otherwise scheduled on the drawings. Each starter shall utilize 24 V dc control voltage for safety.

D. Solid-state reduced-voltage starters, shall be provided where shown on the contract drawings. The solid-state reduced-voltage starter shall be UL and CSA listed in the motor control center, and consist of an SCR-based power section, logic board and paralleling bypass contactor. The paralleling bypass contactor shall be energized when the motor reaches full speed. Bypass contactors external of the SSRV starter shall not be allowed. Each starter shall have an addressable communication card capable of transmitting control and diagnostic data over an open DeviceNet network to either a personal computer or PLC.

2.05 CONTROL POWER SUPPLY UNITS

A Each structure shall have a control power supply unit that will provide 24VDC control power to other control units in that structure. The unit shall be 1X (6 inch) minimum. This will be accomplished by using a single control power supply that converts line voltage to 24V DC directly with out the use of a control power transformer. The unit will use a DC stab to energize the DC bus that is mounted in the structure.

B. Each Power supply unit shall be sized to power eleven (11) NEMA size 2 starter unit. The power supply shall be sized to provide 14 Cycle ride through at 0 V on the primary, when fully loaded.

C. Power supplies shall contain an electronic fuseless over current protection that will safely shut down the power supply in the event of a short circuit on the power supply output.

2.06 OVERCURRENT DEVICES

A. Circuit Breakers

1. Individual feeder breakers shall have a minimum interrupting capacity of 65 kAIC at rated voltage or as scheduled on the drawings.

B. DeviceNet devices

1. Motor Control Center assemblies shall be provided with a factory assembled DeviceNet fieldbus communications network providing direct connectivity between MCC devices and the system controller and/or HMI.

2. The DeviceNet system installed in the MCC shall include a complete and tested cabling system compliant and approved by the ODVA DeviceNet standard. The cabling system shall consist of trunk and drop line cabling including all splice and tap connectors and terminating resistors. The trunk and drop cabling shall be 600V insulation and include electrical shielding as per the standard ODVA DeviceNet specification. Non-standard, non-shielded flat cable will not be accepted.

3. The trunk line shall be installed in the top horizontal wireway of the MCC. The trunk line shall be thick cable as specified by the ODVA standard. Sealed, threaded, and keyed device tap connectors located and mounted in the top horizontal wireway shall “T” off the top wireway to drop cable mounted in each of the vertical wireways. Each DeviceNet device shall have a dedicated drop line connection via T Connector. The drop cable shall be thin cable as specified by the ODVA standard. Each section of motor control shall be connected with sealed, threaded, and keyed device tap connectors located and mounted in the top horizontal wireway All cabling shall be securely supported and attached to the MCC structure in accordance with the contract drawings and the manufacturer’s recommendations.

4. DeviceNet communications modules shall be provided at each device interfacing to the DeviceNet fieldbus. The communications modules shall be installed in the unit device compartment or bucket, and shall be direct-connected to the DeviceNet drop cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated DeviceNet device.

5. Port expanders shall be provided where required to permit multiple device communications. The port expander shall be installed in the associated unit device compartment.

6. Motor control centers shall provide required 24 volt DC power to adequately supply power to all the devices in the MCC, and shall be sized per the manufacturers recommendations. The power supply shall be installed in an MCC unit with a disconnect switch, supplementary protection and a cable tap box to prevent damage to/from other power supplies on the network.

7. Operator interface unit(s) shall be provide and be of the same manufacturer as the MCC. Operator interface units shall be able to provide the following. Starter status, three-phase current, control voltage, overload condition (alarm), cause of device trip, operations count, run time, set points, starter description and identification, system

process graphics screens. Operator interface shall have the capability of communicating on the DeviceNet network.

2.07 INCOMING FEEDER TERMINATIONS AND DEVICE

A. Incoming cable shall terminate within the control center on a main breaker termination point. Main lug terminations shall have adequate dedicated space for the type and size of cable used and the lugs shall be compression-type with anti-turn feature. Main breakers shall be provided as indicated on the drawings and shall be molded case circuit breakers.

2.08 CUSTOMER METERING

A. Provide current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.

B. Provide potential transformers including primary and secondary fuses with disconnecting means fused potential taps as the potential source] for metering.

C. Metering shall be DeviceNet compatible.

D. Metering shall provide the following data:

1. Voltage each phase
2. Amperage each phase
3. Total voltage harmonics
4. Total current harmonic
5. Voltage balance
6. Current balance

2.09 ENCLOSURES

A. The type of enclosure shall be in accordance with NEMA standards for Type 1A with gasketed doors. ll enclosing sheet steel, wireways and unit doors shall be gasketed.

2.10 NAMEPLATES

A. Each unit will have a 1.0 x 2.5-inch engraved nameplate. The lettering shall be black 3/16-inch high, on a white background.

2.11 FINISH

A. The control center shall be given a phosphatizing pretreatment. The paint coating shall be a polyester urethane, thermosetting powder paint. Manufacturer’s standard color shall be used.

B. The control center finish shall pass 600 hours of corrosion-resistance testing per ASTM B 117.

2.12 SPARE PARTS

A. The following spare parts shall be furnished:

1. One (1) box of power fuses of each size furnished.

2. One (1) set of starter contacts for each NEMA size installed.

3. One (1) starter coil for each NEMA size installed.

4. One (1) box of pilot lights.

5. One (1) DeviceNet interface module of each type.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The motor control center housings shall be bolted to angle iron sills imbedded in the concrete on the two longest sides. The sills shall be the full length of the motor control center housing and shall be installed level in all directions.

B. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported such that circuit termination are not stresses.

C. The motor control centers shall be maintained in an upright position at all times. Lifting shall be only at the floor sills or the top mounted lifting angle.

D. The motor control centers shall be protected against damage at all times. Any damage to the paint shall be carefully repaired using touch-up paint furnished by motor control centers manufacturer.

E. Installer shall provide DeviceNet trunk and drop cabling with threaded, sealed and keyed device taps

3.02 TESTS AND CHECKS

A. The following minimum tests and checks shall be made after the assembly of the motor control centers, but prior to the termination of any field wiring.

1. Megger terminals and buses after disconnecting devices sensitive to megger voltage.

2. A 1,000 VDC megger shall be used for these tests.

3. The first test shall be made with main circuit breaker closed and all remaining breakers open. A second test shall be made with all circuit breakers closed.

4. The test results shall be recorded and forwarded to the Engineer for his review. Minimum megger readings shall be 100 megohms in both tests.

5. Test failures will be the Contractors responsibility to correct at no charge to the Owner.

6. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed

7. A certified test report of all standard production tests shall be available to the Engineer upon request.

8. Installing Contractor to verify NEC clearances as dictated on the contract drawings prior to installation. Verify UL labeling of the assembly prior to installation

9. Overload relay heater ratings must be properly sized and coordinated for each motor starter unit

10. Follow the minimum requirements as stipulated in the latest NETA testing procedure for this type of motor control center assembly

B. The following shall be done before energizing the motor control centers:

1. Remove all current transformer shunts after completing the secondary circuit.

2. Install overload relay heaters based on actual motor nameplate current. If capacitors are installed between starter and motor, use overload relay heaters based on measured motor current.

3. Check all mechanical interlocks for proper operation.

4. Vacuum clean all interior equipment.

3.03 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the contractor in installation and startup of the equipment specified under this section for a period of five (5) working days. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative

1. Rig the MCC assembly into final location and install on level surface

2. Check all removable cells and starter units for easy removal and insertion.

3. Perform insulation tests on each phase and verify low-resistance ground connection on ground bus

4. Calibrate any solid-state metering or control relays for their intended purpose and make written notations of adjustments on record drawings. Perform startup of any solid-state starters.

5. Connect all power wiring and control wiring and verify basic operation of each starter from control power source

6. Torque all bolted connections made in the field and verify all factory bolted connections

C. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.04 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations. Equipment shall be inspected prior to the generation of any reports

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification

3.05 TRAINING

A. The Contractor shall provide a training session for up to five (5) owner's representatives for two (2) normal workdays at the jobsite or other office location chosen by the Owner.

B. The training session shall be conducted by a manufacturer's qualified representative.

C. The training program shall consist of the following:

1. Review of the MCC one-line drawings and schedules.
2. Review of the factory record shop drawings and placement of the various cells
3. Review of each type of starter cell, components within, control, and power wiring
4. Review contactor coil replacement and contact replacement procedures
5. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program
6. Provide three-ring binders to participants complete with copies of drawings and other course material covered

END OF SECTION

SECTION 16440

PANELBOARDS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment and incidentals required and install all panelboards as hereinafter specified and as shown on the Drawings.

1.02 QUALITY ASSURANCE

A. Standards:

1. Panelboards shall be in accordance with the Underwriter Laboratories, Inc. "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.

B. Manufacturer (NEMA 1):

1. 120/240V, single-phase, 3-wire, and 120/208V three-phase, 4-wire panelboards shall be type AQ as manufactured by Square D, Allen-Bradley, Siemens, or General Electric Company.

2. 480V, three phase, 3-wire panelboards shall be type AE as manufactured by Square D, Allen-Bradley, Siemens, or General Electric Company.

C. Manufacturer (NEMA 3 and 12):

1. NEMA 3 and 12 panelboards shall be type NLP as manufactured by the Crouse-Hinds Company or equal.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. See Section 16050 Basic Electrical Requirements

PART 2 - PRODUCTS

2.01 RATING

A. Panelboard ratings shall be as shown on the Drawings. All panelboards shall be rated for the intended voltage.

2.02 CONSTRUCTION AREA (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 or aluminum 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 panel type, number of circuit breakers, ratings and source.

B. Buses:

1. Bus bars for the mains shall be of tin-plated copper. Full size neutral bars shall be included. Bus bar taps for panels with single pole circuit devices shall be arranged for sequence phasing of the branch circuit devises. 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 copper.

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.

C. Boxes:

1. Recessed boxes shall be made from galvanized code gauge steel without multiple knockouts. Surface mounted boxes shall be painted to match the trim. Boxes shall be of sufficient size to provide a minimum gutter space of 4 inches on all sides.

2. Surface mounted boxes shall have an internal and external finish as hereinafter specified in Paragraph D4.

3. At least 4 interior mounting studs shall be provided.

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 inches 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. Two keys shall be supplied for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door.

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. 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 inch all around. Surface trims shall have the same width and height as the box. Trims shall be fastened with quarter turn clamps.

2.03 CONSTRUCTION (NEMA 4X)

A. Interiors and Buses:

1. Interiors and buses shall be as herein-before specified for NEMA 1 construction.

B. Boxes and Covers:

1. Boxes and covers shall be made from stainless steel.

2. Boxes and covers shall be hinged together and gasketed. All metallic parts on exterior shall be stainless steel.

3. Conduit openings shall be sealed with lock rings or sealing washers.

4. Polycarbonate or plastic enclosures or boxes are unacceptable.

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, for NEMA 1 and plug-in for NEMA 4X.

C. Circuit breakers used in 120/240 and 120/208V panelboards shall have an interrupting capacity of not less than 22,000 amperes, RMS symmetrical.

D. Three pole breakers used in 480V panelboards shall have an interrupting capacity of not less than 25,000 - amperes, RMS symmetrical.

E. GFCI:

1. GFCI (ground fault circuit interrupter) shall be provided for circuits where indicated on 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 U.L. listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time), and in interrupting capacity of 10,000 amperes RMS.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Boxes for surface mounted panelboards shall be mounted so there is at least 1/2 inch air space between the box and the wall.

B. 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.

C. All wiring in panelboards shall be neatly formed, grouped, laced 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.

END OF SECTION

SECTION 16450

GROUNDING SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Furnish and install a complete grounding system in strict accordance with Article 250 of the National Electrical Code and as hereinafter specified and shown on the Drawings.

B. Related Work Described Elsewhere

1. Wires and Cables: Section 16120.

2. Raceways: Section 16130.

1.02 QUALITY ASSURANCE

A. Qualifications:

1. The equipment shall be products of manufacturers who are fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The system components shall be designed, constructed, delivered and installed in accordance with the best practices and methods.

1.03 SUBMITTALS

A. Material and Shop Drawings:

1. Copies of all materials required to establish compliance with these specifications shall be submitted in accordance with the provisions of the General Conditions. Submittals shall include at least the following:

a. Certified shop drawings with performance data and physical characteristics.

b. Descriptive literature, bulletins, and/or catalogs of each item of equipment.

c. All information required by Section 01340.

d. Complete wiring diagrams and schematics of all power and control systems showing wiring requirements between system and connections to work of other sections.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver a complete system ready to install as job progress requires.

PART 2 - PRODUCTS

2.01 GENERAL

A. The specifications are intended to give a general description of what is required, but do not cover all details which may vary in accordance with the exact requirements of the equipment as offered. They are, however, intended to cover the furnishings, delivery, installation and field testing of all materials, equipment and apparatus as required. Any additional auxiliary equipment necessary for the proper operation of the proposed installation not mentioned in these specifications, or shown on the Drawings shall be furnished and installed.

B. The material covered by these specifications is intended to be standard equipment of proven ability and as manufactured by reputable concerns having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with best practice and methods and shall operate satisfactorily when installed as shown on the Drawings.

2.02 MATERIALS AND EQUIPMENT

A. Ground rods: Ground rods shall be copper clad steel 3/4 inch x 20 foot, minimum depth. Ground rods shall be copperweld or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The 480 volt switchgear ground bus shall be grounded to a ground loop system. The protecting conduits shall be bonded to the grounding conductor at both ends.

B. All steel building columns shall be bonded together and connected to the building ground grid.

C. Motors shall be grounded as hereinafter specified.

D. Lighting transformer neutrals shall be grounded to the nearest grounding electrode.

E. Grounding electrodes shall be driven as required. Where rock is encountered, grounding plates may be used in lieu of grounding rods.

F. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel and similar items shall be grounded.

G. Exposed connections shall be made by means of approved grounding clamps. Exposed connections between different metals shall be sealed with No-Oxide Paint Grade A or equal. All buried connections shall be made by welding process such as Cadweld or equal.

H. For reasons of mechanical strength, grounding conductors shall be No. 10 AWG minimum copper, minimum size.

I. All underground conductors shall be laid slack and where exposed to mechanical injury, shall be protected by pipes or other substantial guards. If guards are iron pipe or other magnetic material, conductors shall be electrically connected to both ends of the guard.

J. The Contractor shall exercise care to insure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.

3.02 INSPECTION AND TESTING

A. The Contractor shall obtain the services of an NETA recognized testing firm to measure the ground resistance of the system. All test equipment shall be provided by the Contractor and approved by the Engineer. Dry season resistance of the system shall not exceed 5 ohms. If such resistance cannot be obtained with the system as shown, the Contractor shall provide additional grounding as directed by the Engineer, without additional payment.

END OF SECTION

SECTION 16601

LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment and incidentals required and install a complete lightning protection system for the all above ground structures. The system shall include grounding all handrail and platform structures.

2. Material requirements shall be as listed for Class I buildings.

B. Applicable Publications: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. American National Standards Inst., Inc. (ANSI)
C-135.30 Galvanized Ferrous Ground Rods.

2. National Fire Protection Association (NFPA)
70-1987 National Electrical Code (NEC)
78-1986 Lightning Protection Code

3. Underwriters Laboratories, Inc. (UL)
UL-96 Lightning Protection Components
UL-96A Installation Requirements for Lightning Protection Systems
UL-467 Grounding and Bonding Equipment

1.02 QUALITY ASSURANCE

A. Equipment Manufacturer: The material furnished under this specification shall consist of the standard products of a manufacturer regularly engaged in the production of lightning protection systems.

B. Supervision: The system shall be installed under supervision of, or by, a person specifically trained for installation of lightning protection systems.

1.03 SUBMITTALS

A. Shop Drawings: Shop drawings shall be submitted in accordance with Section 01340 and shall consist of a complete list of materials, including manufacturer's descriptive and technical literature; catalog cuts; drawings; and installation instructions. Shop drawings shall contain details to demonstrate that the system has been coordinated and will function as a unit. Drawings shall show proposed layout and mounting and relationship to other parts of the work.

B. Proof of Compliance: Where materials or equipment are specified to comply with requirements of the UL, proof of such compliance shall be submitted. The label of or listing in the UL Electrical Construction Materials Directory will be acceptable evidence. In lieu of the label or listing, a written certification may be submitted from an approved nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of Underwriters' Laboratories.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General Requirements:

1. The system furnished shall be complete with all air terminals, fittings, clamps, supports, roof conductors, down conductors, and horizontal grounds required. The system shall be interconnected with the building ground grid. All conductors, fittings, clamps, and air terminals furnished shall be of the highest quality.

2. System shall be an exposed conductor system. Care shall be taken that the materials used will not discolor roofs or walls. Down conductors shall be protected to 10 feet above grade and shall be located so that visual impact will be minimal.

3. No combination of materials shall be used that form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, conductors with protective coatings or oversize conductors shall be used. Where a mechanical hazard is involved, the conductor size shall be increased to compensate for the hazard or the conductors shall be protected by covering them with molding or tubing made of wood or non-magnetic material.

B. Copper: Copper conductors shall not be less than #6 AWG for main conductor and #8 for secondary conductor. Below grade conductors shall be #4/0 bare copper.

C. Air Terminals: Air terminals shall be OSHA impalement protected 3/8 inch diameter stainless steel and a minimum 24 inches in length. Air terminals over 24 inches shall be supported.

D. Ground Rods: Ground rods shall be 3/4 inch by 10 feet copper-clad steel, with the top of the rod, 12 inches below grade minimum and a minimum of 2 feet from building foundation and footings.

E. Clamp-Type Connectors: Clamp-type connectors shall be of copper, bronze, or stainless steel. Clamps shall be secured with at least two (2) bolts or cap screws.

F. Metal Bodies: Metal bodies of conductance shall be bonded to the system if not within the zone of protection on an air terminal. Metal bodies of inductance shall be bonded to the system at their closest point to the system if within 6 feet of the system at their closest point to the system if within 6 feet of the system main conductor or other bonded metal body. The main lightning conductor shall be bonded to the main potable service water pipe.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Requirements: The lightning protection system shall consist of air terminals, roof conductors, down conductors, ground connections, and grounds, electrically interconnected to form the shortest distance to ground without passing through any non-conducting parts of the structure. All conductors on the structures shall be exposed except where conductors are in protective sleeves exposed on the outside walls. Exposed conductors shall not be allow on the outside face of the Operation/Laboratory building. Secondary conductors shall interconnect with grounded metallic parts within the building. Interconnections made within side-flash distances shall be at or above the level of the grounded metallic parts.

B. Air Terminals: Air terminal design and support shall be in accordance with NFPA 78. Terminals shall be rigidly connected to, and made electrically continuous with, roof conductors by means of pressure connectors or crimped joints with of T-shaped malleable metal and connected to the air terminal by a dowel or threaded fitting. Air terminals at the ends of the structure shall be set not more than 2 feet from the ends of the ridge or edges and corners of roofs. Spacing of air terminals 2 feet in height on ridges, parapets and around the perimeter of buildings with flat roofs shall not exceed 25 feet. In specific instances where it is necessary to exceed this spacing, the specified height of air terminals shall be increased not less than 2 inches for each foot of increase over 25 feet. On large, flat or gently sloping roofs, as defined in NFPA 78, air terminals shall be placed at points of the intersection of imaginary lines dividing the surface into rectangles having sides not exceeding 50 feet in length. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure. Metal projections and metal parts of buildings, smokestacks, and other

metal objects that do not contain hazardous materials and that may be struck but not appreciably damaged by lightning, need not be provided with air terminals. However, these metal objects shall be bonded to the lightning conductor through a metal conductor of the same unit weight per length as the main conductor. Where metal ventilators are installed, air terminals shall be mounted thereon, where practicable. Any air terminal erected by necessity adjacent to a metal ventilator shall be bonded to the ventilator near the top and bottom thereof. Where nonmetallic spires, steeples, or ventilators are present, air terminals shall be mounted thereon or to the side. In addition, where spires or steeples project more than 10 feet above the building, the conductor between the air terminal and metal roof shall be continued to the nearest down conductor and securely connected thereto.

C. Roof Conductors: Roof conductors shall be connected directly to the roof or ridge roll. Sharp bends or turns in conductors shall be avoided. Necessary turns shall have a radius of not less than 8 inches. Conductors shall preserve a downward or horizontal course and shall be rigidly fastened every 4 feet along the roof and down the building to ground. Metal ventilators shall be rigidly connected to the roof conductor at three places. All connections shall be electrically continuous. Roof conductors shall be coursed along the contours of flat roofs, ridges, parapets, and edges; and where necessary, over flat surfaces, in such a way as to join each air terminal to all the rest. Roof conductors surrounding tank tops, decks, flat surfaces, and flat roofs shall be connected to form a closed loop.

D. Down Conductors: Down conductors shall be electrically continuous from air terminals and roof conductors to grounding electrodes. Down conductors shall be coursed over extreme outer portions of the building, such as corners, with consideration given to the location of ground connections and air terminals. Each building or structure shall have not less than two (2) down conductors located as widely separated as practicable, at diagonally opposite corners. On irregularly shaped structures, the total number of down conductors shall be sufficient to make the average distance between them along the perimeter not greater than 100 feet. Additional down conductors shall be installed when necessary to avoid "dead ends" or branch conductors exceeding 16 feet in length, ending at air terminals. Down conductors shall be equally and symmetrically spaced about the perimeter of the structure. Down conductors shall be protected where necessary, to prevent mechanical injury to the conductor.

E. Interconnection of Metallic Parts: Metal doors, windows, and gutters shall be connected directly to the grounds or down conductors using not smaller than No. 6 copper conductor, or equivalent. Conductors placed where there is probability of unusual wear, mechanical injury, or corrosion shall be of greater electrical capacity than would normally be used, or shall be protected. The ground connection to metal doors and windows shall be by means of mechanical ties under pressure, or equivalent.

F. Ground Connections: Ground connections Comprising continuations of down conductors form the structure to the grounding electrode shall securely connect the down conductor and ground in a manner to ensure electrical continuity between the two. All connections shall be of the clamp type. There shall be a ground connection for

each down conductor. Metal water pipes and other large underground metallic objects shall be bonded together with all grounding mediums. Ground connections shall be protected from mechanical injury. In making ground connections, advantage shall be taken of all permanently moist places where practicable, although such places shall be avoided if the area is wet with waste water that contains chemical substances, especially those corrosive to metal.

