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IFB NO. Y18-725-TA **ISSUED: November 29, 2017**

INVITATION FOR BIDS

FOR

EASTERN REGIONAL WATER SUPPLY FACILITY IMPROVEMENTS PHASE IIIB

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PART H
TECHNICAL SPECIFICATIONS

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PART H
VOLUME III

ORANGE COUNTY
EASTERN REGIONAL
WATER SUPPLY FACILITY IMPROVEMENTS
PHASE IIIB

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DIVISION 11

EQUIPMENT

C. General Design

1. Three (3) aerated water transfer pumping units are required for this Contract. These pumps shall be of the above base discharge, vertical turbine variable speed type. The pumping units shall be located and arranged as shown on the Drawings. The aerated water transfer pumps will be installed on top of the proposed clearwell from which they will take suction as shown on the Drawings.

2. Two (2) high service pumping units and two (2) suction barrels are required for this Contract. These pumps will be of the above base discharge, vertical turbine, variable speed type. The pumping units shall be located and arranged as shown on the Drawings. The high service pumps shall be installed in suction barrels taking suction from the finished water storage tanks as shown on the Drawings.

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.

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 manufactured by:

a. Flowserve
   1) Transfer Pump – Model 27SNL
   2) High Service Pump – Model ENM
b. Fairbanks Morse
   1) Transfer Pump –Model 30D-BRZ
   2) Transfer Pump –Model 31M-BRZ
c. Peerless
   1) Transfer Pump – Model – 24HHOH
   2) High Service Pump – Model 28HXB

3. The motors shall be manufactured by:

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

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. Long term storage requirements.

2. Descriptive literature, 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 the actual 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 in addition to those specified in Paragraph 1.05, 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. 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 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 20% above to 20% 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 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 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. 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 bond 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 warranties in accordance with the General Conditions and Section 01740.

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 as recommended by the pump manufacturer, and provided and installed 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.

2.02 MATERIAL AND EQUIPMENT

A. General

1. The high service pumps shall be variable speed, water lubricated, open line shaft, vertical turbine type suitable to pump finished water from the water treatment plant. The transfer pumps shall be variable speed, water lubricated, open line shaft, vertical turbine type suitable to pump finished water from the clearwell to the ground storage tanks.

2. 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. 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 barrel, the pump efficiency shall take into consideration all losses from the barrel 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 horsepower listed in Table 11214-B. If the pumping units require more than the horsepower listed in these tables at the motor output shaft at any full motor speed operation point between Design Point #2 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 prove 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 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 Heads or Motor Stands

a. The discharge head shall have bolted register or rabbet-fit connections for the motor or driver. Discharge head shall have connections for the pump column and discharge piping and shall support the loading which is imposed as well as hydrostatic and hydrodynamic heads. Discharge head shall be fabricated either 3-piece mitered elbow or long radius elbow.

b. 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.

c. 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. Discharge heads for the high service pumps will be fitted with a 150-lb. flat face flange discharge connection to match the barrel flange. The transfer pumps discharge head shall be mounted on a separate base plate and be anchored to a concrete equipment pad.

d. OSHA guards will be supplied for all rotating assemblies. They shall be 316 stainless steel.

e. The fabricated discharge head will incorporate a four piece spacer coupling. A four piece spacer coupling will be provided consisting of one motor half coupling, one pump half coupling, one internal threaded adjusting plate and a spacer. The assembly will be joined together by a minimum of four bolts complete with lock washers. The motor half coupling will be fitted with one stainless steel split ring key and one vertical shaft key. The pump half coupling will be fitted with a vertical shaft key. The impeller will be axial adjustable by means of the adjusting plate threaded onto the pump shaft. The spacer will be of ample size to permit removal of complete mechanical seal assembly, or stuffing box gland assembly without removing the motor. The assembly will be manufactured by 416 stainless steel material.

f. The mechanical shaft seal will be a balanced internal type seal. The discharge head will be plumbed to allow for return lines of 316 stainless steel construction. The 316 stainless steel seal flange will include ports for recirculation and venting. The rotating assembly will be secured to a shaft sleeve that will seal against the shaft with a viton O-ring seal. The shaft sleeve will attach to the shaft by means of a 316 stainless steel locking collar. The seal rotating housing, disc plate and spring will be manufactured of 316 stainless steel. The rotating washer will be silicon construction. The stationary seat will be viton O-ring fitted into the seal flange and manufactured from tungsten. The seal will be a John Crane type T-5610.

g. Transfer Pump Foundation Plate: A suitable foundation plate of fabricated ASTM A36 steel shall be provided and attached to the bottom of the discharge head. It shall be sized to match the dimensions of the pad and be capable of supporting the entire pump, motor, and appurtenances. It shall be fitted with machine bolt holes in accordance with the manufacturer's recommendations.

h. Discharge head connections shall be the size shown on the Drawings, minimum. Pump manufacturers with larger diameter discharge head connections shall provide a discharge head reduce to match the size shown on the Drawing.

i. Provide for lifting the discharge heads by means of lifting eyes that are capable of sustaining the weight of the complete unit, less the motor.

j. The interior of the discharge head shall be coated with ANSI-NSF Standard 61 approved epoxy coating, in accordance with Section 09900.

D. Column and Lineshafting

1. The column pipe shall have rabbet flanged connections with integral bearing retainers.

2. The interior and exterior of the column pipe shall be coated with ANSI-NSF Standard 61 approved epoxy coating, in accordance with Section 09900.

3. The outer column shall be of steel. The weight of the column shall be no less than that stated in ANSI Specification B58.1. Friction loss through the columns shall not exceed 5 feet per 100 feet.

4. Head shafting or an adjustable spacer coupling shall be provided to allow the removal of the mechanical seal and stuffing box without disturbing the driver.

5. Shafting shall be polished over its full length.

6. Total lateral deflection of the shaft above the packing box shall not exceed 0.002-inch total indicator reading. Shaft couplings for shaft diameters two (2) inches or larger shall be of the key and thrust-ring types or other non-threaded design.

7. Lineshafting shall not exceed 10 feet in length and shall have butting faces machined square to the axis of the shaft with angular misalignment of thread and shaft axis not exceeding 0.002 inches in 6 inches.

8. Threaded coupling may be used for shaft diameters smaller than two (2) inches.

9. Pumps shall have open self-lubricated lineshafts.

E. Bowl Assembly

1. Each bowl assembly shall consist of the discharge bowl, impeller and impeller shafting and bearings. Bearings shall be located above and below

the impeller. Bearings (other than sleeve type) shall have ABMA L-10 life of at least 20,000 hours at any specified flow condition excluding the shutoff head.

2. Pump bowls shall be sufficiently rigid to prevent adverse changes in bearing alignment and to maintain the running clearance of seal rings. Each bowl shall have a replaceable wear ring. Wear rings and running clearances shall not exceed 0.002-inch clearance per inch of diameter. Bowl to bowl fits shall be rabbet fit.

3. Bowls shall be flanged with male and female rabbet or threaded for joining to the suction bell and the discharge column. Waterways and the diffusion vanes shall be smooth and free from nodules, bumps and dips.

4. The exterior of the bowls shall be coated with ANSI-NSF Standard 61 approved epoxy coating in accordance with Section 09900.

F. Suction Bell: The suction bell shall have, as an integral part, vanes supporting a central hub in which the bottom bearing is carried below the impeller. The outer suction bell entrance shall be at least the size of the maximum pump bowl dimension and as large as is practical. Maximum entrance velocity shall not exceed six (6) fps at the specified maximum flow. The contour between the outer edge and the impeller suction eye shall be smooth, continuous and bell shaped.

G. Impellers:

1. Pump impellers shall be of the closed type. Impellers shall be to a material suitable for service of a chlorinated water. Impellers shall be cast in one piece and machined to fit the contour of the bowl. Impellers shall be equipped with replaceable wear rings or with wearing ring hubs for mounting wear rings during future repair or with a bronze bowl liner.

2. Attach impellers to the shaft with tapered collets or with 316 stainless steel split ring and key. Impellers shall be attached such that they cannot become loose under any operating condition or under reverse rotation.

H. Suction Vessel

1. The suction vessel for each high service pump shall be the diameter and have a total length as shown on the Drawings. Suction vessel wall thickness shall be 3/8-inch, minimum. Each suction vessel shall be equipped with a suction pipe and flange. Flange shall be American Standard for 125 pound steam pressure with any special drilling and tapping as required to insure correct alignment and bolting. The suction vessel shall be fabricated from high tensile strength steel. The flange

connection between the discharge head and the barrel shall be "O" ring sealed and conform to ANSI 16.1 flange dimensions. A corrosion resistant exterior coating consisting of 3 coats (4-6 mils DFT per coat) of coal tar epoxy shall be applied to all surfaces. Interior coating of high build polyamide epoxy shall be suitable for potable water use in accordance with ANSI/NSF Standard 61 and Section 09900.

2. Suction vessels shall be provided for each proposed high service pump.

3. Provide a 1-inch NPT steel half coupling welded to the top of the vessel and a 1-inch pipe with stainless steel ball valve for a manual air release.

I. Motors

1. General

a. The motors for the pumps shall be of the vertical solid shaft squirrel cage induction type.

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. Refer to the electrical drawings, Section 16405 and Section 16485.

b. Each motor shall have a 1.15 service factor.

c. Motors shall have horsepower 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.

3. Construction

a. The transfer pump motors shall be of the totally enclosed fan cooled (TEFC) design and the high service pump motors shall be of the WP-I design.

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 B rise non-hygroscopic epoxy sealed or encapsulated insulation system. All connections shall be silver soldered with no crimp connections used. 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. Thrust bearings shall be oil lubricated antifriction type with an AFBMA average bearing life of 20 years.