G. Grounding Electrodes: A grounding electrode shall be provided for each down conductor located as shown. A driven ground shall extend into the earth for a distance of not less than 10 feet. Ground rods shall be set not less than 2 feet, nor more than 10 feet, from the structure. The complete installation shall have a total resistance to ground of not more than 10 ohms (if a counterpoise is not used). When two of any three ground rods, driven not less than 10 feet into the perimeter, give a combined value exceeding 50 ohms immediately after driving, a counterpoise shall be used. A counterpoise, where required, shall be of No. 1/0 copper cable or equivalent material having suitable resistance to corrosion and shall be laid around the perimeter of the structure in a trench not less than 2 feet deep at a distance not less than 2 feet nor more than 10 feet from the nearest point of the structure. All connections between ground connectors and grounds or counterpoise, and between counterpoise and grounds shall be electrically continuous. Where so indicated on the drawings, an alternate method for grounding electrodes in shallow soil shall be provided by digging trenches radially from the building. The lower ends of the down conductors (or their equivalent in the form of metal strips or wires) are then buried in the trenches.

H. Interconnection of Metal Bodies: Metal bodies of conductance shall be protected if not within the zone of protection of an air terminal. All metal bodies of conductance having an area of 400 square inches or greater or a volume of 1000 cubic inches or greater shall be bonded to the lightning protection system using main size conductors and a bonding plate having a surface contact area of not less than 3 square inches. Provisions shall be made to guard against the corrosive effect of bonding dissimilar metals. Metal bodies of inductance shall be bonded at their closest point to the lighting protection system using secondary bonding conductors and fittings. A metal body that exceeds 5 feet in any dimension, that is situated wholly within a building, and that does not at any point come within 6 feet of a lightning conductor or metal connected thereto shall be independently grounded.

3.02 TESTING

A. System shall be installed so that tests of the grounds may be performed upon completion of the installation of the system and in the future.

B. As soon as practicable after award of contract, the Contractor shall submit for approval complete details of the system including a layout drawing so that the system furnished can be coordinated in the refurbishing of the building.

END OF SECTION

SECTION 16611

UNINTERRUPTIBLE POWER SUPPLY SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Furnish all labor, materials equipment and mechanical characteristics and requirements for a continuous-duty, three-phase, solid-state, on-line uninterruptible power supply (UPS) system. The UPS shall include all equipment to properly interface the AC power to the sensitive electronic loads.

1.02 SUBMITTALS

A. Electrical and mechanical drawings shall be provided by the manufacturer which shows unit dimensions, weight, component location, connection details, installation considerations and wiring diagram. The manufacturer shall furnish and installation manual with installation, startup and operating instruction for the UPS system as furnished. The manufacturer must base their submittal on the requirements of this specification and must state any deviations from the specification in their proposal. A single-line system diagram must be submitted, illustrating the system configuration and the equipment proposed. Any submittal which cannot meet these requirements are subject to rejection or any other technologies other than what is specified are subject to rejection.

1.03 APPLICABLE STANDARDS AND CODES

A. The UPS shall be designed and manufactured in accordance with the applicable sections of the current revision of the following documents. Where a conflict arises between these documents and statements made herein, the statements in this specification shall govern.

1. UL Standard 1778
2. NEMA PE-1.
3. ANSI C62.41-1980
4. ASME.
5. National Electric Code (NFPA-70).
6. OSHA.
7. FCC Part 15, Sub Part J, Class A.
8. Local Codes.

B. The UPS system shall be UL listed per UL1778.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide pre-approval product by the following:

1. EATON, 30 KVA.
2. APC, 30KVA

2.02 MODE OF OPERATION

A. The UPS shall be designed to operate as an on-line reverse transfer system in the following modes:

1. Normal: The critical AC load is continuously supplied by the UPS inverter. The rectifier/charger derives power from a utility AC source and supplies DC power to the inverter while simultaneously float-charging a power reserve battery.

2. Emergency: Upon failure of utility AC power, the critical AC load is supplied by the inverter, which without any switching, obtains power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.

3. Recharge: Upon restoration of utility AC power, after a utility AC power outage, the rectifier/charger shall automatically restart, walk-in, and gradually assume the inverter and battery recharge loads.

4. Bypass: If the UPS must be taken out of service for maintenance or repair, or should the inverter overload capacity be exceeded, the static transfer switch shall perform a reverse transfer of the load from the inverter to the bypass source with no interruption in power to the critical AC load.

5. Alternate A/C Source. The UPS shall be equipped with a timed walk-in circuit and a 10% input current THD filter to properly interface with the backup diesel generator A/C source and to reduce the effects harmonics have on the A/C power source. Other technologies like ferroresonant UPS, line-interacting using bi-directional converters, or off-line UPS will not be accepted.

2.03 ELECTRICAL RATING

A. Voltage: Input/Output voltage specifications of the UPS shall be:

1. Input: 480 volts, three-phase, 3-wire-plu--ground.

2. Output:120/208 volts, three-phase, 4-wire-plus-ground.

B. Output Load Capacity: Specified output load capacity of the UPS shall be as indicated on the drawings, at 0.8 lagging power factor.

C. External Battery Plant: Battery plant specifications shall be:

1. Sealed, lead-acid, value regulated.

2. Reserve Time: 5 minutes at full load, 0.8 power factor, with ambient temperature between 20 and 30 degree C.

3. Recharge Time: Ten (10) times discharge time to 95% capacity.

4. Battery shall be in a cabinet that matches the UPS cabinet style. A disconnect means shall be included for isolation of the battery pack from the UPS module.

2.04 ENVIRONMENTAL RATINGS

A. Ambient Temperature Range:

1. Operating: UPS: 0°C to +40°C; Battery: 25°C 5°C.

2. Storage: -20°C to +70°C.

B. Relative Humidity: 0 to 95% non-condensing.

C. Altitude:

1. Operating: 0 to 6,600 ft. Derated for higher altitudes.

2. Storage/Transport: 0 to 40,000 ft.

D. Audible Noise:

1. Noise generated by the UPS under any condition of normal operation shall not exceed a sound pressure level of 65 dBA measured 2 meters from the surface of the UPS.

2.05 PERFORMANCE REQUIREMENTS:

The UPS shall meet or exceed the following electrical specifications:

A. AC INPUT TO UPS, UPS Rectifier/Charger.

1. Voltage Configuration: Three-phase, 3-wire-plus-ground.

2. Voltage Range: + 10%, -15% of nominal.

3. Frequency: Nominal frequency 5%.

4. Power Factor: 0.90 lagging minimum at nominal input voltage and full rated UPS output load.

5. Inrush Current: 800% of full load current maximum for transformer magnetization surge.

6. Current Limit: 125% of nominal AC input current maximum.

7. Input Current Walk-In: 20 seconds to full rated input current maximum. Field selectable 5 or 20 seconds.

8. Surge Protection: Sustains input surges w/o damage per criteria listed in ANSI C62.41-1980.

9. Current Distortion: 10% THD maximum at full load.

B. AC Output, UPS Inverter:

1. Voltage Configuration: Three-phase, 4-wire-plus-ground

2. Voltage Regulation: 1% three-phase RMS average for a balanced three-phase load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature, and load power factor.

3. Two percent three-phase RMS average for a 50% unbalanced load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature, and load power factor.

4. Frequency: Nominal frequency 0.1%.

5. Frequency Slew Rate: 1.0 Hertz per second maximum.

6. Phase Displacement: 1o for balanced load. 3o for 50% unbalanced load.

7. Bypass Line Sync Range: 0.5, 1.0, 3.0 Hertz. Switch selectable.

8. Voltage Distortion. 5% total harmonic distortion (THD) for linear loads. 3% maximum for any single harmonic.

9. Load Power Factor Range: 1.0 to 0.65 lagging.

10. Output Power Rating: Rated kVA at 0.8 lagging power factor.

11. Overload Capability: 125% for 10 minutes (without bypass source). 150% for 30 seconds (without bypass source).

12. Inverter Output Voltage Adjustment: 5% manual adjustment.

13. Voltage Transient Response: 20% load step 4%; 30% load step 5%; 50% load step 8%; loss or return of AC input power 1%; manual transfer of 100% load 4%.

14. Transient Recovery Time: To within 1% of output voltage within 50 milliseconds.

15. Voltage Unbalance: Balanced load 1%; 20% unbalanced load 1%; 50% unbalanced load 2%; 100% unbalanced load 5%.

16. Fault Clearing: Sub-cycle current of at least 300%.

2.06 SYSTEM COMPONENTS

A. Input Isolation Transformer: An input isolation transformer shall be included. The transformer shall be an all copper winding Delta/Wye configuration located inside the UPS module cabinet. The transformer shall provide common mode noise attenuation for all system operating modes including while on bypass. The transformer shall be designed such that input voltage configuration of 208 volts shall be served by the same transformer through tap selection.

B. Rectifier/Charger: The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging. The rectifier/charger shall be a phase-controlled, solid-state SCR type with constant voltage/constant current control circuitry. The rectifier/charger shall be designed with the necessary filtering to reduce reflective input current distortion to 10%. A six-pulse solid-state rectifier/charger design is acceptable, but a 10% input current THD filter circuit is required. The input filter circuit is necessary to reduce the effects high input current distortion has on a Diesel Generator. The rectifier/charger shall contain a timed walk-in circuit that causes the unit to gradually assume the load over a 15-second time interval after input voltage is applied. The walk-in circuit is necessary to eliminate any unnecessary step-loading on the Diesel Generator. In addition to supplying power for the inverter load, the rectifier/charger shall be capable of recharging the battery from discharge to 95% charge within ten (10) times the discharge time of the battery.

C. Inverter: The inverter shall convert DC power from the rectifier/charger output or the battery, into regulated AC power for supporting the critical AC load. The inverter shall be a transistorized, phase-controlled, pulse width modulated (PWM) design capable of providing the specified AC output.

D. For rapid removal of the inverter from the critical load, the inverter control electronics shall instantaneously turn off the inverter transistors. Simultaneously, the static transfer switch shall be turned on to maintain continuous power to the critical load.

E. The inverter shall be protected by the following disconnect levels, which shall be independently adjustable for UPS application flexibility:

1. DC Overvoltage Disconnect.

2. DC Undervoltage Warning (Low Battery Reserve)

3. DC Undervoltage Disconnect (End of Discharge)

F. Output Power Transformer: A dry type power transformer shall be provided for the inverter AC output. It shall have copper wiring exclusively. The transformers hottest spot winding temperature shall not exceed the temperature limit of the transformer insulation class of material when operating at full load at maximum ambient temperature.

G. Static Transfer Switch: A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be a naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously. The switch shall have an overload rating of 200% rated load for five minutes and 2000% rated load for two cycles. The static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits specified herein, when an overload of malfunction occurs within the UPS, or for bypassing the UPS for maintenance.

H. Maintenance Bypass Switch: A manually operated maintenance bypass switch shall be incorporated into the UPS cabinet to directly connect the critical load to the input AC power source, bypassing the rectifier/charger, inverter, and static transfer switch. With the critical load powered from the maintenance bypass circuit, it shall be possible to check out the operation of the rectifier/charger, inverter, and static transfer switch. It shall also be possible to check battery operation. All energized terminals shall be shielded to ensure that maintenance personnel do not inadvertently come in contact with energized parts or terminals. A means to de-energize the static switch shall be provided when the UPS is in the maintenance bypass mode of operation

I. Battery Power Pack: The battery power pack shall include sealed, lead-acid valve-regulated, batteries housed in a separate cabinet, that match the UPS cabinet styling to form an integral system line-up. Battery cells shall be mounted on slide-out trays for ease of maintenance. Casters and leveling feet shall be provided with the battery power pack cabinet for ease of installation.

J. Monitoring and Control: The UPS shall be provided with a microprocessor based unit status display and controls section designed for convenient and reliable operator interfacing. A system power flow diagram shall be provided as part of the monitoring and controls section which depicts a single-line diagram of the UPS. Electrically-illuminated visual indicators shall be of the-life light-emitting diode (LED) type. All of the operator controls and monitors shall be located on the front of the UPS cabinet. The monitoring functions such as metering, status and alarms shall be displayed on an alpha-numeric digital display. The monitoring system shall also include a Menu-Driven Display, Real Time Clock, Alarm History with time and date stamp, Automatic Battery Test system and Battery Backup Memory.

1. Metering: The following parameters shall be displayed:

a. Input AC voltage line-to-line and line-to-neutral for each phase.
b. Input AC current for each phase.
c. Input Frequency
d. Battery voltage.
e. Battery charge/discharge current.
f. Output AC voltage line-to-line and line-to neutral for each phase.
g. Output AC current for each phase.
h. Output Frequency
i. Percent of rated load being supplied by the UPS.
j. Battery time left during battery operation.

2. Alarms: The following alarms shall be displayed:

a. Input power out of tolerance.
b. Input phase rotation incorrect.
c. Input frequency out of range.
d. Rectifier/charger fault.
e. Low battery warning (adjustable 1 to 99 minutes).
f. Low battery shutdown.
g. Bypass frequency out of range.
h. Bypass voltage out of range.
i. Overload transfer to bypass.
j. Static switch failure.
k. UPS output not synchronized to bypass
l. Output overvoltage.
m. Output undervoltage.
n. Output overload.
o. Overload shutdown imminent.

3. Overload shutdown.

a. Power supply problem.
b. Control fault.
c. Fan failure.
d. Over temperature shutdown impending.
e. Over temperature shutdown.
f. An audible alarm shall be provided and activated by any of the above alarm conditions.

4. The following additional alarms shall be displayed but shall not activate the audible alarm.

a. Normal operation.
b. Load on maintenance bypass.
c. Load on UPS.
d. Load on static bypass
e. System shutdown.

f. UPS on battery.

5. Controls: UPS start-up, shutdown, and maintenance bypass operations shall be accomplished by a single rotary control switch. An advisory display and menu-driven user prompts shall be provided to guide the operator through system operation without the use of additional manuals. Pushbuttons shall be provided to display the status of the UPS. Pushbuttons shall also be provided to test and reset visual and audible alarms.

6. Power Status Diagram: A mimic panel shall be provided to depict a single line diagram of the UPS. Indicating lights shall be integrated within the single line diagram to illustrate the status of the UPS power paths. Two LED's located on the diagram shall indicate whether UPS input and/or output power is present. The diagram shall be color coded with the positions of the rotary control switch for visual confirmation of the UPS operating mode.

7. Automatic Battery Test System: The Automatic Battery Test (ABT) system shall be provided to test the battery system under load and record the status or detect and report a problem. The ABT shall be designed so that the operator can determine test intervals. During the test, if a battery system failure is detected, the ABT system shall display a battery alarm. The battery alarm shall remained activated until an authorized field service engineer checks out the battery system and manually resets the alarm.

2.07 GENERAL REQUIREMENTS

A. Cabinet: The UPS unit, comprised of rectifier/charger, inverter, static transfer switch, and maintenance bypass switch shall be housed in a single free-standing NEMA Type 1 enclosure. Cabinet doors/covers shall require a tool for gaining access. Casters and leveling feet shall be provided. Front access only shall be required for expedient servicing, adjustments, and installation. The UPS cabinet shall be structurally adequate and have provisions for hoisting, jacking, and forklift handling.

B. Material: All materials and components making up the UPS shall be new, of current manufacture, and shall not have been in prior service except as required during factory test. All active electronic devices shall be solid-state. All relays shall be provided with dust covers.

C. Cooling: Cooling of the UPS shall be by forced-air. Redundant fans shall be used. Low velocity fans shall be used to minimize audible noise output. Fan power shall be provided by the UPS output.

D. Thermal Design: The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices for the forced-air cooled power circuit components so that internal or external fault conditions will be cleared by the protective devices before excessive component or internal cabinet temperatures are exceeded.

E. Cable Entry: Provision shall be made for power cables to enter or lead from the top or bottom, of the UPS cabinet.

F. Serviceability: The UPS shall be constructed of replaceable subassemblies. Printed circuit assemblies shall be plug-in. Like subassemblies and like components shall be interchangeable.

G. Finish: The UPS cabinet shall be cleaned, primed, and painted with the manufacturer's standard color.

H. Semiconductor Fusing: All rectifier and inverter power semiconductor switching circuits shall be fused to prevent cascading or sequential semiconductor failures.

I. Wiring: Wiring practices, materials, and coding shall be in accordance with the requirements of the National Electric Code NFPA 70 and other applicable codes and standards.

J. Conductors: All power cabling shall be tin-plated copper, and all copper and aluminum bus bars and heat sinks shall be plated for corrosion resistance and connection integrity.

K. EMI Suppression: Electromagnetic interference (EMI) shall be minimized to ensure that computer systems, or other sensitive electronic systems, shall neither adversely affect nor be adversely affected by the UPS.

L. Input Protection: The UPS shall have built-in protection against undervoltage, overcurrent, and overvoltage conditions including low-energy lightning surges, introduced on the primary AC source. UPS operations and the critical AC load bus shall not be affected by impressed transient voltage and current levels when tested per the guidelines of ANSI C62.41 (IEEE 587).

PART 3 - EXECUTION

3.01 FACTORY TESTING

Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification. These tests shall include operational discharge and recharge tests on at least a one-minute battery plant to assure guaranteed rated performance.

3.02 FIELD ENGINEERING SUPPORT

The UPS manufacturer shall directly employ a field service organization staffed by factory trained field service engineers dedicated to the startup, maintenance and repair of UPS equipment. The organization shall consist of a regional office in the State of Florida and a local office in the Central Florida region. The Central Florida regional office shall have a minimum of (2) full time service engineers and shall be located within 75 miles of the installation. Third party independently owned field service organization will not be accepted. In addition, the

organization shall also provide startup, maintenance and repair of the battery system. Address and phone number of the local service office must be included with the proposal.

3.03 UPS SYSTEM STARTUP

An on-site factory startup by manufacturer's field service organization shall be provided with proposal. On-site factory startup shall include a non-powered inspection and electrical checkout and calibration of both the UPS module and the battery pack. It shall also include the necessary equipment and parts as well as labor and travel expenses.

3.04 MAINTENANCE CONTRACT

A full service maintenance contract shall be included. The full service agreement shall maintain user's equipment to the latest engineering levels as they are developed and must be maintained by a local directly employed field service engineers. The full service agreement shall include two preventive maintenance visits per year for the UPS module and four preventive visits per year for the battery system, scheduled Monday-Friday 7:00 AM to 6:00 PM. The full service maintenance contract shall include 24 hour a day, 7 day a week coverage period for service calls and all parts (excluding batteries), labor and travel. A manufacturers field service engineer must be on call 24 hours a day, 7 days a week, 365 days a year to perform any necessary maintenance or repairs, whether they are covered under this agreement or not.

3.05 UPS WARRANTY

The UPS warranty shall be in effect no less than one (1) year after Owner acceptance The UPS warranty shall include all parts, labor and travel related expenses.

3.06 BATTERY WARRANTY

The battery manufacturer's standard warranty shall be passed through to the end user.

3.07 INSTALLATION AND OPERATION DATA

The specified UPS system shall be supplied with two (2) copies of installation and operation manuals.

3.08 QUALIFYING EXPERIENCE

A minimum of five (5) year's experience in the design, manufacture, and testing of solid-state UPS systems is required.

END OF SECTION

Palm Bay Utilities

APPENDIX A

Subsurface Soil Exploration and
Geotechnical Engineering Evaluation
Proposed SRWTP Expansion
Palm Bay, Brevard County, Florida

Ardaman & Associates, Inc.

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Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

October 1, 2019
File No. 19-6372

Tetra Tech, Inc.
201 E. Pine Street, Suite 1000
Orlando, Florida 32801

Attention: Mr. Jon Bundy, P.E.

Subject: Subsurface Soil Exploration and
Geotechnical Engineering Evaluation
Proposed SRWTP Expansion
Palm Bay, Brevard County, Florida

Dear Mr. Bundy:

As requested and authorized, we have completed a shallow subsurface soil exploration for the subject project. The purposes of performing this exploration were to evaluate the general subsurface conditions within the proposed structure and pipeline areas and to provide recommendations for site preparation and foundation support. In addition, we have estimated the normal seasonal high groundwater level at the boring locations. This report documents our findings and presents our engineering recommendations.

SITE LOCATION AND SITE DESCRIPTION

The site for the proposed expansion is located at the Palm Bay South Regional Water Treatment Plant (SRWTP) at 250 Osmosis Drive Southeast in Palm Bay, Brevard County, Florida (Section 30, Township 29 South, Range 37 East). The general site location is shown superimposed on the Fellsmere NW, Florida U.S.G.S. quadrangle map presented on Figure 1.

The site is currently developed with the existing SRWTP facilities. The locations of the proposed structures and pipeline are generally open grassy areas adjacent to the existing facilities. The proposed production well is located in a wooded area on the east side of the site.

PROPOSED CONSTRUCTION AND GRADING

It is our understanding that the proposed development includes the following:

- 2 MG Potable Water Ground Storage Tank
- Carbon Dioxide Storage System
- Raw Water Production Well
- Approximately 1,600 linear feet of 12” to 20” Pipeline

We were provided with approximate structure dimensions by Tetra Tech. For the purposes of our analysis we have assumed the maximum loading conditions for the various structures to be as shown below.

Structure	Approx. Dimensions	Assumed Ground Loads (psf)
2 MG Water Tank	Diameter - 100' Sidewater - 35'	2,500
Carbon Dioxide Storage Tank Founded on Slab-on-grade	14' x 70'	350
Production Well Pad	10' x 25'	300

Grading plans are not complete at this time, therefore, we have assumed that approximately 0 to 3 feet of fill is required to raise the structure areas to final elevation(s). If actual structure loads or fill height exceed our assumptions, then the recommendations in this report may not be valid.

REVIEW OF SOIL SURVEY MAPS

Based on the 1974 Soil Survey for Brevard County, Florida, as prepared by the U.S. Department of Agriculture Soil Conservation Service, the proposed ground storage tank is located in an area mapped as the "Wabasso sand" soil series and the proposed Carbon Dioxide Storage System, production well and pipeline are located in an area mapped as the "EauGallie sand" soil series.

The "Wabasso sand" soil series consists of nearly level sandy soil on broad areas in the flatwoods and on low ridges on the flood plains. The internal drainage of the "Wabasso sand" is poor and the soil permeability is rapid to a depth of about 28 inches and moderate between 28 and 62 inches. According to the Soil Survey, the seasonal high water table for the "Wabasso sand" soil series is typically within 10 inches of the natural ground surface.

The "EauGallie sand" soil series consists of nearly level sandy soils on broad, low ridges in the flatwoods. The internal drainage of the "EauGallie sand" is poor and the soil permeability is rapid to a depth of about 22 inches, moderate to moderately rapid from 22 to 35 inches, rapid from 35 to 55 inches, moderate to moderately rapid from 55 to 61 inches and rapid below 61 inches. According to the Soil Survey, the seasonal high water table for the "EauGallie sand" soil series is typically within 10 inches of the natural ground surface.

FIELD EXPLORATION PROGRAM

SPT and Auger Borings

The field exploration program included performing 8 Standard Penetration Test (SPT) borings and 6 auger borings. The SPT borings were advanced to depths ranging from 25 to 100 feet below the ground surface using the methodology outlined in ASTM D-1586. A summary of this field procedure is included in Appendix I. Split-spoon soil samples recovered during performance of the borings were visually classified in the field and representative portions of the samples were transported to our laboratory in sealed sample jars.

The auger borings were drilled using a truck-mounted, 4-inch diameter, continuous flight auger to a depth of 10 feet below the ground surface. A summary of this field procedure is included in Appendix I. Representative soil samples were recovered from the auger borings and transported to our laboratory for further analysis.

The groundwater level at each of the boring locations was measured during drilling. Borings TH-1 through TH-5 were backfilled with cement grout upon completion and all other borings were backfilled with soil cuttings.

Relatively Undisturbed Tube Sampling

In order to perform laboratory consolidation testing of clayey soil, two relatively undisturbed tube samples were obtained by drilling a wash boring adjacent to Boring TH-1 and sampling from depths of 28 to 30 feet and 30 to 32 feet below the ground surface. The samples were retrieved using a 3-inch diameter, thin-walled Shelby tube. The samples were sealed in the Shelby tubes and transferred to our laboratory for classification and testing.

Test Locations

The approximate locations of the borings are schematically illustrated on a site plan shown on Figure 2. These locations were determined in the field by Global Positioning System (GPS) utilizing hand-held GPS equipment and coordinates obtained from Google Earth 7.3. Boring locations should be considered accurate only to the degree implied by the method of locating used.

LABORATORY PROGRAM

Visual Examination and Classification Testing

Representative soil samples obtained during our field sampling operation were packaged and transferred to our laboratory for further visual examination and classification. The soil samples for the ground storage tank, carbon dioxide system and well pad structures were visually classified in general accordance with the Unified Soil Classification System (ASTM D-2488). The soil samples for the pipelines borings were visually classified in general accordance with AASHTO

soil classification system (ASTM D-3282). The resulting soil descriptions are shown on the soil boring profiles presented on Figures 3 through 6.

In addition, we conducted 2 natural moisture content tests (ASTM D2216), 1 grain size analysis (ASTM D6913), 5 percent fines analyses (ASTM D1140), and 2 Atterberg limits tests (ASTM D4318) on selected soil samples obtained from the borings. The results of these tests are presented adjacent to the sample depth on the boring profiles on Figures 3 through 6.

Consolidation Testing

Two consolidation tests were performed on subsamples of clayey soil selected from the Shelby tube samples obtained from Boring TH-1. The testing was designed to provide information on the compressibility of the soil. The resulting void ratio versus log pressure curve of the tests are included in Appendix II.

GENERAL SUBSURFACE CONDITIONS

General Soil Profile

The results of the field exploration and laboratory programs are graphically summarized on the soil boring profiles presented on Figures 3 through 6. The stratification of the boring profiles represents our interpretation of the field boring logs and the results of laboratory examinations of the recovered samples. The stratification lines represent the approximate boundary between soil types. The actual transitions may be more gradual than implied.

The results of the borings indicate the following general soil profile:

12" to 20" Pipeline (Borings AB-1 through AB-6)

Depth Below Ground Surface (feet)		Description
From	To	
0	6	Fine sand (SP) to fine sand with silt (A-3), fine sand with clay (SP-SC) to clayey fine to clayey fine sand (A-2-4), A-2-6)
6	10	Clayey fine sand (A-2-6)

Ground Storage Tank, Carbon Dioxide System and Well Pad (Borings TH-1 through TH-8)

Depth Below Ground Surface (feet)		Description
From	To	
0	32½	Very loose to very dense fine sand (SP), fine sand with silt (SP-SM), fine sand with clay (SP-SC), silty clayey fine sand (SM/SC), clayey fine sand (SC) and very soft to medium stiff sandy clay (CH)
32½	100	Very loose to dense fine sand (SP), fine sand with silt (SP-SM), silty clayey fine sand (SM/SC) and clayey fine sand (SC)

The above soil profiles are outlined in general terms only. Please refer to Figures 3 through 6 for soil profile details.

We note that the thickness of asphaltic concrete and base shown on Boring AB-1 should be considered a rough approximation only. Coring of the pavement section would be required to provide an accurate thickness measurement.

Groundwater Level

The groundwater level was measured in the boreholes during drilling. As shown on Figures 3 through 6, groundwater was encountered at depths that ranged from 1 to 5 feet below the existing ground surface on the dates indicated. Fluctuation in groundwater levels should be anticipated throughout the year primarily due to seasonal variations in rainfall and other factors that may vary from the time the borings were conducted.

NORMAL SEASONAL HIGH GROUNDWATER LEVEL

The normal seasonal high groundwater level each year is the level in the August-September period at the end of the rainy season during a year of normal (average) rainfall. The water table elevations associated with a higher than normal rainfall and in the extreme case, flood, would be higher to much higher than the normal seasonal high groundwater level. The normal high water levels would more approximate the normal seasonal high groundwater levels.

The seasonal high groundwater level is affected by a number of factors. The drainage characteristics of the soils, the land surface elevation, relief points such as drainage ditches, lakes, rivers, swamp areas, etc., and distance to relief points are some of the more important factors influencing the seasonal high groundwater level.

Based on our interpretation of the site conditions using our boring logs, we estimate the normal seasonal high groundwater level at the boring locations to be approximately 1 foot above the groundwater levels measured at the time of our field exploration. Groundwater may perch

temporarily at higher levels on top of the clayey soil during periods of heavy and/or prolonged rainfall.

ENGINEERING EVALUATION AND RECOMMENDATIONS – PIPLELINE

General

The results of our exploration indicate that, with proper site preparation as recommended in this report, the existing soils are suitable for supporting the proposed 1,600 linear foot pipeline. We caution that clayey soils may be encountered near the foundation elevation for the pipeline. The clayey soil will be very difficult to moisture condition and compact. If moisture conditions preclude compaction of the clayey soil, to facilitate construction it may be most feasible to over-excavate approximately 1 to 2 feet below the proposed foundation bottom and backfill the excavation with compacted gravel.

The following are our recommendations for overall site preparation and foundation support which we feel are best suited for the proposed pipeline relative to the soil conditions encountered in the borings. The recommendations are made as a guide for the design engineer, parts of which should be incorporated into the project's specifications.

Pipeline Excavation

Based on the conditions encountered during the field exploration, we anticipate that the sandy soil as encountered in the borings can be excavated with standard earth moving equipment (i.e., front-end loaders and backhoes).

The soils below the bottom of the excavations should not be disturbed by the excavation process. If soils become disturbed and difficult to compact, they should be overexcavated to a depth necessary to remove all disturbed soils. Over-excavated areas should be replaced with compacted backfill meeting the "Backfill Requirements" presented in a following report section.

Excavation should be safely braced to prevent injury to personnel or damage to equipment. Temporary safe slopes should be cut at a minimum 1.5 Horizontal (H) to 1 Vertical (V) in accordance with OSHA, 29 CFR Part 1926 Final Rule, Excavation Requirements or successor regulations. Flatter slopes should be used if deemed necessary. Surcharge loads should be kept at least 5 feet from excavations. Spoil banks adjacent to excavations should be sloped no steeper than 2.0H to 1.0V. Provisions for maintaining workers' safety within excavations is the sole responsibility of the Contractor.

Dewatering

The control of the groundwater may be required to achieve the necessary depths of excavation and subsequent construction and backfilling and compaction requirements presented in the following sections. The actual method(s) of dewatering should be determined by the Contractor, however, regardless of the method(s) used, we suggest drawing down the water table sufficiently,

say 2 to 3 feet, below the bottom of the excavation(s) to preclude “pumping” and/or compaction-related problems with the foundation soils.

Pipeline Bedding

Pipe bedding material should be compacted as necessary to achieve a density equivalent to 95 percent of the maximum dry density, as determined by the Modified Proctor (ASTM D-1557), to a minimum depth of 6 inches below the bottom of the pipe (compact deeper if recommended by the pipe manufacturer).

It is our recommendation that the bedding for the pipe be pre-shaped by means of a template, prior to placement of the structure, to ensure that the upward reaction on the bottom of the pipe will be well distributed over the width of the bedding contact. Based on the cost involved with pre-shaping the bedding material, and the construction time requirements, an alternative procedure may be to utilize a level bed for the pipe and require a higher pipe strength class which will adequately carry the load on a lower class of bedding. It would be prudent to perform an economic analysis of the two alternatives, or specify both design conditions within the contract documents, and allow the Contractor to decide the most efficient method.

If level bedding is utilized, it will be necessary to place and compact the haunching backfill (backfill between the bedding and the centerline of the pipe) to the centerline of the pipe. This material should be placed in simultaneous layers on each side of the pipe and must be compacted in such a manner as to ensure an intimate contact with the sides of the pipe. Do not use blocking to raise the pipe to grade. Provide bell holes at each joint to permit the joint to be assembled while maintaining uniform pipe support.

The final backfill above the haunching or centerline of the pipe must extend all the way to the trench walls and should be placed in level lifts not exceeding 8 inches. Each lift should be compacted to at least 95 percent of the maximum dry density, as determined by the Modified Proctor (ASTM D-1557). Care should be taken not to damage the pipe by compacting directly above the pipe where there is insufficient cover material present. Minimum cover criteria should be in accordance with the pipe manufacturer’s recommendations.

A soils engineer or a designated representative from Ardaman & Associates, Inc. should observe and test all prepared and compacted areas to verify that all bedding, haunching and final backfill are prepared and compacted in accordance with the aforementioned specifications.

Backfill Requirements

As a general guide to aid the Contractor, we recommend using fill with less than 12 percent by dry weight of material passing the U.S. Standard No. 200 sieve size. Soils with more than 12 percent passing the No. 200 sieve will be more difficult to compact due to their inherent nature to retain soil moisture. Based on the soil samples obtained during our subsurface investigation, the fine sand and fine sand with silt (A-3) (Stratum 1 on Figure 6) without roots and/or organics appears suitable for use as structural backfill for the pipe.

Stratum 2 as shown on Figure 6 (A-2-4) may also be used as backfill, however these soils will be more difficult to moisture condition and compact than soils discussed in the above paragraph. These soils will be difficult to compact because of their relatively high fines content. They may be used as backfill if it is possible to achieve the required degree of compaction. However, extensive moisture conditioning would likely be required.

Stratum 3 soils as shown on Figure 6 (A-2-6) having more than 20 percent fines are generally considered unsuitable for use as structural fill because of the extreme difficulty in moisture conditioning and compacting these soils. Import soils may be required to replace silty or clayey soils if these existing soils cannot be moisture conditioned and compacted efficiently.

Resistance to Horizontal Forces on Pipeline Structures

Horizontal forces which act on structures such as thrust blocks or anchor blocks can be resisted to some extent by the earth pressures that develop in contact with the buried vertical face (buried vertical face is perpendicular and in front of the applied horizontal load) of the block structures and by shearing resistance mobilized along the base of the block structures and subgrade interface.

Allowable earth pressure resistance may be determined using an equivalent fluid density of 100 pounds per cubic foot (pcf) for moist soil and 60 pcf for submerged soils below the water table.

Equivalent fluid density (moist soil) = $K_p\gamma_m$/S.F. = 100 pcf

Equivalent fluid density (submerged soil) = K_p (γ_s-γ_w)/S.F. = 60 pcf

Where:

K_p = effective coefficient of passive earth pressure = 3.0
S.F. = safety factor (values given above)
γ_m = unit weight of moist soil = 110 pcf
γ_s = unit weight of saturated soil = 118 pcf
γ_w = unit weight of water = 62.4 pcf

The passive earth pressures are developed from ground surface (assuming there is no excavation in the vicinity of the block structure that would reduce the available passive pressure) to the bottom of the block structure.

The values presented above presume that the block structures are surrounded by well compacted sand backfill extending at least 5 feet horizontally beyond the vertical buried face. In addition, it is presumed that the block structures can withstand horizontal movements on the order of one-quarter (1/4) to three-eighths (3/8) inch before mobilizing full passive resistance. The factors of safety assumed in the above recommendations are 2.5 for passive pressure with submerged conditions, and 3.0 for passive pressure without submerged conditions.

The sliding shearing resistance mobilized along the base of the block structure may be determined by the following formula:

Allowable Shearing Resisting Force, $P=V \tan(2/3\varphi)/F.S.$

Where:

P = Shearing Resistance Force (pounds)
V = Net Vertical Force (total weight of block and soil overlying the structure minus uplift forces including buoyancy forces) (pounds)
φ = Angle of Internal Friction of Soil = 30 degrees
S.F. = Safety Factor = 1.5

The vertical earth pressures developed by the overburden weight of soil can be calculated using the following unit weights:

- Compacted moist soil = 115 pcf
- Saturated soil = 118 pcf

Vertical pressure distributions in accordance with the above do not take into account vertical forces from construction equipment, wheel loads or other surcharge loads.

Foundation Support and Estimated Settlements – Pipeline Elements

The permanent structures such as anchor blocks, thrust blocks, air release valves, blow offs, etc., bearing at least 18 inches below adjacent grade can be designed for the maximum vertical bearing capacities presented below.

- 1,500 psf on undisturbed natural granular soils.

- 2,000 psf on compacted natural or backfilled subgrade; this value assumes compaction of 95 percent of the standard Proctor maximum density (ASTM D-698, AASHTO T-99) for a depth of 2 feet below the structure.

Pipe settlement during and after construction should be negligible (less than ½-inch), provided the bedding and backfilling criteria in the above sections are satisfied. The volume of soil displaced by the pipe, compared to the weight of the pipe when full, will result in little if any net increase in bearing stress to the subsurface soils.

Uplift Resistance

Permanent structures submerged below the groundwater table will be subjected to uplift forces caused by buoyancy. The components resisting this buoyancy include: 1) the total weight of the pipe or structure divided by an appropriate factor of safety; 2) the buoyant weight of soil overlying

the pipe or structure; and 3) the shearing forces that act on shear planes that radiate vertically upward from the perimeter of the pipe or the edges of the structure to the ground surface. The allowable unit shearing resistance may be determined by the following formula:

Allowable Unit Shearing Resistance, $F=K_o\gamma_m h(2/3\ \tan\varphi)/S.F.$ (above groundwater table)

Allowable Unit Shearing Resistance, $F=K_o[\gamma_m h_w+\gamma_b(h-h_w)](2/3\tan\varphi)/S.F.$ (below groundwater table)

Where:

F = unit shearing resistance (psf)
K_o = coefficient of earth pressure at rest = 0.5
γ_m = unit weight of moist soil = 110 pcf
γ_b = buoyant unit weight of soil = 55.6 pcf
h = vertical depth (feet) below grade at which shearing resistance is determined
h_w = vertical depth (feet) below grade to groundwater table
φ = angle of internal friction of the soil = 30 degrees
S.F. = safety factor = 2

The values given for the above parameters assume that the permanent structures are covered by clean, well compacted granular backfill that extends horizontally at least 2 feet beyond the structures.

Earth Pressure on Shoring and Bracing

If temporary shoring and bracing is required for any excavations, the system should be designed to resist lateral earth pressure. The design earth pressure will be a function of the flexibility of the shoring and bracing system. For a flexible system restrained laterally by braces placed as the excavation proceeds, the design earth pressure for shoring and bracing can be computed using a uniform earth pressure distribution with depth. It is recommended that soils be de-watered around the excavations. For such de-watered excavations, we recommended using the following uniform pressure distribution over the full braced height as follows:

Uniform Soil Pressure Distribution, $p = 0.65K_a\gamma_s H$

Where:

p = uniform pressure distribution for design of braced excavation
K_a = coefficient of active earth pressure = 0.33
γ_s = unit weight of saturated soils = 118 pcf
H = depth of excavation

An appropriate factor of safety should be applied for the design of the braced excavations.

Lateral pressure distributions determined in accordance with the above do not take hydrostatic pressures or surcharge loads into account. To the extent that such pressures and forces may act on the walls, they should be included in the design.

Construction equipment and excavated fill should be kept a minimum distance of 5 feet from the edge of the braced or shored excavation. Backfill material placed adjacent to (maintaining a minimum 5-foot horizontal clearance) the braced or shored excavation should have a minimum slope of 2.0H:1.0V, or flatter if required by site specific conditions and/or to meet OSHA requirements.

Means and methods of excavation and bracing should be the responsibility of the Contractor; however, excavation and/or bracing should at a minimum adhere to the requirements of the Occupational Safety Health Administration (OSHA).

ENGINEERING EVALUATION AND RECOMMENDATIONS – TANK AND WELL PAD STRUCTURES

General

The results of our exploration indicate that, with proper site preparation as recommended in this report, the existing soils are suitable for supporting the various proposed structures on conventional shallow foundation systems (contingent upon settlement as noted below relative to the 2 MG ground storage tank being acceptable to the design team and owner). Ringwall and/or mat foundations should provide an adequate support system for the structures.

Very soft clay was encountered in the borings drilled relative to the ground storage tank. The presence of the very soft clay results in the potential for long term settlement for this structure. We used the results of the Standard Penetration Test (SPT) borings to undertake a settlement analysis for the proposed 2 MG water storage tank. The results of the settlement analysis are presented in the “Foundation Support by Ringwall and/or Mat Foundations and Foundation Compaction Criteria for Tank and Well Pad Structures” section of this report. Assuming that the calculated settlements are deemed acceptable, then with proper site preparation as recommended in this report, the existing soils are suitable for supporting the proposed tank on a conventional shallow foundation (i.e., ringwall and/or mat foundation).

The following are our recommendations for overall site preparation and foundation support which we feel are best suited for the proposed facility and existing soil conditions. The recommendations are made as a guide for the design engineer, parts of which should be incorporated into the project’s specifications.

We note that if the calculated total and differential settlements for the proposed 2 MG ground storage tank, as detailed in the “Foundation Support by Ringwall and/or Mat Foundations and Foundation Compaction Criteria for Tank and Well Pad Structures” section of this report are deemed unacceptable, then an alternative deep foundation system (i.e., piles) may be required.

Alternatively it may be possible to reduce settlement to within tolerable limits by reconfiguring the tank to be of a greater diameter but lower side water depth (i.e., for the same storage capacity).

Stripping and Grubbing

The "footprints" of the proposed structures, plus a minimum margin of five feet, should be stripped of all surface vegetation, stumps, debris, organic topsoil or other deleterious materials, as encountered. Buried utilities should be removed or plugged to eliminate conduits into which surrounding soils could erode.

After stripping, the site should be grubbed or root-raked such that roots with a diameter greater than ½-inch, stumps, or small roots in a dense state, are completely removed. The actual depth(s) of stripping and grubbing must be determined by visual observation and judgment during the earthwork operation.

Proof-rolling

We recommend proof-rolling the cleared surface to locate any unforeseen soft areas or unsuitable surface or near-surface soils, to increase the density of the upper soils, and to prepare the existing surface for the addition of the fill soils (as required). Proof-rolling of the structure areas should consist of at least 10 passes of a compactor capable of achieving the density requirements described in the next paragraph. Each pass should overlap the preceding pass by 30 percent to achieve complete coverage. If deemed necessary, in areas that continue to "yield", remove all deleterious material and replace with clean, compacted sand backfill. The proof-rolling should occur after cutting and before filling.

A density equivalent to or greater than 95 percent of the modified Proctor (ASTM D-1557) maximum dry density value for a depth of 2 feet in the structure areas must be achieved beneath the stripped and grubbed ground surface. Additional passes and/or overexcavation and recompaction may be required if these minimum density requirements are not achieved. The soil moisture should be adjusted as necessary during compaction.

Proof-rolling may cause upward movement or "pumping" of the groundwater. However, we recommend that the existing surface be level and firm prior to the addition of fill soils. Proof-rolling with a front-end loader may help achieve the desired surface and compaction condition before adding the fill soils. The site should be dewatered as necessary.

Care should be exercised to avoid damaging any neighboring structures while the compaction operation is underway. Prior to commencing compaction, occupants of adjacent structures should be notified and the existing condition (i.e., cracks) of the structures documented with photographs and survey (if deemed necessary). Compaction should cease if deemed detrimental to adjacent structures, and Ardaman & Associates should be notified immediately. Heavy vibratory compaction should not be used within 200 feet of existing structures.

Suitable Fill Material and Compaction of Fill Soils

All fill materials should be free of organic materials, such as roots and vegetation. We recommend using fill with less than 12 percent by dry weight of material passing the U.S. Standard No. 200 sieve size. The fine sand and fine sand with silt (Strata Nos. 1 and 2 without roots, as shown on Figures 3 through 5) are suitable for use as fill materials and, with proper moisture control, should densify using conventional compaction methods. Soils with more than 12 percent passing the No. 200 sieve can be used in some applications, but will be more difficult to compact due to their inherent nature to retain soil moisture.

All structural fill should be placed in level lifts not to exceed 12 inches in uncompacted thickness. Each lift should be compacted to at least 95 percent of the modified Proctor (ASTM D-1557) maximum dry density value. The filling and compaction operations should continue in lifts until the desired elevation(s) is achieved. If hand-held compaction equipment is used, the lift thickness should be reduced to no more than 6 inches.

Foundation Support and Foundation Compaction Criteria for Equipment and Well Pads

Relative to the equipment and well pads, excavate the foundations to the proposed bottom of mat elevations and, thereafter, verify the in-place compaction for a depth of 2 feet below the mat bottoms. If necessary, compact the soils at the bottom of the excavation to at least 95 percent of the modified Proctor maximum dry density (ASTM D-1557) for a depth of 2 feet below the mat bottoms.

Based on the existing soil conditions and, assuming the above outlined overexcavation, backfill, and compaction criteria are implemented, an allowable soil bearing pressure of up to 1,000 pounds per square foot (psf) may be used in the foundation design for the pads. This bearing pressure should result in foundation settlement on the order of 1 inch or less with differential settlement on the order of ½-inch. The equipment pads should be stiffened as necessary to accommodate differential settlement.

Mat foundations should be at least 3 feet wide. We recommend embedding the bottom of the mat foundations at least 8 inches below adjacent grade.

Foundation Support and Foundation Compaction Criteria for Ground Storage Tank

Excavate the foundation to the proposed bottom of footing elevation and, thereafter, verify the in-place compaction for a depth of 2 feet below the mat and ringwall bottoms. If necessary, compact the soils at the bottom of the excavations to at least 95 percent of the modified Proctor maximum dry density (ASTM D-1557) for a depth of 2 feet below the footing bottoms. Based on the existing soil conditions and, assuming the above outlined proof-rolling and compaction criteria are implemented, an allowable soil bearing pressure of 2,500 pounds per square foot (psf) may be used in the foundation design contingent upon the settlements noted below for the ground storage tank being acceptable to the design team and owner.

In the case of the ringwall for the proposed tank, all bearing wall foundations should be a minimum of 36 inches wide. A minimum soil cover of 30 inches should be maintained from the bottom of the exterior ringwall foundation to the adjacent outside finished grade.

Settlement analysis for the proposed ground storage tank was performed using the computer program ("Settle3D" by Rocscience) which models the subsurface conditions as a layered soil profile. Published correlations relying on the SPT N-values were used to estimate the elastic moduli for the soils. Westergaard stress distribution method was used for calculating the stress changes caused by the estimated weight of the tanks in the underlying foundation soils. Specifically, a uniform soil bearing pressure was applied at a depth of 1-foot below the existing ground surface over a 100-foot diameter area for the 2.0 MG ground storage tank.

The soil bearing pressure used for the structure and the results of the settlement calculations are presented in the below table.

Tank/Structure	Assumed Bearing Pressure (psf)	Estimated Max Total Settlement (inch)	Estimated Max Differential Settlement (inch)
2.0 MG Ground Storage Tank	2,500	5.2	2.4

We estimate that around 70% of the settlement will be elastic in nature, occurring as the loads are applied. The remaining settlement may be attributed to longer term consolidation of clayey soils.

We recommended that utility connections to the tanks be flexible enough to accommodate the settlement and that final fitting of connectors be undertaken after the tanks have been subjected to initial loading.

Output from the Settle3D computer program is included in Appendix III for informational purposes.

QUALITY ASSURANCE

We recommend establishing a comprehensive quality assurance program to verify that all site preparation and foundation construction is conducted in accordance with the appropriate plans and specifications. Materials testing and inspection services should be provided by Ardaman & Associates.

As a minimum, an on-site engineering technician should monitor all stripping and grubbing to verify that deleterious materials have been removed and should observe the proof-rolling operation to verify that the appropriate number of passes are applied to the subgrade. In-situ density tests should be conducted during filling activities and below all footings and slabs to verify that the required densities have been achieved. In-situ density values should be compared to

laboratory Proctor moisture-density results for each of the different natural and fill soils encountered.

Finally, we recommend inspecting and testing the construction materials for the foundations and other structural components.

IN-PLACE DENSITY TESTING FREQUENCY

In Central Florida, earthwork testing is typically performed on an on-call basis when the contractor has completed a portion of the work. The test result from a specific location is only representative of a larger area if the contractor has used consistent means and methods and the soils are practically uniform throughout. The frequency of testing can be increased and full-time construction inspection can be provided to account for variations. We recommend that the following minimum testing frequencies be utilized.

In proposed structural areas, a minimum frequency of one in-place density test for each 2,500 square feet of area should be used. In-place density testing should be performed at this minimum frequency for a depth of 2 feet below natural ground and for every 1-foot lift of fill placed in the structural area. In addition, density tests should be performed in each column footing for a depth of 2 feet below the bearing surface.

Utility backfill should be tested at a minimum frequency of one in-place density test for each 12-inch lift for each 200 linear feet of pipe. Additionally, tests should be performed in backfill in manholes, inlets, etc.

Representative samples of the various natural ground and fill soils, as well as stabilized subgrade (where applicable) and base materials should be obtained and transported to our laboratory for Proctor compaction tests. These tests will determine the maximum dry density and optimum moisture content for the materials tested and will be used in conjunction with the results of the in-place density tests to determine the degree of compaction achieved.

CLOSURE

The analyses and recommendations submitted herein are based on the data obtained from the soil borings presented on Figures 3 through 6 and the assumed loading conditions. This report does not reflect any variations which may occur adjacent to or between the borings. The nature and extent of the variations between the borings may not become evident until during construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations presented in this report after performing on-site observations during the construction period and noting the characteristics of the variations.

In the event any changes occur in the design, nature, or location of the proposed facility, we should review the applicability of conclusions and recommendations in this report. We recommend a general review of final design and specifications by our office to verify that earthwork and foundation recommendations are properly interpreted and implemented in the

design specifications. Ardaman and Associates should attend the pre-bid and preconstruction meetings to verify that the bidders/contractor understand the recommendations contained in this report.

This study is based on a relatively shallow exploration and is not intended to be an evaluation for sinkhole potential. This study does not include an evaluation of the environmental (ecological or hazardous/toxic material related) condition of the site and subsurface.

This report has been prepared for the exclusive use of Tetra Tech, Inc. in accordance with generally accepted geotechnical engineering practices for the purpose of the proposed SRWTP Expansion project in Palm Bay, Florida. No other warranty, expressed or implied, is made.

We are pleased to be of assistance to you on this phase of the project. When we may be of further service to you or should you have any questions, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.
Certificate of Authorization No. 5950

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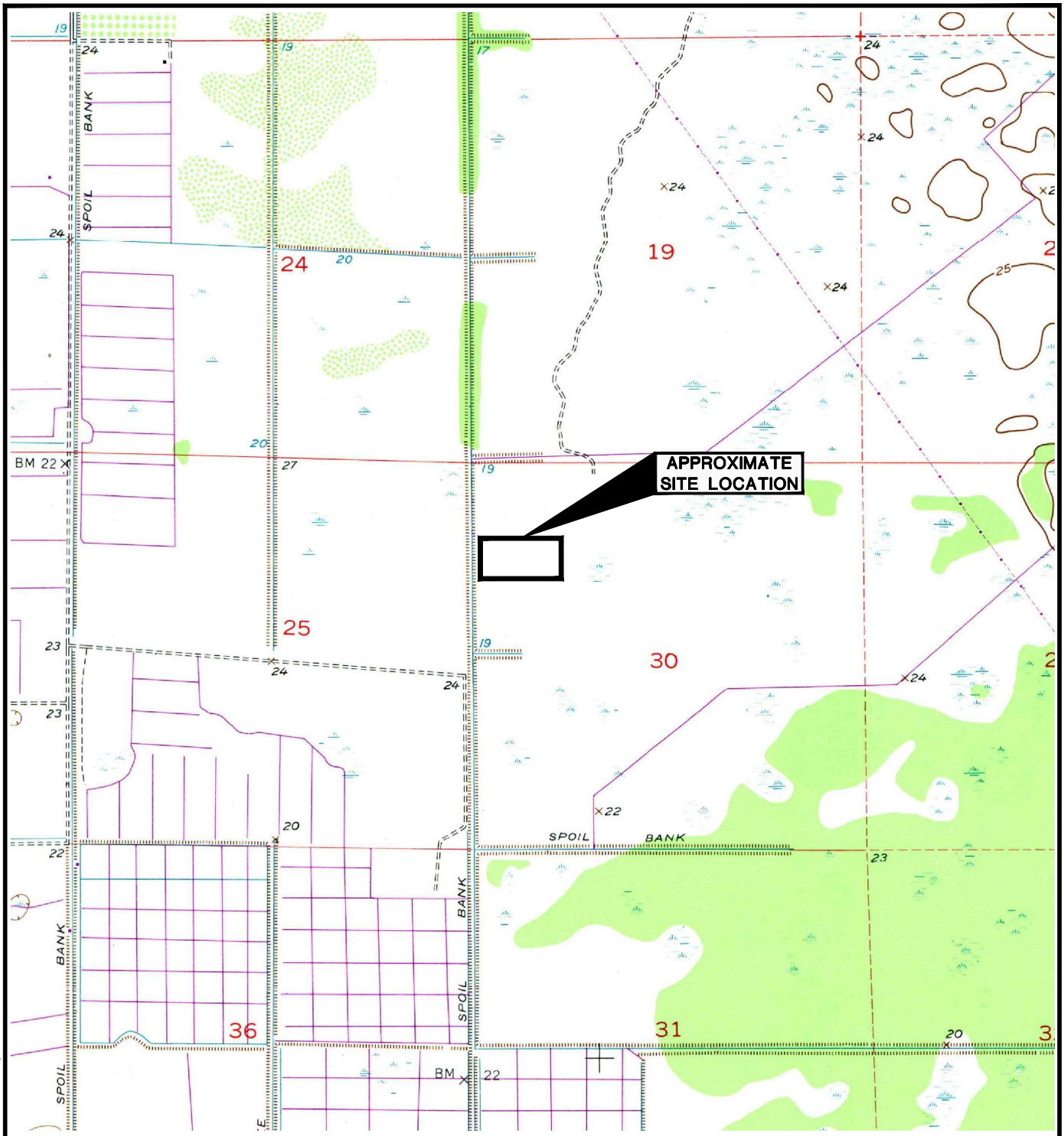
ECB/CHC/jj/gb
19-6372 TT SRWTP Expansion Palm Bay (Geo 2019)



SECTION 30
TOWNSHIP 29 SOUTH
RANGE 37 EAST

OBTAINED FROM U.S.G.S. QUAD MAP: FELLSMERE NW, FLORIDA 1953
(PHOTOREVISED 1970)

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SCALE: (FEET)

QUADRANGLE LOCATION

SITE LOCATION MAP

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUBSURFACE SOIL EXPLORATION
PROPOSED SRWTP EXPANSION
PALM BAY, BREVARD COUNTY, FLORIDA

DRAWN BY: CD	CHECKED BY:	DATE: 07/16/19
FILE NO. 19-6372	APPROVED BY:	FIGURE: 1

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LEGEND

SOIL DESCRIPTIONS

1	FINE SAND (SP)	
2	FINE SAND WITH SILT (SP-SM)	
3	FINE SAND WITH CLAY (SP-SC)	
4	SILTY CLAYEY FINE SAND (SM/SC)	
5	CLAYEY FINE SAND (SC)	
6	SANDY CLAY (CH)	
7	ASPHALTIC CONCRETE AND BASE	

COLORS

A	GRAYISH BROWN
B	LIGHT BROWN TO BROWN
C	LIGHT GRAY TO GRAY
D	GREENISH GRAY
E	DARK BROWN

TH	STANDARD PENETRATION TEST (SPT) BORING
N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
NM	NATURAL MOISTURE CONTENT IN PERCENT (ASTM D-2216)
-200	PERCENT PASSING NO. 200 SIEVE SIZE (PERCENT FINES)(ASTM D-1140)
LL	LIQUID LIMIT (ASTM D-4318)
PL	PLASTIC LIMIT (ASTM D-4318)
PI	PLASTICITY INDEX (ASTM D-4318)
▼	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
WOH	SAMPLER ADVANCED BY STATIC WEIGHT OF HAMMER AND RODS ONLY
SP,SP-SM SM,SC,CH	UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

NOTES: 1. UPON COMPLETION OF SPT BORINGS TH-1 THROUGH TH-5, THE BOREHOLE WAS GROUTED WITH CEMENT-BENTONITE SLURRY. UPON COMPLETION OF ALL OTHER BORINGS, THE BOREHOLE WAS BACKFILLED WITH SOIL CUTTINGS.

2. ALL SPT BORINGS WERE PERFORMED USING AN AUTOMATIC HAMMER TO THE BORING TERMINATION DEPTH. AUTOMATIC HAMMER N-VALUES MAY BE CONVERTED TO EQUIVALENT SAFETY HAMMER N-VALUES BY MULTIPLYING BY 1.24.

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

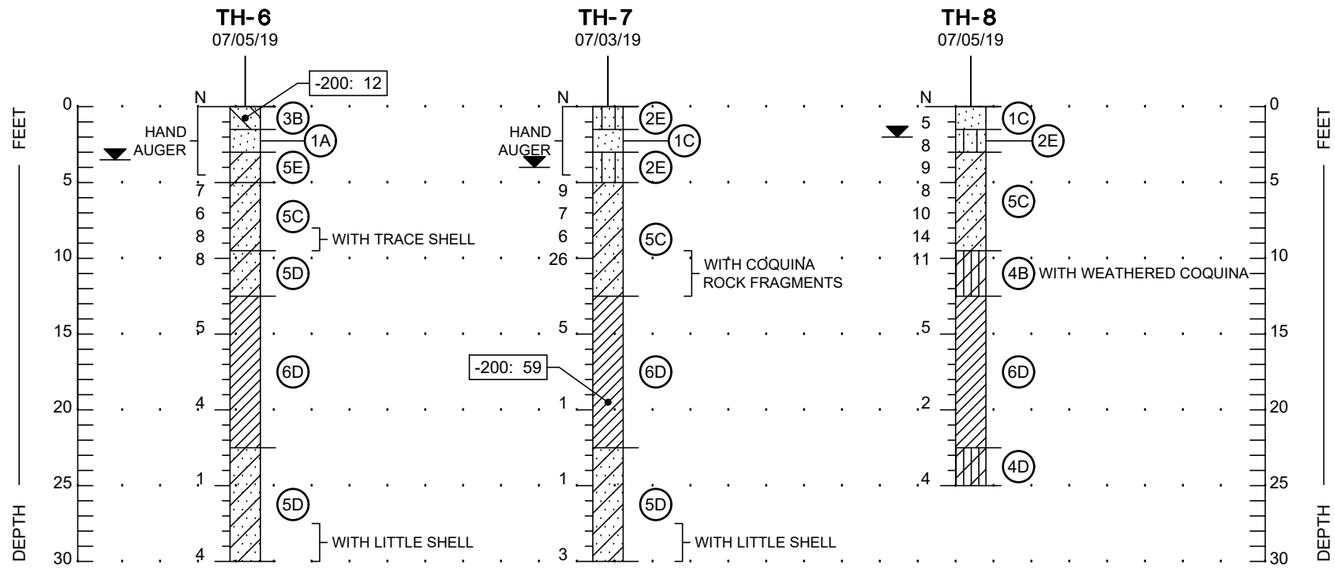
DESCRIPTION	BLOW COUNT "N"
VERY LOOSE	<4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	>50

II COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, QU, TSF	BLOW COUNT "N"
VERY SOFT	<1/4	<2
SOFT	1/4 TO 1/2	2 TO 4
MEDIUM STIFF	1/2 TO 1	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	>4	>30

WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATIONS ON THE PARTICULAR DATE DRILLED.

GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR.



SOIL BORING PROFILES

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUBSURFACE SOIL EXPLORATION
PROPOSED SRWTP EXPANSION
PALM BAY, BREVARD COUNTY, FLORIDA

DRAWN BY: CD	CHECKED BY:	DATE: 07/17/19	
FILE NO. 19-6372	APPROVED BY:	FIGURE: 5	

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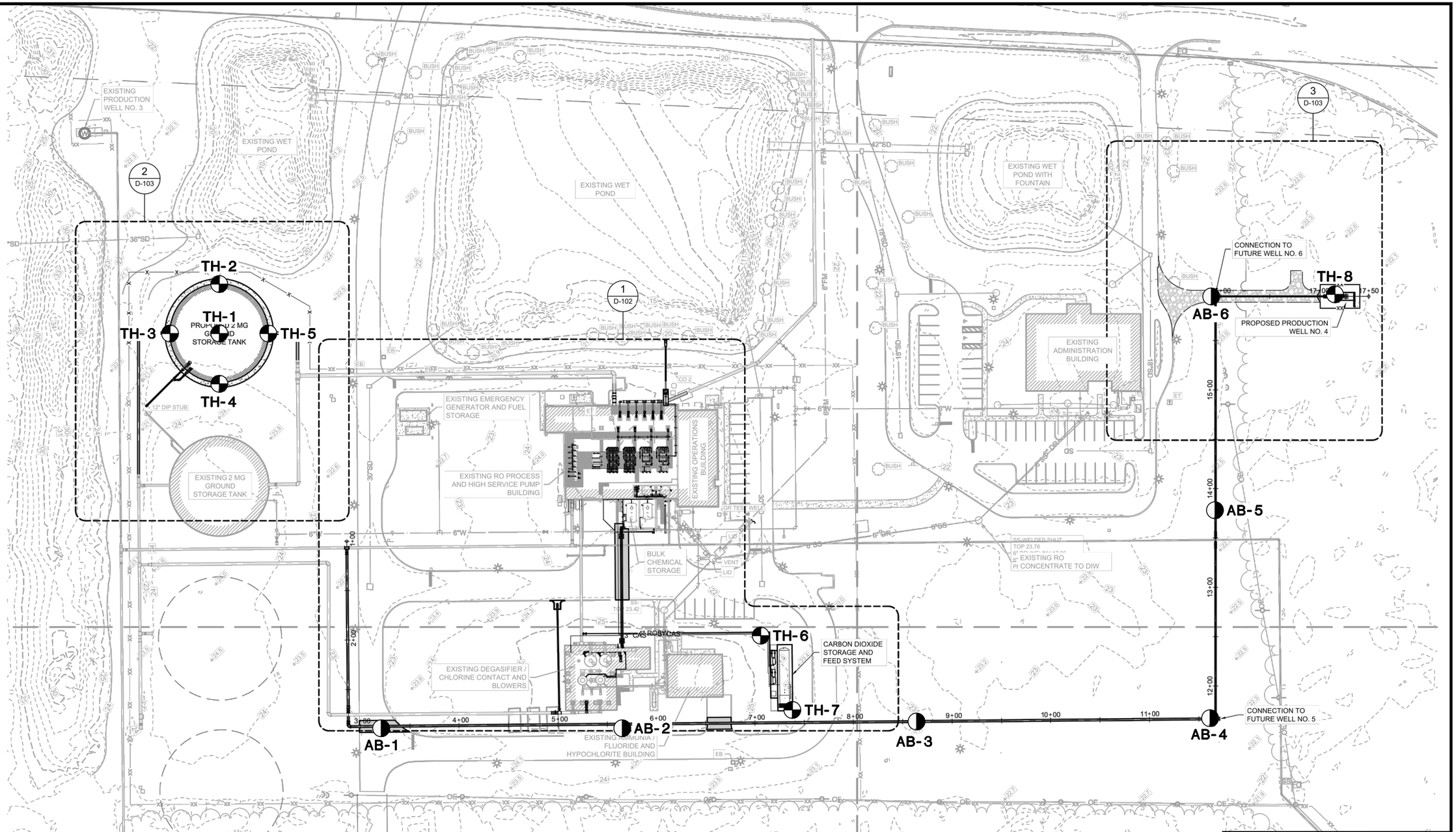

LEGEND

TH	STANDARD PENETRATION TEST (SPT) BORING LOCATION
AB	AUGER BORING LOCATION

NOTE: THE BASE MAP FOR THE BORING LOCATION PLAN IS A SITE PLAN BY TETRA TECH AND PROVIDED ON JULY 17, 2019.

N

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SCALE: (FEET)

BORING LOCATION PLAN

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUBSURFACE SOIL EXPLORATION
PROPOSED SRWTP EXPANSION
PALM BAY, BREVARD COUNTY, FLORIDA

DRAWN BY: CD	CHECKED BY:	DATE: 07/16/19
FILE NO. 19-6372	APPROVED BY:	FIGURE: 2

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LEGEND

SOIL DESCRIPTIONS

1. FINE SAND (SP)
2. FINE SAND WITH SILT (SP-SM)
3. FINE SAND WITH CLAY (SP-SC)
4. SILTY CLAYEY FINE SAND (SM/SC)
5. CLAYEY FINE SAND (SC)
6. SANDY CLAY (CH)
7. ASPHALTIC CONCRETE AND BASE

COLORS

A. GRAYISH BROWN
B. LIGHT BROWN TO BROWN
C. LIGHT GRAY TO GRAY
D. GREENISH GRAY
E. DARK BROWN

TH	STANDARD PENETRATION TEST (SPT) BORING
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NM	NATURAL MOISTURE CONTENT IN PERCENT (ASTM D-2216)
-200	PERCENT PASSING NO. 200 SIEVE SIZE (PERCENT FINES)(ASTM D-1140)
LL	LIQUID LIMIT (ASTM D-4318)
PL	PLASTIC LIMIT (ASTM D-4318)
PI	PLASTICITY INDEX (ASTM D-4318)
▽	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
US-1	UNDISTURBED SAMPLE OBTAINED WITH A 3-INCH DIA. SHELBY TUBE
	3 1/2-INCH DIAMETER TEMPORARY STEEL CASING
SP,SP-SM SM,SC,CH	UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

NOTES: 1. UPON COMPLETION OF SPT BORINGS TH-1 THROUGH TH-5, THE BOREHOLE WAS GROUTED WITH CEMENT-BENTONITE SLURRY. UPON COMPLETION OF ALL OTHER BORINGS, THE BOREHOLE WAS BACKFILLED WITH SOIL CUTTINGS.

2. ALL SPT BORINGS WERE PERFORMED USING AN AUTOMATIC HAMMER TO THE BORING TERMINATION DEPTH. AUTOMATIC HAMMER N-VALUES MAY BE CONVERTED TO EQUIVALENT SAFETY HAMMER N-VALUES BY MULTIPLYING BY 1.24.

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

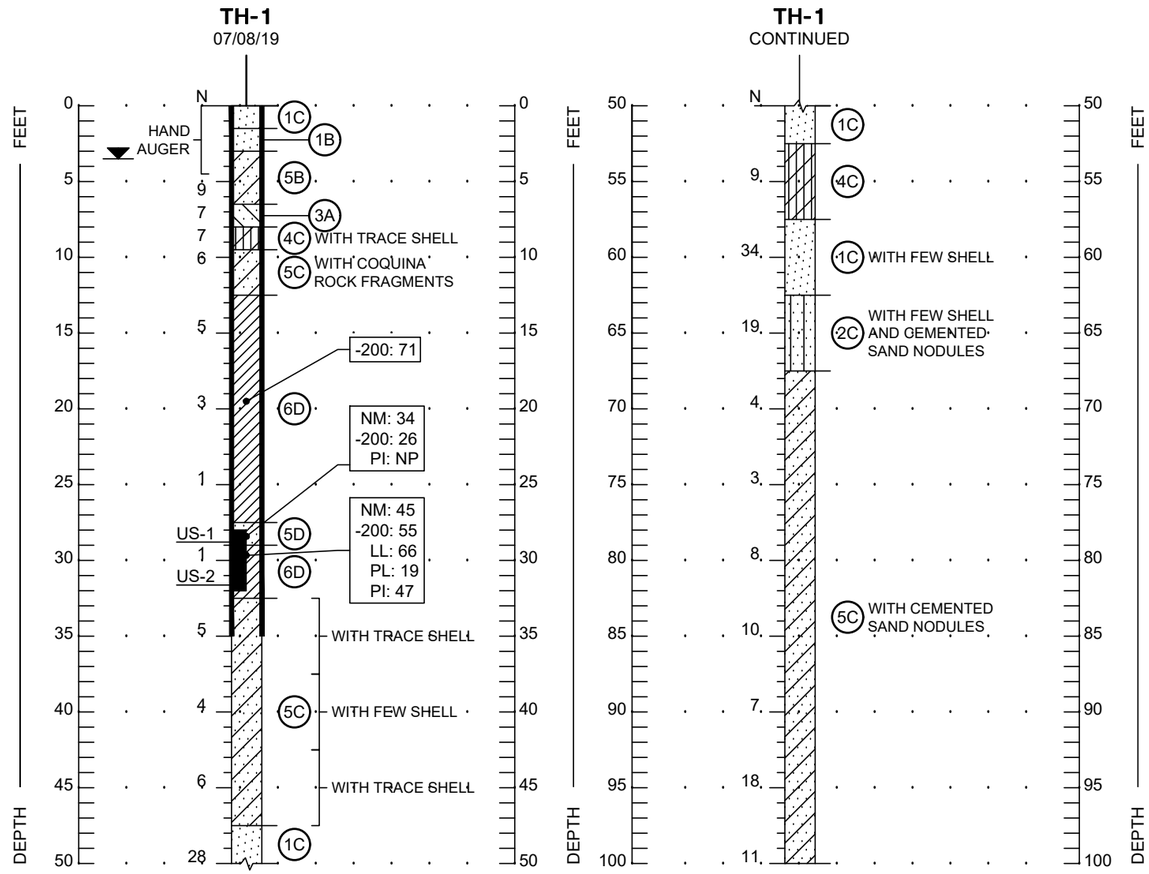
DESCRIPTION	BLOW COUNT "N"
VERY LOOSE	<4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	>50

II COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, QU, TSF	BLOW COUNT "N"
VERY SOFT	<1/4	<2
SOFT	1/4 TO 1/2	2 TO 4
MEDIUM STIFF	1/2 TO 1	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	>4	>30

WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATIONS ON THE PARTICULAR DATE DRILLED.

GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR.



SOIL BORING PROFILES

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUBSURFACE SOIL EXPLORATION
PROPOSED SRWTP EXPANSION
PALM BAY, BREVARD COUNTY, FLORIDA

DRAWN BY: CD	CHECKED BY:	DATE: 07/17/19
FILE NO. 19-6372	APPROVED BY:	FIGURE: 3

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LEGEND

SOIL DESCRIPTIONS

1	FINE SAND (SP)
2	FINE SAND WITH SILT (SP-SM)
3	FINE SAND WITH CLAY (SP-SC)
4	SILTY CLAYEY FINE SAND (SM/SC)
5	CLAYEY FINE SAND (SC)
6	SANDY CLAY (CH)
7	ASPHALTIC CONCRETE AND BASE

COLORS

A	GRAYISH BROWN
B	LIGHT BROWN TO BROWN
C	LIGHT GRAY TO GRAY
D	GREENISH GRAY
E	DARK BROWN

TH	STANDARD PENETRATION TEST (SPT) BORING
N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
NM	NATURAL MOISTURE CONTENT IN PERCENT (ASTM D-2216)
-200	PERCENT PASSING NO. 200 SIEVE SIZE (PERCENT FINES)(ASTM D-1140)
LL	LIQUID LIMIT (ASTM D-4318)
PL	PLASTIC LIMIT (ASTM D-4318)
PI	PLASTICITY INDEX (ASTM D-4318)
▼	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
WOH	SAMPLER ADVANCED BY STATIC WEIGHT OF HAMMER AND RODS ONLY
SP,SP-SM SM,SC,CH	UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

NOTES: 1. UPON COMPLETION OF SPT BORINGS TH-1 THROUGH TH-5, THE BOREHOLE WAS GROUTED WITH CEMENT-BENTONITE SLURRY. UPON COMPLETION OF ALL OTHER BORINGS, THE BOREHOLE WAS BACKFILLED WITH SOIL CUTTINGS.

2. ALL SPT BORINGS WERE PERFORMED USING AN AUTOMATIC HAMMER TO THE BORING TERMINATION DEPTH. AUTOMATIC HAMMER N-VALUES MAY BE CONVERTED TO EQUIVALENT SAFETY HAMMER N-VALUES BY MULTIPLYING BY 1.24.

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

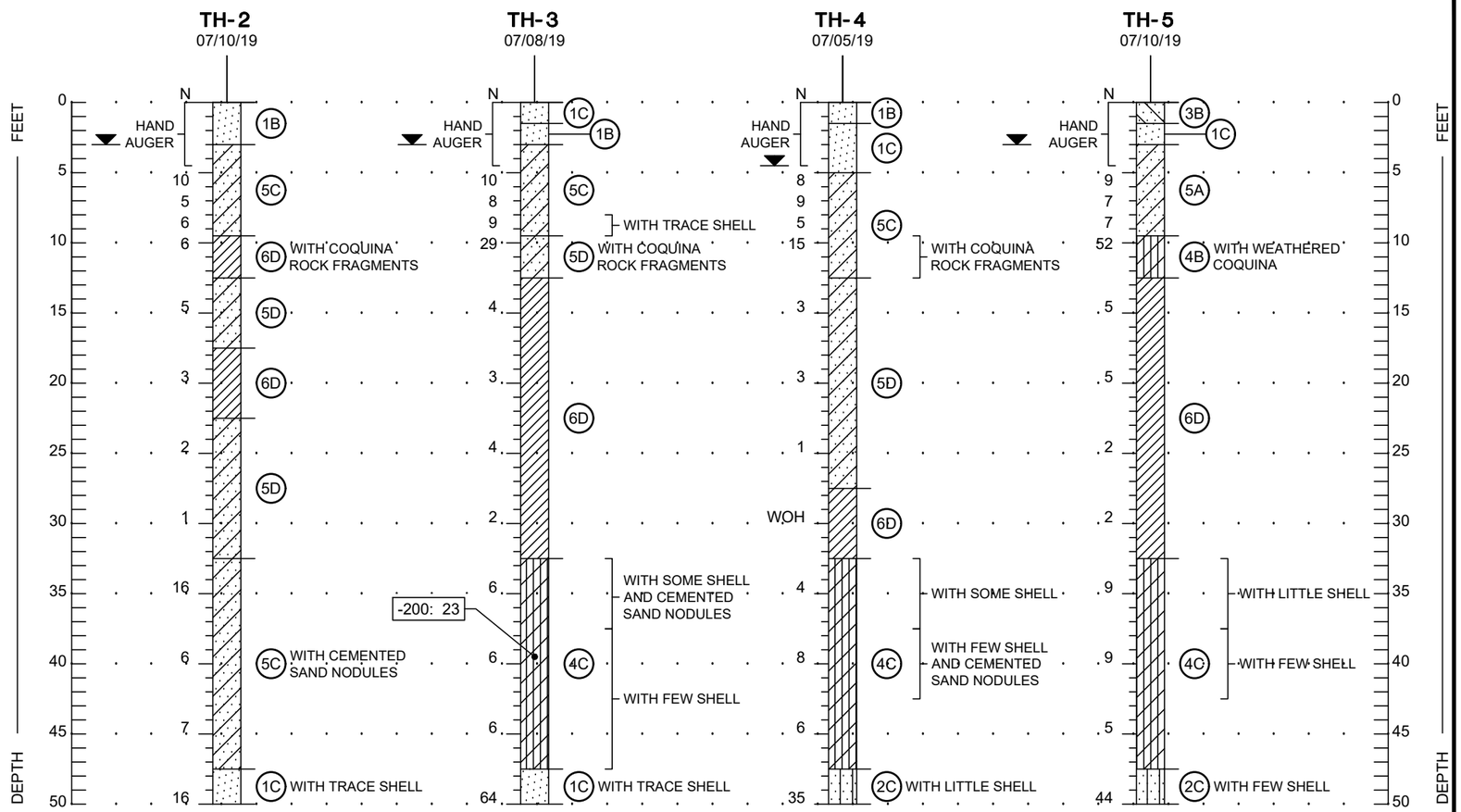
DESCRIPTION	BLOW COUNT "N"
VERY LOOSE	<4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	>50

II COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, QU, TSF	BLOW COUNT "N"
VERY SOFT	<1/4	<2
SOFT	1/4 TO 1/2	2 TO 4
MEDIUM STIFF	1/2 TO 1	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	>4	>30

WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATIONS ON THE PARTICULAR DATE DRILLED.

GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR.



SOIL BORING PROFILES

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUBSURFACE SOIL EXPLORATION
PROPOSED SRWTP EXPANSION
PALM BAY, BREVARD COUNTY, FLORIDA

DRAWN BY: CD	CHECKED BY:	DATE: 07/17/19
FILE NO. 19-6372	APPROVED BY:	FIGURE: 4

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LEGEND

SOIL DESCRIPTIONS

1. FINE SAND TO FINE SAND WITH SILT (A-3)
2. FINE SAND WITH CLAY TO CLAYEY FINE SAND (A-2-4)
3. CLAYEY FINE SAND (A-2-6)
4. ASPHALTIC CONCRETE AND BASE

COLORS

- A GRAYISH BROWN
- B LIGHT BROWN TO BROWN
- C LIGHT GRAY TO GRAY
- D GREENISH GRAY
- E DARK BROWN

AB	AUGER BORING
NM	NATURAL MOISTURE CONTENT IN PERCENT (ASTM D-2216)
-200	PERCENT PASSING NO. 200 SIEVE SIZE (PERCENT FINES)(ASTM D-1140)
LL	LIQUID LIMIT (ASTM D-4318)
PL	PLASTIC LIMIT (ASTM D-4318)
PI	PLASTICITY INDEX (ASTM D-4318)
▼	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
A-3,A-2-4 A-2-6,A-2-7	AASHTO SOIL CLASSIFICATION SYSTEM (ASTM D-3282)

NOTE: UPON COMPLETION OF SPT BORINGS TH-1 THROUGH TH-5, THE BOREHOLE WAS GROUTED WITH CEMENT-BENTONITE SLURRY. UPON COMPLETION OF ALL OTHER BORINGS, THE BOREHOLE WAS BACKFILLED WITH SOIL CUTTINGS.

WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATIONS ON THE PARTICULAR DATE DRILLED.

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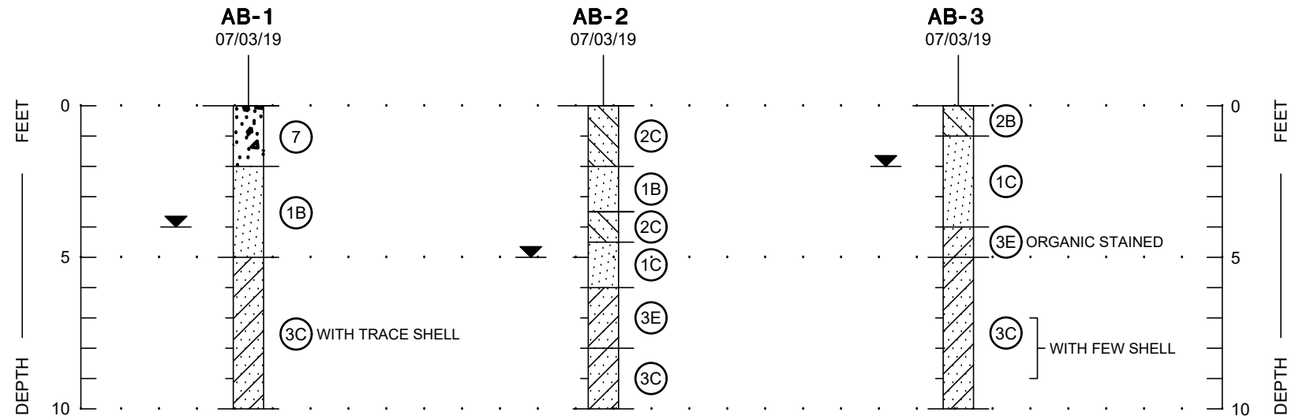

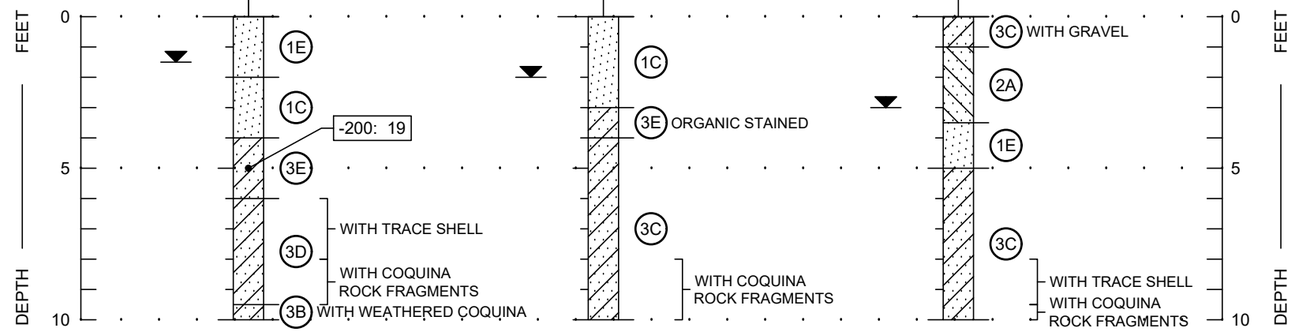

SOIL BORING PROFILES

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUBSURFACE SOIL EXPLORATION
PROPOSED SRWTP EXPANSION
PALM BAY, BREVARD COUNTY, FLORIDA

DRAWN BY: CD	CHECKED BY:	DATE: 07/17/19	
FILE NO. 19-6372	APPROVED BY:	FIGURE: 6	

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APPENDIX I

Standard Penetration Test and Auger Boring Procedures

STANDARD PENETRATION TEST

The standard penetration test is a widely accepted test method of *in situ* testing of foundation soils (ASTM D 1586). A 2-foot long, 2-inch O.D. split-barrel sampler attached to the end of a string of drilling rods is driven 18 inches into the ground by successive blows of a 140-pound hammer freely dropping 30 inches. The number of blows needed for each 6 inches of penetration is recorded. The sum of the blows required for penetration of the second and third 6-inch increments of penetration constitutes the test result or N-value. After the test, the sampler is extracted from the ground and opened to allow visual examination and classification of the retained soil sample. The N-value has been empirically correlated with various soil properties allowing a conservative estimate of the behavior of soils under load.

The tests are usually performed at 5-foot intervals. The test holes are advanced to the test elevations by rotary drilling with a cutting bit, using circulating fluid to remove the cuttings and hold the fine grains in suspension. The circulating fluid, which is a bentonitic drilling mud, is also used to keep the hole open below the water table by maintaining an excess hydrostatic pressure inside the hole. In some soil deposits, particularly highly pervious ones, NX-size flush-coupled casing must be driven to just above the testing depth to keep the hole open and/or prevent the loss of circulating fluid.

Representative split-spoon samples from the soils are brought to our laboratory in air-tight jars for further evaluation and testing, if necessary. Samples not used in testing are stored for 30 days prior to being discarded.

AUGER BORINGS

Auger borings are used when continuous sampling of soil strata close to ground surface is desired. A 4-inch diameter, continuous flite, helical auger with a cutting head at its end is screwed into the ground in 5-foot sections. It is powered by the rotating action of the Kelly bar of a rotary drill rig. The sample is recovered by withdrawing the auger out of the ground without rotating it. The soil sample so obtained, is classified and representative samples put in bags or jars and brought back to the laboratory for classification testing.

APPENDIX II

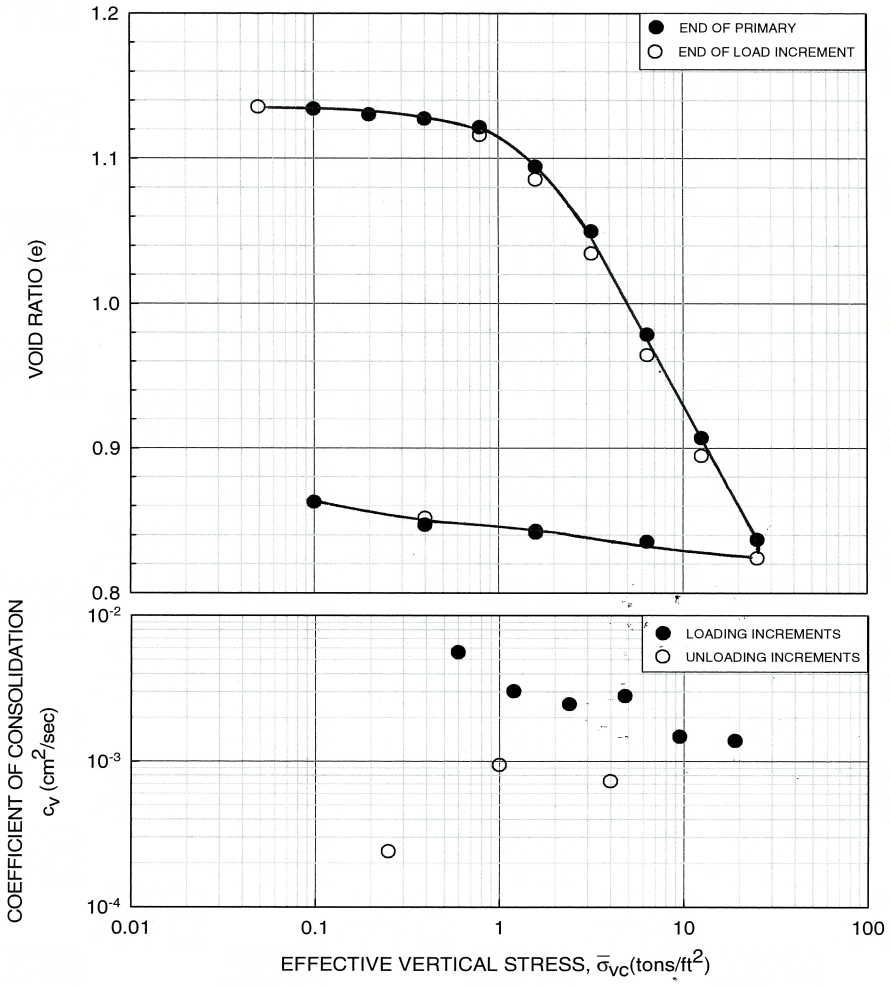
Laboratory Consolidation Test Results

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ONE-DIMENSIONAL INCREMENTAL LOADING CONSOLIDATION TEST REPORT

CLIENT: _____
PROJECT: Palm Bay
FILE NO.: 19-60-6372

INCOMING SAMPLE NO.: -----
BORING: TH-1 SAMPLE: US-1 Block 2
DEPTH: 28.0 - 30.0 ☑ feet; ☐ meters
LAB IDENTIFICATION NO.: 196372/TH-1
SAMPLE DESCRIPTION.: Gray clayey sand [SC]

DATE SAMPLE RECEIVED: -----
DATE SAMPLE SET-UP: 07/19/19
DATE REPORTED: 09/17/19



Test Methods & Procedures

ASTM Standard D2435
☐ Method A
☑ Method B
c_v Interpretation Method
☐ c_v [Log Time]
☑ c_v [Sq. Root Time]
Trimming Method
☑ cutting shoe
☐ other _____
Initial Sample Diameter 7.30 (cm)

Test Conditions

☐ Tested at Natural Moisture Content
☑ Specimen Tested Inundated
Inundated at σ'_{vc} 0.05 (tsf)
Inundation Fluid:
☑ tap water
☐ other _____

Specimen Conditions

Parameter	Initial	Final
D (cm)	5.00	5.00
H (cm)	1.905	1.659
w_c (%)	40.3	32.0
γ_d (pcf)	78.2	89.9
e	1.139	0.863
S (%)	95	100

G_s: 2.68 ☐ Assumed ☑ Measured

Index Properties

LL	---
PL	---
PI	---

Particle-Size Analysis ☐ ASTM D6913 ☑ ASTM D1140-Method B	U.S. Standard Sieve Size	Gravel			Coarse Sand	Medium Sand		Fine Sand			
		3/4"	3/8"	No. 4	No. 10	No. 20	No. 40	No. 60	No. 100	No. 140	No. 200
Dry Mass(g): 46.86	Soil Passing (%, dry mass basis)	-----	-----	-----	-----	-----	-----	-----	-----	-----	26.4

Where: H=Specimen height; D = Specimen diameter; w_c = Water content (ASTM D2216); γ_d = Dry density; e = Void ratio; S = Saturation; G_s= Specific gravity; c_v = Coefficient of consolidation; and $C_{\alpha e}$ = Secondary compression index.

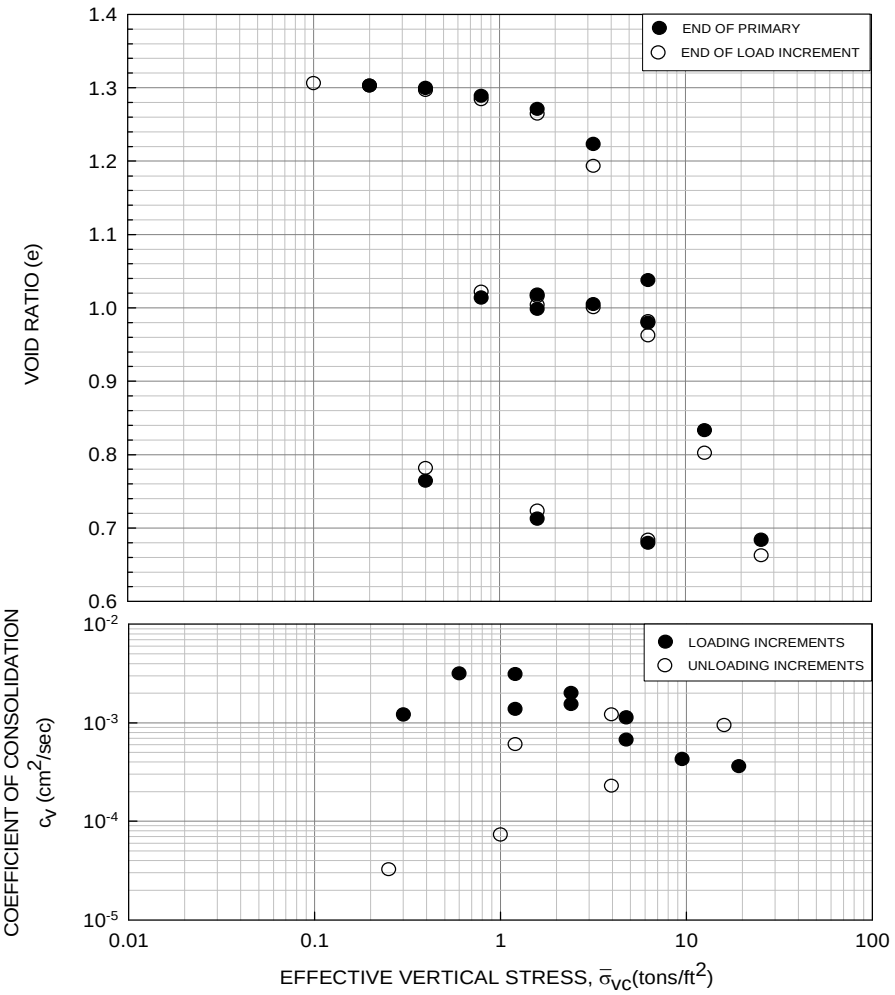
Checked By: RM Date: 09/17/19

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ONE-DIMENSIONAL INCREMENTAL LOADING CONSOLIDATION TEST REPORT

CLIENT: _____
PROJECT: PALM BAY
FILE NO.: 19-60-6372

DATE SAMPLE RECEIVED: ------
DATE SAMPLE SET-UP: 07/23/19
DATE REPORTED: 09/05/19

INCOMING SAMPLE NO.: -----
BORING: **TH-1** SAMPLE: **US-1 Block 3**
DEPTH: 28.0 - 30.0 ☑ ft; ☐ m
LAB IDENTIFICATION NO.: 196372/TH1
SAMPLE DESCRIPTION.: Gray sandy clay



Test Methods & Procedures

ASTM Standard D2435
- ☐ Method A
- ☑ Method B

c_v Interpretation Method
- ☐ c_v [Log Time]
- ☑ c_v [Sq. Root Time]

Trimming Method
- ☑ cutting shoe
- ☐ other _____

Initial Sample Diameter 7.30 (cm)

Test Conditions

- ☐ Tested at Natural Moisture Content
- ☑ Specimen Tested Inundated

Inundated at σ'_{vc} 0.05 (tsf)

Inundation Fluid:
- ☑ tap water
- ☐ other _____

Specimen Conditions

Parameter	Initial	Final
D (cm)	5.00	5.00
H (cm)	1.905	1.533
w_c (%)	48.1	32.1
γ_d (pcf)	72.4	90.0
e	1.310	0.859
S (%)	98.4	100

G_s: 2.68 ☐ Assumed ☑ Measured

Index Properties

LL	66
PL	19
PI	47

Particle-Size Analysis
☐ ASTM D6913
☑ ASTM D1140-Method B

Dry Mass(g): 43.40

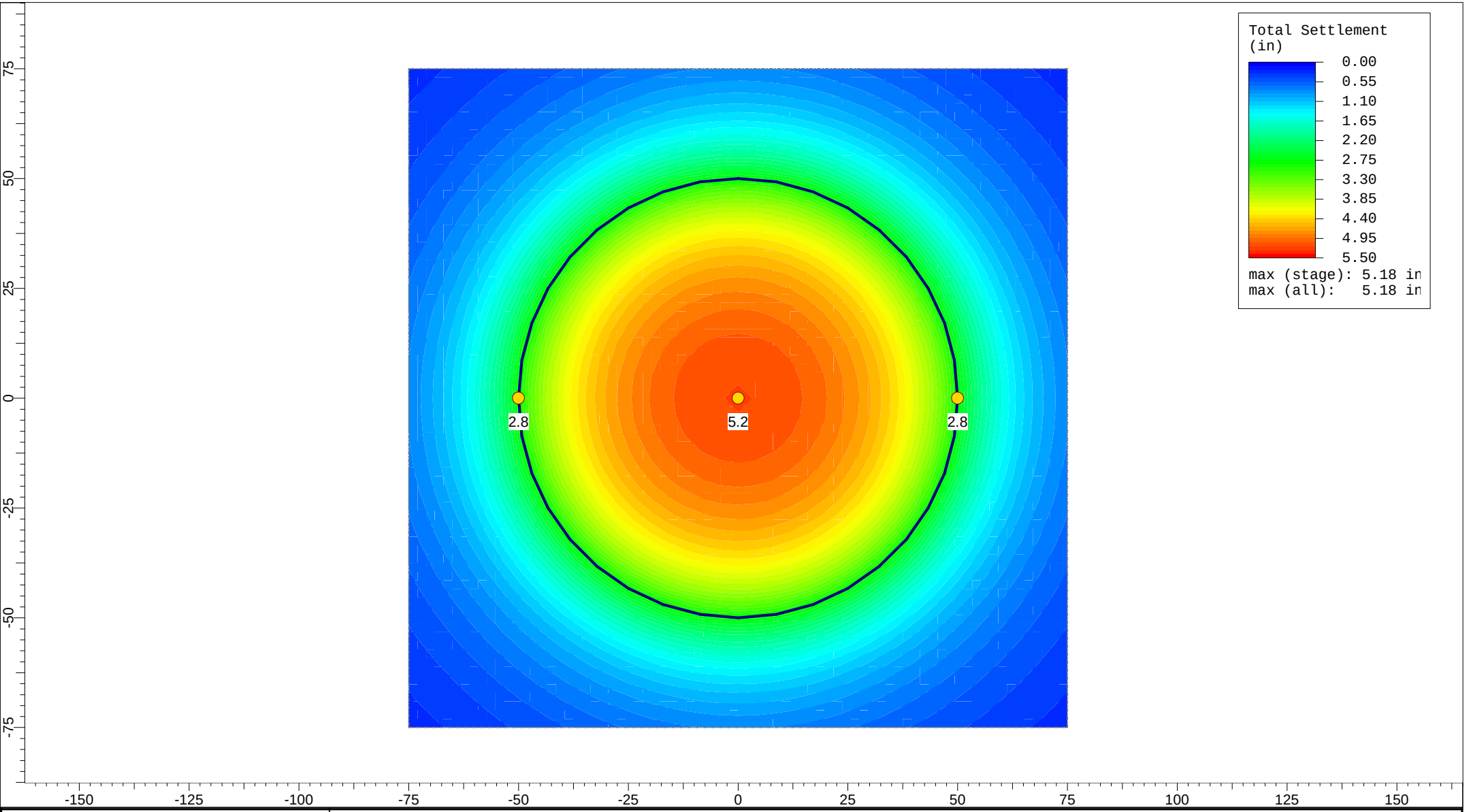
U.S. Standard Sieve Size	Gravel			Coarse Sand	Medium Sand		Fine Sand			
	3/4"	3/8"	No. 4	No. 10	No. 20	No. 40	No. 60	No. 100	No. 140	No. 200
Soil Passing (%, dry mass basis)	-----	-----	-----	-----	-----	-----	-----	-----	-----	55.1

Where: H=Specimen height; D = Specimen diameter; w_c = Water content (ASTM D2216); γ_d = Dry density; e = Void ratio; S = Saturation; G_s= Specific gravity; c_v = Coefficient of consolidation; and $C_{\alpha e}$ = Secondary compression index.

Checked By: _____ Date: _____

APPENDIX III

Settle 3D Computer Program Output



50 Years Ardaman & Associates, Inc.	*Project*	Palm Bay SRWTP Expansion	
	Analysis Description	Water Storage Tanks	
	Drawn By	ECB	*Company* Ardaman & Associates
	Date	9/25/2019, 06:04:34 PM	*File Name* 2.0 MG Tank.s3z

SETTLE3D 2.019

Palm Bay Utilities

APPENDIX B

FLORIDA DEPARTMENT OF Environmental Protection

CENTRAL DISTRICT OFFICE
3319 MAGUIRE BLVD, SUITE 232
ORLANDO FLORIDA 32803

Ron DeSantis
Governor

Jeanette Nuñez
Lt. Governor

Noah Valenstein
Secretary

April 28, 2020

ELECTRONIC CORRESPONDENCE

In the matter of an
Application for Permit by:

Christopher A. Little, P.E., Utilities Director
City of Palm Bay
250 Osmosis Drive SE
Palm Bay, FL 32909
Christopher.little@palmbayflorida.org

DEP File No. 0032426-378-WC
County: Brevard

NOTICE OF PERMIT ISSUANCE

Enclosed is Permit Number 0032426-378-WC to construct the Palm Bay South Regional Reverse Osmosis Water Treatment Plant (WTP) Expansion, issued pursuant to Section 403.861(9), Florida Statutes.

This action is final and effective on the date filed with the Clerk of the Department unless a petition for an administrative hearing is timely filed under Sections 120.569 and 120.57, F.S., before the deadline for filing a petition. On the filing of a timely and sufficient petition, this action will not be final and effective until a subsequent order of the Department. Because the administrative hearing process is designed to formulate final agency action, the subsequent order may modify or take a different position than this action.

Petition for Administrative Hearing

A person whose substantial interests are affected by the Department's action may petition for an administrative proceeding (hearing) under Sections 120.569 and 120.57, F.S. Pursuant to Rules 28-106.201 and 28-106.301, F.A.C., a petition for an administrative hearing must contain the following information:

(a) The name and address of each agency affected and each agency's file or identification number, if known;
(b) The name, address, any e-mail address, any facsimile number, and telephone number of the petitioner, if the petitioner is not represented by an attorney or a qualified representative; the name, address, and telephone number of the petitioner's representative, if any, which shall be the address for service purposes during the course of the proceeding; and an explanation of how the petitioner's substantial interests will be affected by the agency determination;
(c) A statement of when and how the petitioner received notice of the agency decision;
(d) A statement of all disputed issues of material fact. If there are none, the petition must so indicate;
(e) A concise statement of the ultimate facts alleged, including the specific facts that the petitioner contends warrant reversal or modification of the agency's proposed action;
(f) A statement of the specific rules or statutes that the petitioner contends require reversal or modification of the agency's proposed action, including an explanation of how the alleged facts relate to the specific rules or statutes; and

(g) A statement of the relief sought by the petitioner, stating precisely the action that the petitioner wishes the agency to take with respect to the agency's proposed action.

The petition must be filed (received by the Clerk) in the Office of General Counsel of the Department at 3900 Commonwealth Boulevard, Mail Station 35, Tallahassee, Florida 32399-3000, or via electronic correspondence at Agency_Clerk@dep.state.fl.us. Also, a copy of the petition shall be mailed to the applicant at the address indicated above at the time of filing.

Time Period for Filing a Petition

In accordance with Rule 62-110.106(3), F.A.C., petitions for an administrative hearing by the applicant and persons entitled to written notice under Section 120.60(3), F.S., must be filed within 14 days of receipt of this written notice. Petitions filed by any persons other than the applicant, and other than those entitled to written notice under Section 120.60(3), F.S., must be filed within 14 days of publication of the notice or within 14 days of receipt of the written notice, whichever occurs first. You cannot justifiably rely on the finality of this decision unless notice of this decision and the right of substantially affected persons to challenge this decision has been duly published or otherwise provided to all persons substantially affected by the decision. While you are not required to publish notice of this action, you may elect to do so pursuant Rule 62-110.106(10)(a).

The failure to file a petition within the appropriate time period shall constitute a waiver of that person's right to request an administrative determination (hearing) under Sections 120.569 and 120.57, F.S., or to intervene in this proceeding and participate as a party to it. Any subsequent intervention (in a proceeding initiated by another party) will be only at the discretion of the presiding officer upon the filing of a motion in compliance with Rule 28-106.205, F.A.C. If you do not publish notice of this action, this waiver may not apply to persons who have not received a clear point of entry.

Extension of Time

Under Rule 62-110.106(4), F.A.C., a person whose substantial interests are affected by the Department's action may also request an extension of time to file a petition for an administrative hearing. The Department may, for good cause shown, grant the request for an extension of time. Requests for extension of time must be filed with the Office of General Counsel of the Department at 3900 Commonwealth Boulevard, Mail Station 35, Tallahassee, Florida 32399-3000, or via electronic correspondence at Agency_Clerk@dep.state.fl.us, before the deadline for filing a petition for an administrative hearing. A timely request for extension of time shall toll the running of the time period for filing a petition until the request is acted upon.

Mediation

Mediation is not available in this proceeding.

Judicial Review

Once this decision becomes final, any party to this action has the right to seek judicial review pursuant to Section 120.68, F.S., by filing a Notice of Appeal pursuant to Florida Rules of Appellate Procedure 9.110 and 9.190 with the Clerk of the Department in the Office of General Counsel (Station #35, 3900 Commonwealth Boulevard, Tallahassee, Florida 32399-3000) and by filing a copy of the Notice of Appeal accompanied by the applicable filing fees with the appropriate district court of appeal. The notice must be filed within 30 days from the date this action is filed with the Clerk of the Department.

EXECUTION AND CLERKING
Executed in Orlando, Florida.

STATE OF FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Erin Rasnake
Program Administrator
Permitting and Waste Cleanup Program

Enclosures: Permit No**.** 0032426-378-WC

CERTIFICATION OF SERVICE

The undersigned duly designated deputy clerk hereby certifies that this permit and all copies were sent on the filing date below to the following listed persons:

Jonathan Bundy, P.E., Tetra Tech [Jon.bundy@tetratech.com]
Reggie Philips, Jill Farris, Daissan A. Villareal-FDEP

FILING AND ACKNOWLEDGEMENT

FILED, on this date, under Section 120.52(7), Florida Statutes, with the designated Department Clerk, receipt of which is hereby acknowledged.

April 28, 2020
Clerk **Date**

FLORIDA DEPARTMENT OF Environmental Protection

CENTRAL DISTRICT OFFICE
3319 MAGUIRE BLVD, SUITE 232
ORLANDO FLORIDA 32803

Ron DeSantis
Governor

Jeanette Nuñez
Lt. Governor

Noah Valenstein
Secretary

April 28, 2020

ELECTRONIC CORRESPONDENCE

PERMITTEE
City of Palm Bay
250 Osmosis Drive SE
Palm Bay, FL 32909

PWS ID NUMBER: 3050442
PERMIT NUMBER: 0032426-378-WC
DATE OF ISSUANCE: April 28, 2020
EXPIRATION DATE: April 27, 2025
COUNTY: Brevard
PROJECT: Palm Bay South Regional Reverse Osmosis Water Treatment Plant (WTP) Expansion

This permit is issued under the provisions of Chapter 403, Florida Statutes (F.S.), and Florida Administrative Code (F.A.C.) Chapters 62-4, 62-550, 62-555, and 62-560. The above named permittee is hereby authorized to perform the work or operate the facility shown on the application and approved drawings, plans, and other documents attached hereto or on file with the Department and made a part hereof and specifically described as follows:

TO CONSTRUCT: Upgrades to the existing water supply, treatment, storage, and pumping facilities of the South Regional Reverse Osmosis (RO) WTP to expand the rated maximum day design capacity from 4 million gallons per day (MGD) to 6 MGD. The raw water supply will be designed to meet the proposed Maximum Day Demand (MDD) of 6.0 MGD with an 80 percent (%) recovery rate in the RO membrane process. The existing plant has raw water bypass facilities that allow raw water to bypass the RO process and blend with RO permeate. Approximately 12% to 13% of raw water bypass or 0.75 MGD of bypass capacity is proposed for the expansion. Based on this, the proposed RO permeate capacity is 5.25 MGD (1.75 MGD per skid), which will be blended with the 0.75 MGD raw water bypass and provide a total 6.0 MGD.

<u>The equipping and connecting of one new Floridan supply well will be submitted under a separate permit modification application.</u>

The following components are proposed under this permit:

1. Two (2) new reverse osmosis (RO) pretreatment cartridge filter units.
2. One (1) new RO feed pump and one (1) existing spare RO feed pump.
3. Two (2) new RO skids.
4. One (1) new finished water transfer pump.
5. One (1) new 2.0 MG finished water ground storage tank.
6. Two (2) new high service pumps.
7. One (1) new carbon dioxide storage and feed system.

8. Addition of one (1) new blower for the degasification system.
9. Expansion of electrical power and motor control center (MCC) facilities to accompany additional treatment
10. Instrumentation and controls for additional equipment and systems
11. Miscellaneous facility and process rehabilitation and improvements.

PROPOSED CONSTRUCTION INCLUDES THE FOLLOWING COMPONENTS:

1. One 2 million-gallon (MG) pre-stressed circular concrete ground storage tank with a diameter of 100 feet and height of 38.1 feet. General design of the tank shall meet the requirements in AWWA D110-95 Standard for Wire and Strand Wound Circular, Pre-stressed Concrete Water Tanks. The new GST shall be fitted/equipped per Chapter 7.0 of the Recommended Standards for Water Works. Paint shall be NSF 61 approved. The ground storage tank was sized in accordance with Chapter 62-555.320(19) F.A.C. to provide 25 percent of maximum day demand plus applicable fire flow. The GST will be located at Latitude 27°56’09.28” N and Longitude 80°40’15.43” W.

2. Two (2) new RO pretreatment horizontal cartridge filter units, in addition to the 3 existing, to provide additional filtering capacity prior to the RO process. The proposed cartridge filter units will be designed to match the unit capacity, orientation, ratings, and materials of construction of the existing cartridge filters. Additionally, the new cartridge filters will be installed in the existing RO process building and adjacent to the existing cartridge filters. The proposed cartridge filter has a maximum loading rate of 4.5 gallons per minute (GPM) per 10-inch cartridge. Total number of proposed filter units will allow at least one (1) cartridge vessel to be taken offline for cartridge replacement or maintenance at and still provide 10.0 MGD of design flow capacity.

3. The installation of two (2) additional 300 horsepower (HP) RO feed pumps is proposed to supply the additional feed flow required for the facility expansion. The unit capacity is 1,750 GPM at 530 feet total dynamic head (TDH). The addition of two (2) dedicated RO feed pumps and corresponding RO treatment skids will allow the facility to meet the design 7.5 million gallons per day (MGD) feed flow with one RO feed pump and membrane skid out of service. The two (2) additional pumps will consists of installing the existing uninstalled spare pump (Ruhrpumpen Model 14B160) and one (1) new RO feed pump. Since the proposed installed equipment will meet the design flow capacity with one unit out of service, an uninstalled spare pump is not proposed.

4. The installation of two (2) new RO treatment skids designed to match the existing RO membrane process with the exception of the membrane element area, which may differ slightly based upon current commercially available membrane elements. Provisions will be included in the RO membrane skid design to accommodate the installation of additional 0.25 MGD membrane treatment capacity per skid (0.75 MGD firm treatment capacity) in the unforeseen case that no raw water bypass is desired. The existing RO process currently utilizes Toray TMG20-430 RO membranes which are currently being phased out. Therefore, a standard 440-square feet (sq. ft.) membrane area per element is proposed. The addition of two (2) RO treatment skids will bring the total blended

permeate capacity up to 8.0 MGD, which will allow the facility to produce 6.0 MGD of treated water with one RO treatment skid out of service. The total installed 8.0 MGD of total blended permeate capacity will also allow future expansion to 8.0 MGD without the need to install an additional RO membrane skid as reliability would be provided by the uninstalled spare RO feed pump.

5. Improvements to the degasification and odor control system which included the installation of one forced draft degasifier with a capacity of 6 MGD with 20 percent overloading in addition to an existing degasifier. One centrifugal fan blower with a capacity of 15,000 cubic feet per minute will provide air to the proposed degasifier in addition to the two blowers in the existing degasifier. The air discharged from the degasifiers is routed through the odor control system to remove hydrogen sulfide, which prevents the potential for creation of nuisance odors and corrosion of adjacent structures. The addition of a third blower is proposed to maintain plant operations and satisfy the requirements for mechanical equipment redundancy. Adding one (1) additional blower will increase the firm capacity of the blowers to be capable of providing 30,000 cubic feet per minute (cfm) to treat the total 10.0 MGD degasification capacity with two (2) blowers in service and one (1) in standby.

   The addition of aluminum ladders and platforms for each of the degasifiers and scrubbers is also proposed to provide access for inspection of the vessels through the top access manways. The platforms and ladders will also provide additional safety measures during routine maintenance of the distribution laterals, nozzles, and packing support system. Ladders will either be provided with a fall arrest system or safety cage.

   The degasification and odor control system improvements will also include the installation of a hydrogen sulfide analyzer system. The addition of an analyzer system will provide monitoring of the concentration of hydrogen sulfide gas in the second stage scrubber outlet stream.

6. A new carbon dioxide storage and feed system is proposed to increase the buffering capacity of the treated water after degasification and allow the City to achieve a higher alkalinity in the finished water. The carbon dioxide solution feed system will consist of one (1) liquid carbon dioxide storage tank and accessories and one (1) pressurized solution feed panel and liquid solution diffuser assembly for post- degasification pH adjustment and stabilization. Additionally, the City is considering adding carbon dioxide prior to degasification as a replacement to sulfuric acid for reducing the pH for hydrogen sulfide removal.

   The 50-ton American Society of Mechanical Engineers (ASME) horizontal insulated steel pressure vessel/liquid carbon dioxide storage tank will be made of made of welded carbon steel and the tank nozzles and piping material will be Schedule 80, Type 304 stainless steel. The pre-degasifier and post degasifier 120 pounds per hour (lbs/hr.) feed panel will have a capacity range of 12 to 120 lbs./hr. and 5 to 120 lbs./hr., respectively. Both the solutions feeder will be pressurized. The solution feed panels will include static mixers to mix the water and carbon dioxide gas, a flow meter to measure the gas flow

rate, a control valve to control the gas flow rate and a programmable logic controller (PLC) to receive a 4-20 milliamp (mA) pacing signal from the supervisory control and data acquisition (SCADA) system to adjust the carbon dioxide feed rate in proportion to the process water flow and pH. Two (2) sets of duplex booster pumps (1 online and 1 standby) will be provided to maintain the necessary feed pressure to the panels. Both the pre degasifier and post degasifier carrier booster pumps will be vertical in-line centrifugal pumps with a capacity of 120 GPM each at a water feed pressure of 150 feet water (H_2O).

For the pre-degasifier application, the carbonic acid solution will be injected via a solution diffuser assembly near the existing sulfuric acid injection location within the combined permeate piping inside the process building. For the post-degasifier application, the carbonic acid solution will be injected via a solution diffuser assembly within the chlorine contact chamber dosing and splitter box.

7. Replacement of the existing chemical feed pumps. Two (2) new sodium hydroxide feed pumps each with a unit capacity of 15 gallons per hour (GPH) are proposed for pH adjustment of the finished water. One (1) new 12 GPH feed pump feed pump to replace one of the 3.16 GPH feed pumps is proposed for the odor control system's stage 1. The proposed chemical feed pumps will be hydraulically actuated diaphragm metering pumps, which are a positive displacement type feed pump. The turndown capacity of hydraulically actuated chemical feed pumps is typically high and would be able to cover the chemical feed range needed for the odor control system. In addition to the feed pump capacity upgrades, the following rehabilitation and improvements are proposed for the sodium hydroxide storage and feed system:
    a. Replacement of the sodium hydroxide feed room piping
    b. Replacement of the sodium hydroxide bulk storage tank piping
    c. Cleaning and inspection of the sodium hydroxide bulk storage tank

   Replacement of the existing caustic soda piping in the feed room has had leaks at multiple locations. Replacement of the associated instrumentation and piping appurtenances is also proposed. Lines associated with the tank are proposed to be replaced with like kind and size. The heat tracing and insulation for the caustic soda day tank supply line will also be replaced. Each chemical feed line is equipped with a spring loaded back pressure valve that will shut off flow if the pump is not in operation, and not permit chemicals to siphon into the process.

8. Transfer Pump Modifications- The installation of one (1) Goulds (Model VIT-FFFM 18LHXC, 1 Stage) 50 HP vertical turbine transfer pump within the existing clearwell is proposed to pump the design maximum daily flow of 6.0 MGD with one pump off-line. The pump will have a design capacity of 3,475 GPM or 5.0 MGD at 36 feet TDH to match the unit capacity of the existing transfer pumps. A 12-inch flush line will be included on the discharge line of the new transfer pump. The flush line off the transfer pump discharge will divert turbid water when a degasifier is brought back on-line. The flush line will terminate to a storm box adjacent to the clearwell to provide an air gap prior to discharging to the stormwater system.

9. Two Goulds (Model VIC-FLFM 14RHMC, 3 Stages) vertical turbine high service pumps (50 HP and 125 HP) each with a capacity of 2,222 GPM at 162 feet TDH.

10. Associated yard piping including the 12-inch PVC raw water main that will connect to future Well No. 5, the 24-inch PVC raw water main that will connect to the existing 24-inch raw water main, the new 2 MG GST 24-inch DI influent and 30-inch DI effluent pipe, the new 12-inch new high service pumps discharge pipes, and all other new yard piping.

11. Expansion of electrical power and motor control center (MCC) facilities to accompany additional treatment equipment listed above.

12. Instrumentation and controls for additional equipment and systems listed above and replacement of existing PLCs.

13. Miscellaneous facility and process rehabilitation and improvements.

The City of Palm Bay South Regional Water Treatment Plant is a Community Public Water System. **After the proposed improvements under this permit and after the equipping and connecting of one new Floridan supply well under a permit modification have been cleared for service by the Department**, the rated maximum day design capacity of the plant will be 6.0 MGD. The plant will be classified as Category II Class B. Accordingly staffing will be by Class C or higher operator; 16 hours per day for 7 days per week. The lead/chief operator must be Class B or higher.

IN ACCORDANCE WITH: The construction plans, engineering report, and specifications received on March 13, 2020 and the response to the RAI received on April 28, 2020.

LOCATION: The Palm Bay South Regional Reverse Osmosis WTP was constructed in 2006 within a City-owned property located at 250 Osmosis Drive SE in Palm Bay, Florida. The site is bounded by Osmosis Drive SE to the north, an undeveloped portion of Bayside Lakes on the east, Melbourne Tillman Drainage District Canal No. 37 on the west, and Port Malabar Development Unit 25 on the south.

This permit does not pertain to any wastewater, storm water, or dredge and fill aspects of the project. Work must be conducted in accordance with the General and Specific Conditions, attached hereto.

The permittee shall be aware of and operate under the Permit Conditions below. These applicable conditions are binding upon the permittee and enforceable pursuant to Chapter 403, F.S. [F.A.C. Rule 62-555.533(1)].

A. GENERAL CONDITIONS

1. The terms, conditions, requirements, limitations, and restrictions set forth in this permit, are "permit conditions" and are binding and enforceable pursuant to Sections 403.141, 403.727, or 403.859 through 403.861, F.S. The permittee is placed on notice that the Department will review this permit periodically and may initiate enforcement action for any violation of these conditions.

2. This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviation from the approved drawings, exhibits, specifications, or conditions of this permit may constitute grounds for revocation and enforcement action by the Department.

3. As provided in Subsections 403.087(6) and 403.722(5), F.S., the issuance of this permit does not convey any vested rights or any exclusive privileges. Neither does it authorize any injury to public or private property or any invasion of personal rights, nor any infringement of federal, state, or local laws or regulations. This permit is not a waiver of or approval of any other department permit that may be required for other aspects of the total project which are not addressed in this permit.

4. This permit conveys no title to land or water, does not constitute State recognition or acknowledgment of title, and does not constitute authority for the use of submerged lands unless herein provided and the necessary title or leasehold interests have been obtained from the State. Only the Trustees of the Internal Improvement Trust Fund may express State opinion as to title.

5. This permit does not relieve the permittee from liability for harm or injury to human health or welfare, animal, or plant life, or property caused by the construction or operation of this permitted source, or from penalties therefore; nor does it allow the permittee to cause pollution in contravention of Florida Statutes and Department rules, unless specifically authorized by an order from the Department.

6. The permittee shall properly operate and maintain the facility and systems of treatment and control (and related appurtenances) that are installed and used by the permittee to achieve compliance with the conditions of this permit, as required by Department rules. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to achieve compliance with the conditions of the permit and when required by Department rules.

7. The permittee, by accepting this permit, specifically agrees to allow authorized Department personnel, upon presentation of credentials or other documents as may be required by law and at reasonable times (reasonable time may depend on the nature of the concern being investigated), access to the premises where the permitted activity is located or conducted to:

    a. Have access to and copy any records that must be kept under conditions of the permit;

b. Inspect the facility, equipment, practices, or operations regulated or required under this permit; and

c. Sample or monitor any substances or parameters at any location reasonably necessary to assure compliance with this permit or Department rules.

8. If, for any reason, the permittee does not comply with or will be unable to comply with any condition or limitation specified in this permit, the permittee shall immediately provide the Department with the following information:

   a. A description of and cause of noncompliance; and

   b. The period of noncompliance, including dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate, and prevent recurrence of the noncompliance. The permittee shall be responsible for any and all damages which may result and may be subject to enforcement action by the Department for penalties or for revocation of this permit.

9. In accepting this permit, the permittee understands and agrees that all records, notes, monitoring data and other information relating to the construction or operation of this permitted source which are submitted to the Department may be used by the Department as evidence in any enforcement case involving the permitted source arising under the Florida Statutes or Department rules, except where such use is prescribed by Sections 403.111 and 403.73, F.S. Such evidence shall only be used to the extent it is consistent with the Florida Rules of Civil Procedure and appropriate evidentiary rules.

10. The permittee agrees to comply with changes in Department rules and Florida Statutes after a reasonable time for compliance; provided, however, the permittee does not waive any other rights granted by Florida Statutes or Department rules. A reasonable time for compliance with a new or amended surface water quality standard, other than those standards addressed in Rule 62-302.500, F.A.C., shall include a reasonable time to obtain or be denied a mixing zone for the new or amended standard.

11. This permit is transferable only upon Department approval in accordance with Rules 62-4.120 and 62-730.300, F.A.C., as applicable. The permittee shall be liable for any non-compliance of the permitted activity until the transfer is approved by the Department.

12. This permit or a copy thereof shall be kept at the work site of the permitted activity.

13. This permit also constitutes:

    a. Determination of Best Available Control Technology (BACT)
    b. Determination of Prevention of Significant Deterioration (PSD)
    c. Certification of compliance with State Water Quality Standards (Section 401, PL 92-500)
    d. Compliance with New Source Performance Standards

14. The permittee shall comply with the following:

a. Upon request, the permittee shall furnish all records and plans required under Department rules. During enforcement actions, the retention period for all records will be extended automatically unless otherwise stipulated by the Department.

b. The permittee shall hold at the facility or other location designated by this permit records of all monitoring information (including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation) required by the permit, copies of all reports required by this permit, and records of all data used to complete the application for this permit. These materials shall be retained at least three years from the date of the sample, measurement, report, or application unless otherwise specified by Department rule.

c. Records of monitoring information shall include:
   i. the date, exact place, and time of sampling or measurements;
   ii. the person responsible for performing the sampling or measurements;
   iii. the dates analyses were performed;
   iv. the person responsible for performing the analyses;
   v. the analytical techniques or methods used;
   vi. the results of such analyses.

15. When requested by the Department, the permittee shall within a reasonable time furnish any information required by law which is needed to determine compliance with the permit. If the permittee becomes aware the relevant facts were not submitted or were incorrect in the permit application or in any report to the Department, such facts or information shall be corrected promptly.

SPECIFIC CONDITIONS

B. Construction Activities

1. Permit Modification

All construction must be in accordance with this permit. Before commencing work on project changes for which a construction permit modification is required pursuant to Rule 62-555.536(1), F.A.C., the permittee shall submit to the Department a written request for a permit modification. Each such request shall be accompanied by one copy of a revised construction permit application, the proper processing fee and one copy of either a revised preliminary design report or revised drawings, specifications and design data. [F.A.C. Rule 62-555.536].

2. Professional Engineer Supervision

Permitted construction or alteration of public water supply systems must be supervised during construction by a professional engineer registered in the State of Florida if the project was designed under the responsible charge of a professional engineer licensed in

the State of Florida. The permittee must retain the service of a professional engineer registered in the State of Florida to observe that construction of the project is in accordance with the engineering plans and specifications as submitted in support of the application for this permit. [F.A.C. Rule 62-555.520(3)].

3. Artifacts

If prehistoric or historic artifacts, such as pottery or ceramics, stone tools or metal implements, dugout canoe remains, or any other physical remains that could be associated with Native American cultures, or early colonial or American settlement are encountered at any time within the project site area, the permitted project should cease all activities involving subsurface disturbance in the immediate vicinity of such discoveries. The permittee, or other designee, should contact the Florida Department of State, Division of Historical Resources, Compliance and Review Section by telephone at 850.245.6333 or 800.847.7278, as well as the appropriate permitting agency office. Project activities should not resume without verbal and/or written authorization from the Division of Historical Resources and the permitting agency. In the event that unmarked human remains are encountered during permitted activities, all work shall stop immediately and the proper authorities notified in accordance with Section 872.05, F.S.

4. Delays and Extension of Permit

If delays will cause project completion to extend beyond the expiration date of this permit, the permittee shall submit to the Department a request to extend the expiration date of this permit including the appropriate processing fee. This request shall specify the reasons for the delay and shall be submitted to the Department for approval prior to the expiration date of this permit. Note that no specific construction permit shall be extended so as to remain in effect longer than five years. [F.A.C. Rule 62-555.536(4)].

5. Permit Transfer

In accordance with General Condition #11 of this permit, this permit is transferable only upon Department approval. Persons proposing to transfer this permit must apply jointly for a transfer of the permit within 30 days after the sale or legal transfer of ownership of the permitted project that has not been cleared for service by the Department using form, 62-555.900(8), Application for Transfer of a PWS Construction Permit along with the appropriate fee. [F.A.C. Rule 62-555.536(5)]

6. Obligation to Obtain Other Permits

This permit satisfies Drinking Water permitting requirements only and does not authorize construction or operation of this facility prior to obtaining all other necessary permits from other program areas within the Department, or required permits from other state, federal, or local agencies.

7. Limits on Authorizing Connections

This permit is for CONSTRUCTION ONLY of the components found on Page 1 of this permit. This permit shall not infer that the clearance necessary for connection will be granted. Partial clearance may be granted, if required.

8. Contamination

If contamination is found at the construction site, work shall be stopped and the proper authorities notified. With the approval of the Department, ductile iron pipe and fittings, and solvent resistant gaskets materials shall be used in the contaminated area. The ductile iron pipe shall extend 100 feet beyond any solvent noted. Any contaminated soil that is excavated shall be placed on an impermeable mat, covered with waterproof covering, and held for disposal. If the site cannot be properly cleaned, then consultation with the Department is necessary prior to continuing with the project construction.

9. Wetlands Jurisdiction

This permit does not constitute approval of construction on jurisdictional wetland areas; therefore, such approval must be obtained separately from the Water Management District or from DEP Environmental Resource Permitting (ERP) Section, as applicable. Permittee shall provide a copy of the permit approval to the Department when water main installation involves activities on wetlands.

10. Security

Permittee shall ensure that the well and drinking water treatment facilities will be protected to prevent tampering, vandalism, and sabotage as required by Rules 62-555.315(1) and 62-555.320(5), F.A.C.

C. Construction Standards

1. National Sanitation Foundation (NSF)

All products, including paints, which shall come into contact with potable water, either directly or indirectly, shall conform to National Sanitation Foundation (NSF) International, Water Chemicals Codex, Food Chemicals Codex, American Water Works Association (AWWA) Standards and the Food and Drug Administration, as provided in Rule 62-555.320(3), F.A.C.

2. American Water Works Association (AWWA)

Water supply facilities, including mains, pipe, fittings, valves, fire hydrants, and other materials shall be installed in accordance with the latest applicable AWWA Standards and Department rules and regulations. The system shall be pressure and leak tested in accordance with AWWA Standard C600 C603, or C605, as applicable, and disinfected in accordance with AWWA Standard C651-653, as well as in accordance with Rule 62-555.340, F.A.C.

3. Lead Free

The installation or repairs of any public water system, or any plumbing in residential or nonresidential facilities providing water for human consumption, which is connected to a public water system shall be lead free in accordance with Rule 62-555.322, F.A.C.

4. Asbestos

If any existing asbestos cement (AC) pipes are replaced under this permit, the permittee shall do so in accordance with the applicable rules of Federal Asbestos Regulation and Florida DEP requirements. For specific requirements applicable to AC pipes, the permittee should contact the Central District Office by telephone at (407) 897-4100 prior to commencing any such activities. Please be aware that a notification is required to be submitted to the Department at least 10 days prior to the start of a regulated project.

5. Hazard and Reuse Setbacks

Setback distances between potable water wells and sanitary hazards shall be in accordance with Rule 62-555.312, F.A.C. Reclaimed water land application areas, if applicable, must not be located within the setback distance from potable water supply wells established in Chapter 62-610, F.A.C.

6. Line Separation

Permittee shall maintain vertical clearance and horizontal separation between water mains and sanitary sewers, storm sewers, etc. unless approved otherwise by the Department, as provided in Rule 62-555.314, F.A.C., and Section 8.6 of *Recommended Standards for Water Works*, a manual adopted by reference in Rule 62-555.330(3), F.A.C.

7. Color Coding of Pipes

The new or altered aboveground piping at the drinking water treatment plant shall be color coded and labeled as recommended in Section 2.14 of "Recommended Standards for Water Works, 1997 Edition". [F.A.C. Rule 62-555.320(10)]

8. Cross Connections

Permittee shall ensure that there shall be no cross-connection with any non-potable water source in accordance with Rule 62-555.360, F.A.C.

D. Operational Requirements

1. Staffing

The City of Palm Bay South Regional Water Treatment Plant is a Community Public Water System. After the proposed improvements under this permit and after the equipping and connecting of one new Floridan supply well under a permit modification have been cleared for service by the Department, the rated maximum day design capacity of the plant will be 6.0 MGD. The plant will be classified as Category II Class B. Accordingly staffing will be by Class C or higher operator; 16 hours per day for 7 days per week. The lead/chief operator must be Class B or higher. [F.A.C. Rule 62-699.310]

2. Operation and Maintenance to comply with Water Quality Standards

The supplier of water shall operate and maintain the public water system so as to comply with applicable standards in Chapter 62-550 and Rule 62-555.350, F.A.C.

3. Operation and Maintenance Manual

The permittee shall provide an operation and maintenance manual for the new or altered treatment facilities to fulfill the requirements under Rule 62-555.350(13), F.A.C. The manual shall contain operation and control procedures, and preventative maintenance and repair procedures, for all plant equipment and shall be made available for reference at the plant or at a convenient location near the plant. Bound and indexed equipment manufacturer manuals shall be considered sufficient to meet the requirements of the subsection.

4. Monthly Operating Reports (MORs)

The permittee shall submit monthly operation reports (MORs), DEP Form 62-555.900(3), for the groundwater treatment, to the Department, no later than the tenth of each succeeding month. Systems with multiple treatment plants must also submit DEP Form 62-555.900(11) entitled "Monthly Operation Report for Summation of Finished-Water Production by CWSs That Have Multiple Treatment Plants."

5. Record Drawings

The permittee shall have complete record drawings produced for the project in accordance with Rule 62-555.530(4), F.A.C.

6. State Watch Office

The permittee or suppliers of water shall telephone the State Watch Office (SWO), at 1-800-320-0519 immediately (i.e., within two hours) after discovery of any actual or suspected sabotage or security breach, or any suspicious incident, involving a public water system in accordance with Rule 62-555.350(10), F.A.C.

E. Monitoring Provisions

1. Compliance Monitoring by System Type

Permittee shall follow the guidelines of Chapters 62-550, 62-555, and 62-560, F.A.C., regarding public drinking water system standards, monitoring, reporting, permitting, construction, and operation.

This facility is a Community Water System as defined in Rule 62-550.200(12), F.A.C., and shall comply with the applicable chemical, radiological, lead and copper, and bacteriological monitoring requirements of Chapter 62-550, F.A.C. Such requirements shall be initiated within the quarter that the water treatment facility is placed into service (i.e. January—March or April—June, the preceding are examples of quarters) and the results submitted to the Department.

2. Combined Chlorine Residual

The Water Treatment Plant shall maintain throughout the distribution system, a minimum continuous and effective minimum combined chlorine residual of 0.6 mg/L. A minimum

system pressure of 20 psi must be maintained throughout the system. Also, safety equipment shall be provided and located outside of chlorine room.

F. Clearance Requirements

1. Clearance Letter

The permittee must instruct the engineer of record to request system clearance from the Department within sixty (60) days of completion of construction, testing and disinfecting the system. Bacteriological test results shall be considered unacceptable if the test were completed more than 60 days before the Department received the results. [F.A.C. Rule 62-555.340(2)(c)]

Permitted construction or alteration of a public water system may not be placed into service until a letter of clearance has been issued by this Department. [F.A.C. Rule 62-555.345]

2. Requirements to Obtain Clearance

After submitting the permit clearance package, the permittee shall contact the Department by telephone at 407.897.4100 or by email at DEP_CD@dep.state.fl.us to establish a date/time for an inspection of the components contained in this permit.

a. The engineer's *Certification of Construction Completion and Request for Clearance to Place Permitted PWS Components Into Operation* {DEP Form 62-555.900(9)};

b. Copy of a satisfactory pressure test of the process piping, performed in accordance with AWWA Standards. [F.A.C. Rule 62-555.320(21)(a)(1)]

c. Analytical results from two consecutive days of satisfactory bacteriological samples from locations found in paragraph 3 below.

d. Submit the 100 percent signed and sealed final construction drawings and technical specifications

e. Provide evidence that the required operation and maintenance manual for the water treatment plant is in place, which will be updated thereafter as necessary to reflect plant modifications. The manual shall contain operation and control procedures, and preventive maintenance and repair procedures, for all plant equipment and shall be made available for reference at the plant or at a convenient location near the plant. Bound and indexed equipment manufacturer manuals shall be considered sufficient to meet the requirements of this subsection. [F.A.C. 62-555.350 (13)].

f. Photographs of above ground WTP components.

3. Cleaning, Disinfecting, and Bacteriological Samples

The new facilities shall be cleaned, disinfected, and bacteriologically cleared in accordance with Chapter 62-555, F.A.C. The bacteriological clearance data shall be submitted to the Department with the engineer's certification of construction completion. [F.A.C. 62-555.340 and 62-555.315(6)(b),]. The engineer-of-record shall submit a

sampling plan showing the location of the bacteriological sampling points, considering the following locations:

a. At the end of the 12-inch PVC raw water main that will connect to future Well No. 5.
b. At the end of the 24-inch PVC raw water main that will connect to the existing 24-inch raw water main.
c. At the new 2 MG GST 24-inch DI influent and 30-inch DI effluent pipe.
d. At the new 12-inch new high service pumps discharge pipes.
e. All other new yard piping.

Each location shall be sampled on two separate days (at least 6 hours apart) with sample point locations and chlorine residual readings clearly indicated on the report and/or drawings. A sketch or description of all bacteriological sampling locations must be provided.

Bacteriological sample results will be considered unacceptable if the tests were completed more than 60 days before the Department received the results.

Each location shall be sampled on two separate days (at least 6 hours apart) with sample point locations and chlorine residual readings clearly indicated on the report and/or drawings.

In order to facilitate the issuance of a letter of clearance, the Department requests that all of the above information be submitted as one package.

Please submit the entire clearance document package in electronic format to DEP_CD@dep.state.fl.us. If the file is very large, you may post it to the Water Electronic Submittal folder on the Central District's ftp site at:

ftp://ftp.dep.state.fl.us/pub/incoming/Central_District/Water%20Electronic%20Applications.

After posting the document, send an e-mail to DEP_CD@dep.state.fl.us, alerting the Department that it has been posted.

Any submitted drawings (should be sized 11" x 17") and the engineer of record's signed seal and dates on the required document must be legible for acceptance.

Forms: http://www.dep.state.fl.us/water/drinkingwater/forms.htm

STATE OF FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Erin Rasnake

_____

Erin Rasnake
Program Administrator
Permitting and Waste Cleanup Program

St. Johns River
Water Management District
Ann B. Shortelle, Ph.D., Executive Director

4049 Reid Street • P.O. Box 1429 • Palatka, FL 32178-1429 • 386-329-4500
On the internet at www.sjrwmd.com.

April 16, 2020

City of Palm Bay – *Sent via email:* Christopher.Little@palmbayflorida.org

SUBJECT: Permit Number: 87977-5
Project Name: South Regional WRF

Dear Sir/Madam:

Enclosed is your individual permit issued by the St. Johns River Water Management District on April 16, 2020. This permit is a legal document and should be kept with your other important documents. Permit issuance does not relieve you from the responsibility of obtaining any necessary permits from any federal, state, or local agencies for your project.

Technical Staff Report:
If you wish to review a copy of the Technical Staff Report (TSR) that provides the District's staff analysis of your permit application, you may view the TSR by going to the Permitting section of the District's website at www.sjrwmd.com/permitting. Using the "search applications and permits" feature, you can use your permit number or project name to find information about the permit. When you see the results of your search, click on the permit number and then on the TSR folder.

Noticing Your Permit:
For noticing instructions, please refer to the noticing materials in this package regarding closing the point of entry for someone to challenge the issuance of your permit. Please note that if a timely petition for administrative hearing is filed, your permit will become non-final and any activities that you choose to undertake pursuant to your permit will be at your own risk. Please refer to the attached Notice of Rights to determine any legal rights you may have concerning the District's agency action.

Compliance with Permit Conditions:
To submit your required permit compliance information, go to the District's website at www.sjrwmd.com/permitting. Under the "Apply for a permit or submit compliance data" section, click to sign-in to your existing account or to create a new account. Select the "Compliance Submittal" tab, enter your permit number, and select "No Specific Date" for the Compliance Due Date Range. You will then be able to view all the compliance submittal requirements for your project. Select the compliance item that you are ready to submit and then attach the appropriate information or form. The forms to comply with your permit conditions are available at www.sjrwmd.com/permitting under the section "Handbooks, forms, fees, final orders". Click on forms to view all permit compliance forms, then scroll to the ERP application forms section and select the applicable compliance forms. Alternatively, if you have difficulty finding forms or need copies of the appropriate forms, please contact the Bureau of Regulatory Support at (386) 329-4570.

Transferring Your Permit:
Your permit requires you to notify the District within 30 days of any change in ownership or control of the project or activity covered by the permit, or within 30 days of any change in ownership or control of the real property on which the permitted project or activity is located or occurs. You will need to provide the District with the information specified in rule 62-330.340, Florida Administrative Code (F.A.C.). Generally, this will require you to complete and submit Form 62-330.340(1), "Request to Transfer Permit," available at http://www.sjrwmd.com/permitting/permitforms.html.

Please note that a permittee is liable for compliance with the permit before the permit is transferred. The District, therefore, recommends that you request a permit transfer in advance in accordance with the applicable rules. You are encouraged to contact District staff for assistance with this process.

Thank you and please let us know if you have additional questions. For general questions contact e-permit@sjrwmd.com or (386) 329-4570.

Sincerely,

Michelle Reiber, Bureau Chief
Division of Regulatory Services
St. Johns River Water Management District
525 Community College Parkway, S.E.
Palm Bay, FL 32909
(321) 409-2129

Enclosures: Permit
Notice of Rights
List of Newspapers for Publication

cc: District Permit File
Consultant: Burl Reardon - Tetra Tech – *Sent via email*

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
Post Office Box 1429
Palatka, Florida 32178-1429

PERMIT NO: 87977-5 **DATE ISSUED:** April 16, 2020

PROJECT NAME: South Regional WRF

A PERMIT AUTHORIZING:
Minor Modification of Permit No. 87977-4 for South Regional WRF to include the construction and operation of a 0.33-acre project as per plans received by the District on March 19, 2020.

LOCATION:
Section(s): 30 Township(s): 29S Range(s): 37E
Brevard County

Receiving Water Body:

Name	Class
Turkey Creek	III Fresh, IW

ISSUED TO:
City of Palm Bay
250 Osmosis Dr SE
Palm Bay, FL 32909-2356

The permittee agrees to hold and save the St. Johns River Water Management District and its successors harmless from any and all damages, claims, or liabilities which may arise from permit issuance. Said application, including all plans and specifications attached thereto, is by reference made a part hereof.

This permit does not convey to the permittee any property rights nor any rights or privileges other than those specified herein, nor relieve the permittee from complying with any law, regulation or requirement affecting the rights of other bodies or agencies. All structures and works installed by permittee hereunder shall remain the property of the permittee.

This permit may be revoked, modified or transferred at any time pursuant to the appropriate provisions of Chapter 373, Florida Statutes.

PERMIT IS CONDITIONED UPON:

See conditions on attached “Exhibit A”, dated April 16, 2020

AUTHORIZED BY: St. Johns River Water Management District
Division of Regulatory Services

By: Marjorie D. Cook

Marjorie Cook
Supervising Professional Engineer

"EXHIBIT A"
CONDITIONS FOR ISSUANCE OF PERMIT NUMBER 87977-5
South Regional WRF
DATED: April 16, 2020

1. All activities shall be implemented following the plans, specifications and performance criteria approved by this permit. Any deviations must be authorized in a permit modification in accordance with Rule 62-330.315, F.A.C. Any deviations that are not so authorized may subject the permittee to enforcement action and revocation of the permit under Chapter 373, F.S.

2. A complete copy of this permit shall be kept at the work site of the permitted activity during the construction phase, and shall be available for review at the work site upon request by the District staff. The permittee shall require the contractor to review the complete permit prior to beginning construction.

3. Activities shall be conducted in a manner that does not cause or contribute to violations of state water quality standards. Performance-based erosion and sediment control best management practices shall be installed immediately prior to, and be maintained during and after construction as needed, to prevent adverse impacts to the water resources and adjacent lands. Such practices shall be in accordance with the State of Florida Erosion and Sediment Control Designer and Reviewer Manual (Florida Department of Environmental Protection and Florida Department of Transportation June 2007), and the Florida Stormwater Erosion and Sedimentation Control Inspector's Manual (Florida Department of Environmental Protection, Nonpoint Source Management Section, Tallahassee, Florida, July 2008), which are both incorporated by reference in subparagraph 62-330.050(9)(b)5, F.A.C., unless a project-specific erosion and sediment control plan is approved or other water quality control measures are required as part of the permit.

4. At least 48 hours prior to beginning the authorized activities, the permittee shall submit to the District a fully executed Form 62-330.350(1), "Construction Commencement Notice," (October 1, 2013) (http://www.flrules.org/Gateway/reference.asp?No=Ref-02505), incorporated by reference herein, indicating the expected start and completion dates. A copy of this form may be obtained from the District, as described in subsection 62-330.010(5), F.A.C., and shall be submitted electronically or by mail to the Agency. However, for activities involving more than one acre of construction that also require a NPDES stormwater construction general permit, submittal of the Notice of Intent to Use Generic Permit for Stormwater Discharge from Large and Small Construction Activities, DEP Form 62-621.300(4)(b), shall also serve as notice of commencement of construction under this chapter and, in such a case, submittal of Form 62-330.350(1) is not required.

5. Unless the permit is transferred under Rule 62-330.340, F.A.C., or transferred to an operating entity under Rule 62-330.310, F.A.C., the permittee is liable to comply with the plans, terms and conditions of the permit for the life of the project or activity.

6. Within 30 days after completing construction of the entire project, or any independent portion of the project, the permittee shall provide the following to the Agency, as applicable:

    a. For an individual, private single-family residential dwelling unit, duplex, triplex, or quadruplex — "Construction Completion and Inspection Certification for Activities Associated with a Private Single-Family Dwelling Unit" [Form 62-330.310(3)]; or

    b. For all other activities — "As-Built Certification and Request for Conversion to

Operation Phase" [Form 62-330.310(1)].

c. If available, an Agency website that fulfills this certification requirement may be used in lieu of the form.

7. If the final operation and maintenance entity is a third party:

   a. Prior to sales of any lot or unit served by the activity and within one year of permit issuance, or within 30 days of as-built certification, whichever comes first, the permittee shall submit, as applicable, a copy of the operation and maintenance documents (see sections 12.3 thru 12.3.4 of Volume I) as filed with the Florida Department of State, Division of Corporations and a copy of any easement, plat, or deed restriction needed to operate or maintain the project, as recorded with the Clerk of the Court in the County in which the activity is located.

   b. Within 30 days of submittal of the as- built certification, the permittee shall submit "Request for Transfer of Environmental Resource Permit to the Perpetual Operation and Maintenance Entity" [Form 62-330.310(2)] to transfer the permit to the operation and maintenance entity, along with the documentation requested in the form. If available, an Agency website that fulfills this transfer requirement may be used in lieu of the form.

8. The permittee shall notify the District in writing of changes required by any other regulatory District that require changes to the permitted activity, and any required modification of this permit must be obtained prior to implementing the changes.

9. This permit does not:

   a. Convey to the permittee any property rights or privileges, or any other rights or privileges other than those specified herein or in Chapter 62-330, F.A.C.;

   b. Convey to the permittee or create in the permittee any interest in real property;

   c. Relieve the permittee from the need to obtain and comply with any other required federal, state, and local authorization, law, rule, or ordinance; or

   d. Authorize any entrance upon or work on property that is not owned, held in easement, or controlled by the permittee.

10. Prior to conducting any activities on state-owned submerged lands or other lands of the state, title to which is vested in the Board of Trustees of the Internal Improvement Trust Fund, the permittee must receive all necessary approvals and authorizations under Chapters 253 and 258, F.S. Written authorization that requires formal execution by the Board of Trustees of the Internal Improvement Trust Fund shall not be considered received until it has been fully executed.

11. The permittee shall hold and save the District harmless from any and all damages, claims, or liabilities that may arise by reason of the construction, alteration, operation, maintenance, removal, abandonment or use of any project authorized by the permit.

12. The permittee shall notify the District in writing:

    a. Immediately if any previously submitted information is discovered to be inaccurate; and

b. Within 30 days of any conveyance or division of ownership or control of the property or the system, other than conveyance via a long-term lease, and the new owner shall request transfer of the permit in accordance with Rule 62-330.340, F.A.C. This does not apply to the sale of lots or units in residential or commercial subdivisions or condominiums where the stormwater management system has been completed and converted to the operation phase.

13. Upon reasonable notice to the permittee, District staff with proper identification shall have permission to enter, inspect, sample and test the project or activities to ensure conformity with the plans and specifications authorized in the permit.

14. If prehistoric or historic artifacts, such as pottery or ceramics, projectile points, stone tools, dugout canoes, metal implements, historic building materials, or any other physical remains that could be associated with Native American, early European, or American settlement are encountered at any time within the project site area, the permitted project shall cease all activities involving subsurface disturbance in the vicinity of the discovery. The permittee or other designee shall contact the Florida Department of State, Division of Historical Resources, Compliance Review Section (DHR), at (850) 245-6333, as well as the appropriate permitting agency office. Project activities shall not resume without verbal or written authorization from the Division of Historical Resources. If unmarked human remains are encountered, all work shall stop immediately and the proper authorities notified in accordance with Section 872.05, F.S. For project activities subject to prior consultation with the DHR and as an alternative to the above requirements, the permittee may follow procedures for unanticipated discoveries as set forth within a cultural resources assessment survey determined complete and sufficient by DHR and included as a specific permit condition herein.

15. Any delineation of the extent of a wetland or other surface water submitted as part of the permit application, including plans or other supporting documentation, shall not be considered binding unless a specific condition of this permit or a formal determination under Rule 62-330.201, F.A.C., provides otherwise.

16. The permittee shall provide routine maintenance of all components of the stormwater management system to remove trapped sediments and debris. Removed materials shall be disposed of in a landfill or other uplands in a manner that does not require a permit under Chapter 62-330, F.A.C., or cause violations of state water quality standards.

17. This permit is issued based on the applicant's submitted information that reasonably demonstrates that adverse water resource-related impacts will not be caused by the completed permit activity. If any adverse impacts result, the District will require the permittee to eliminate the cause, obtain any necessary permit modification, and take any necessary corrective actions to resolve the adverse impacts.

18. A Recorded Notice of Environmental Resource Permit may be recorded in the county public records in accordance with Rule 62-330.090(7), F.A.C. Such notice is not an encumbrance upon the property.

19. All wetland areas or water bodies that are outside the specific limits of construction authorized by this permit must be protected from erosion, siltation, scouring or excess turbidity, and dewatering.

20. This permit does not authorize the permittee to cause any adverse impact to or "take" of state listed species and other regulated species of fish and wildlife. Compliance with state laws regulating the take of fish and wildlife is the responsibility of the owner or applicant associated with this project. Please refer to Chapter 68A-27 of the Florida Administrative Code for definitions of "take" and a list of fish and wildlife species. If listed species are

observed onsite, FWC staff are available to provide decision support information or assist in obtaining the appropriate FWC permits. Most marine endangered and threatened species are statutorily protected and a “take” permit cannot be issued. Requests for further information or review can be sent to FWCConservationPlanningServices@MyFWC.com.

21. This permit for construction will expire five years from the date of issuance.

22. The operation and maintenance entity shall inspect the stormwater or surface water management system once within two years after the completion of construction and every two years thereafter to determine if the system is functioning as designed and permitted. The operation and maintenance entity must maintain a record of each required inspection, including the date of the inspection, the name and contact information of the inspector, and whether the system was functioning as designed and permitted, and make such record available for inspection upon request by the District during normal business hours. If at any time the system is not functioning as designed and permitted, then within 30 days the entity shall submit a report electronically or in writing to the District using Form 62-330.311(1), “Operation and Maintenance Inspection Certification,” describing the remedial actions taken to resolve the failure or deviation.

23. The proposed project must be constructed and operated as per plans and calculations received by the District on March 19, 2020.

24. This permit does not authorize any impacts to wetlands or other surface waters.

Notice of Rights

1. A person whose substantial interests are or may be affected has the right to request an administrative hearing by filing a written petition with the St. Johns River Water Management District (District). Pursuant to Chapter 28-106 and Rule 40C-1.1007, Florida Administrative Code, the petition must be filed (received) either by delivery at the office of the District Clerk at District Headquarters, P. O. Box 1429, Palatka Florida 32178-1429 (4049 Reid St., Palatka, FL 32177) or by e-mail with the District Clerk at Clerk@sjrwmd.com, within twenty-six (26) days of the District depositing the notice of District decision in the mail (for those persons to whom the District mails actual notice), within twenty-one (21) days of the District emailing the notice of District decision (for those persons to whom the District emails actual notice), or within twenty-one (21) days of newspaper publication of the notice of District decision (for those persons to whom the District does not mail or email actual notice). A petition must comply with Sections 120.54(5)(b)4. and 120.569(2)(c), Florida Statutes, and Chapter 28-106, Florida Administrative Code. The District will not accept a petition sent by facsimile (fax), as explained in paragraph no. 4 below.

2. Please be advised that if you wish to dispute this District decision, mediation may be available and that choosing mediation does not affect your right to an administrative hearing. If you wish to request mediation, you must do so in a timely-filed petition. If all parties, including the District, agree to the details of the mediation procedure, in writing, within 10 days after the time period stated in the announcement for election of an administrative remedy under Sections 120.569 and 120.57, Florida Statutes, the time limitations imposed by Sections 120.569 and 120.57, Florida Statutes, shall be tolled to allow mediation of the disputed District decision. The mediation must be concluded within 60 days of the date of the parties' written agreement, or such other timeframe agreed to by the parties in writing. Any mediation agreement must include provisions for selecting a mediator, a statement that each party shall be responsible for paying its pro-rata share of the costs and fees associated with mediation, and the mediating parties' understanding regarding the confidentiality of discussions and documents introduced during mediation. If mediation results in settlement of the administrative dispute, the District will enter a final order consistent with the settlement agreement. If mediation terminates without settlement of the dispute, the District will notify all the parties in writing that the administrative hearing process under Sections 120.569 and 120.57, Florida Statutes, is resumed. Even if a party chooses not to engage in formal mediation, or if formal mediation does not result in a settlement agreement, the District will remain willing to engage in informal settlement discussions.

3. A person whose substantial interests are or may be affected has the right to an informal administrative hearing pursuant to Sections 120.569 and 120.57(2), Florida Statutes, where no material facts are in dispute. A petition for an informal hearing must also comply with the requirements set forth in Rule 28-106.301, Florida Administrative Code.

Notice of Rights

4. A petition for an administrative hearing is deemed filed upon receipt of the complete petition by the District Clerk at the District Headquarters in Palatka, Florida during the District's regular business hours. The District's regular business hours are 8:00 a.m. – 5:00 p.m., excluding weekends and District holidays. Petitions received by the District Clerk after the District's regular business hours shall be deemed filed as of 8:00 a.m. on the District's next regular business day. The District's acceptance of petitions filed by e-mail is subject to certain conditions set forth in the District's Statement of Agency Organization and Operation (issued pursuant to Rule 28-101.001, Florida Administrative Code), which is available for viewing at *sjrwmd.com*. These conditions include, but are not limited to, the petition being in the form of a PDF or TIFF file and being capable of being stored and printed by the District. Further, pursuant to the District's Statement of Agency Organization and Operation, attempting to file a petition by facsimile is prohibited and shall not constitute filing.

5. Failure to file a petition for an administrative hearing within the requisite timeframe shall constitute a waiver of the right to an administrative hearing. (Rule 28-106.111, Florida Administrative Code).

6. The right to an administrative hearing and the relevant procedures to be followed are governed by Chapter 120, Florida Statutes, Chapter 28-106, Florida Administrative Code, and Rule 40C-1.1007, Florida Administrative Code. Because the administrative hearing process is designed to formulate final agency action, the filing of a petition means the District's final action may be different from the position taken by it in this notice. A person whose substantial interests are or may be affected by the District's final action has the right to become a party to the proceeding, in accordance with the requirements set forth above.

7. Pursuant to Section 120.68, Florida Statutes, a party to the proceeding before the District who is adversely affected by final District action may seek review of the action in the District Court of Appeal by filing a notice of appeal pursuant to Rules 9.110 and 9.190, Florida Rules of Appellate Procedure, within 30 days of the rendering of the final District action.

8. A District action is considered rendered, as referred to in paragraph no. 7 above, after it is signed on behalf of the District and filed by the District Clerk.

9. Failure to observe the relevant timeframes for filing a petition for judicial review as described in paragraph no. 7 above will result in waiver of that right to review.

NOTICING INFORMATION

Please be advised that the St. Johns River Water Management District will not publish a notice in the newspaper advising the public that it has issued a permit for this project.

Newspaper publication, using the District's notice form, notifies members of the public of their right to challenge the issuance of the permit. If proper notice is given by newspaper publication, then there is a 21-day time limit for someone to file a petition for an administrative hearing to challenge the issuance of the permit.

To close the point of entry for filing a petition, you may publish (at your own expense) a one-time notice of the District's decision in a newspaper of general circulation within the affected area as defined in Section 50.011 of the Florida Statutes. If you do not publish a newspaper notice to close the point of entry, the time to challenge the issuance of your permit will not expire and someone could file a petition even after your project is constructed.

A copy of the notice form and a partial list of newspapers of general circulation are attached for your convenience. However, you are not limited to those listed newspapers. If you choose to close the point of entry and the notice is published, the newspaper will return to you an affidavit of publication. In that event, it is important that you either submit a scanned copy of the affidavit by emailing it to *compliancesupport@sjrwmd.com* (preferred method) **or** send a copy of the original affidavit to:

Office of Business and Administrative Services
4049 Reid Street
Palatka, FL 32177

If you have any questions, please contact the Office of Business and Administrative Services at (386) 329-4570.

NOTICE OF AGENCY ACTION TAKEN BY THE
ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

Notice is given that the following permit was issued on _____:

(Name and address of applicant)_____
permit#_____. The project is located in _____County, Section _____, Township _____ South, Range _____ East. The permit authorizes a surface water management system on _____ acres for _____ known as _____. The receiving water body is _____.

A person whose substantial interests are or may be affected has the right to request an administrative hearing by filing a written petition with the St. Johns River Water Management District (District). Pursuant to Chapter 28-106 and Rule 40C-1.1007, Florida Administrative Code (F.A.C.), the petition must be filed (received) either by delivery at the office of the District Clerk at District Headquarters, P.O. Box 1429, Palatka FL 32178-1429 (4049 Reid St, Palatka, FL 32177) or by e-mail with the District Clerk at Clerk@sjrwmd.com, within twenty-one (21) days of newspaper publication of the notice of District decision (for those persons to whom the District does not mail or email actual notice). A petition must comply with Sections 120.54(5)(b)4. and 120.569(2)(c), Florida Statutes (F.S.), and Chapter 28-106, F.A.C. The District will not accept a petition sent by facsimile (fax). Mediation pursuant to Section 120.573, F.S., may be available and choosing mediation does not affect your right to an administrative hearing.

A petition for an administrative hearing is deemed filed upon receipt of the complete petition by the District Clerk at the District Headquarters in Palatka, Florida during the District's regular business hours. The District's regular business hours are 8 a.m. – 5 p.m., excluding weekends and District holidays. Petitions received by the District Clerk after the District's regular business hours shall be deemed filed as of 8 a.m. on the District's next regular business day. The District's acceptance of petitions filed by e-mail is subject to certain conditions set forth in the District's Statement of Agency Organization and Operation (issued pursuant to Rule 28-101.001, Florida Administrative Code), which is available for viewing at www.sjrwmd.com. These conditions include, but are not limited to, the petition being in the form of a PDF or TIFF file and being capable of being stored and printed by the District. Further, pursuant to the District's Statement of Agency Organization and Operation, attempting to file a petition by facsimile (fax) is prohibited and shall not constitute filing.

The right to an administrative hearing and the relevant procedures to be followed are governed by Chapter 120, Florida Statutes, Chapter 28-106, Florida Administrative Code, and Rule 40C-1.1007, Florida Administrative Code. Because the administrative hearing process is designed to formulate final agency action, the filing of a petition means the District's final action may be different from the position taken by it in this notice. **Failure to file a petition for an administrative hearing within the requisite time frame shall constitute a waiver of the right to an administrative hearing. (Rule 28-106.111, F.A.C.).**

If you wish to do so, please visit http://www.sjrwmd.com/nor_dec/ to read the complete Notice of Rights to determine any legal rights you may have concerning the District's decision(s) on the permit application(s) described above. You can also request the Notice of Rights by contacting the Director of Business and Administrative Services, 4049 Reid St., Palatka, FL 32177-2529, tele. no. (386)329-4570.

NEWSPAPER ADVERTISING

ALACHUA
The Alachua County Record, Legal Advertising
P. O. Box 806
Gainesville, FL 32602
352-377-2444/ fax 352-338-1986

BAKER
Baker County Press, Legal Advertising
P. O. Box 598
Maclenny, FL 32063
904-259-2400/ fax 904-259-6502

BRAFORD
Bradford County Telegraph, Legal Advertising
P. O. Drawer A
Starke, FL 32901
904-964-6305/ fax 904-964-8628

BREVARD
Florida Today, Legal Advertising
P. O. Box 419000
Melbourne, FL 32941-9000
321-242-3832/ fax 321-242-6618

CLAY
Clay Today, Legal Advertising
1560 Kinsley Ave., Suite 1
Orange Park, FL 32073
904-264-3200/ fax 904-264-3285

DUVAL
Daily Record, Legal Advertising
P. O. Box 1769
Jacksonville, FL 32201
904-356-2466 / fax 904-353-2628

FLAGLER
Flagler Tribune, c/o News Journal
P. O. Box 2831
Daytona Beach, FL 32120-2831
386- 681-2322

INDIAN RIVER
Vero Beach Press Journal, Legal Advertising
P. O. Box 1268
Vero Beach, FL 32961-1268
772-221-4282/ fax 772-978-2340

LAKE
Daily Commercial, Legal Advertising
P. O. Drawer 490007
Leesburg, FL 34749
352-365-8235/fax 352-365-1951

MARION
Ocala Star Banner, Legal Advertising
2121 SW 19th Avenue Road
Ocala, FL 34474
352-867-4010/fax 352-867-4126

NASSAU
News-Leader, Legal Advertising
P. O. Box 766
Fernandina Beach, FL 32035
904-261-3696/fax 904-261-3698

OKEECHOBEE
Okeechobee News, Legal Advertising
P. O. Box 639
Okeechobee, FL 34973-0639
863-763-3134/fax 863-763-5901

ORANGE
Sentinel Communications, Legal Advertising
633 N. Orange Avenue
Orlando, FL 32801
407-420-5160/ fax 407-420-5011

OSCEOLA
Little Sentinel, Legal Advertising
633 N. Orange Avenue
Orlando, FL 32801
407-420-5160/ fax 407-420-5011

PUTNAM
Palatka Daily News, Legal Advertising
P. O. Box 777
Palatka, FL 32178
386-312-5200/ fax 386-312-5209

ST. JOHNS
St. Augustine Record, Legal Advertising
P. O. Box 1630
St. Augustine, FL 32085
904-819-3439

SEMINOLE
Sanford Herald, Legal Advertising
300 North French Avenue
Sanford, FL 32771
407-323-9408

VOLUSIA
News Journal Corporation, Legal Advertising
P. O. Box 2831
Daytona Beach, FL 32120-2831
(386) 681-2322