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.

4. Pump and Motor Coupling Guard

a. 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 wire fabric or expanded metal 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.

5. Over Temperature Protection

a. See Section 16405 for winding and bearing over-temperature protection requirements.

J. Torsional Analysis

1. Perform a torsional analysis per API 610 (8^{th} edition), Section 2.8, on pumps having an electric motor driver 600 horsepower and larger, or any variable speed pump having a driver 75 horsepower and larger.

2.03 ACCESSORIES

A. Gauges

1. Provide a pressure gauge where shown on the Drawings.

2. Gauges for the pumps shall be as specified in Section 15100.

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 brass pipe neatly installed with straight runs and right angle bends.

5. Gauges may be provided by the Contractor.

6. Provide one (1) set of spare pressure gauges.

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. Finish coat may be applied at the factory. Pump finish color shall match the pipe color to which it is attached. Pump motor finish color shall be white.

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

B. Field Painting

1. Field painting is specified under Section 09900: Painting. 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.

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.

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. Contractor shall power up heaters on motors and keep power on heaters for a minimum of 72 hours prior to starting up motors.

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 for installation assistance and inspection.

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

B. See Section 01650 - Start-Up.

C. The Contractor shall disinfect all suction piping, discharge pumping pumps, and barrels in accordance with FDEP regulations.

TABLE 11214-A

MATERIALS OF CONSTRUCTION

Component	Material
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.
Bearing retainers (fabricated integral)	Carbon steel, A 283, Grade B
Bearing retainers (insert type)	Bronze, B584, Alloy C 93700 or C 83600
Impellers	Bronze, ASTM 584, Alloy C 93700 or C 83600 or stainless steel ASTM A 276, Type 316
Lantern ring	Bronze, B 584, Alloy C 83600 or ASTM B 62
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
Lineshaft bearings	Neoprene
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

TABLE 11214-A - Continued

MATERIALS OF CONSTRUCTION

Component	Material
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
Suction vessel	Carbon steel, ASTM A 283, Grade B or ASTM A 53, Grade B

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	High Service	Transfer
Pump Tag Numbers	50-P-7, 50-P-8	30-P-6, 30-P-7, 30-P-8
Pump Type	Vertical Turbine	Vertical Turbine
Maximum Motor Full Load Speed (rpm)	900	900
Motor to be Supplied (hp)	600	150
Minimum Stages	3	1
Column Diameter , (inches)	20	18
Discharge Size, (inches)	20	18
Minimum Pump Shut-Off Head (feet)	325	100
Design Point #1 Capacity (gpm)	10,000	8,000
TDH at Design Point #1 Capacity (feet)	176	60
Minimum Efficiency at Design Point #1	83	84
Design Point #2 Capacity (gpm)	8,000	6,000
Design Point #2 TDH (feet)	200	70
Minimum Pump Efficiency at Design Point #2	82	78
NPSHR at Design point #1, maximum (ft)	35	30
Run-Out Head (feet)	120	32
Pressure Gauge Range (psi)	0-150	0-60

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

END OF SECTION

SECTION 11241

CHEMICAL FEED SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

Furnish all labor, materials, equipment and incidentals required and install complete, ready for operation, and field test the chemical feed systems as shown on the Drawings and as specified herein.

B. Related Work Described Elsewhere

1. Section 11245: Chemical Metering Pumps

2. Process instrumentation and controls are included under Division 13.

3. Mechanical piping, valves, pipe hangers, accessories and appurtenances are included under Division 15.

4. Electrical work is included under Division 16.

C. General Design

1. General:

a. The chemical feed systems specified herein are intended to support the operation of the treatment facility. The design capacity of the treatment facility after the Phase III B improvements is 62.5 MGD.

b. The proposed chemical feed systems specified herein are intended to allow for expansion of the water treatment plant to a maximum day design capacity of 62.5 MGD. Two (2) new sodium hydroxide metering pumps will be installed in the Process 60 chemical building to supply caustic to the new air quality control system.

New sodium hypochlorite and hydrofluosilicic acid chemical feed injection piping will supplied to the new transfer pump station discharge piping, and new sodium hypochlorite injection piping will be supplied to the high service pump station.

2. Sodium Hydroxide (Caustic Soda) Feed System for the Air Quality Control System (Process 62)

a. System Operations:

Sodium hydroxide will be added to the air quality control system (AQCS) to aid in the removal of hydrogen sulfide. Sodium hydroxide, 50% solution, will be delivered to the site in truckloads and stored in existing exterior bulk storage tanks. Sodium hydroxide solution will be transferred daily into the day tank in the chemical feed room by an existing transfer pump from the bulk storage tanks. The sodium hydroxide that will be added to the AQCS scrubbing solution will be fed by metering pumps which will automatically adjust the dosage in proportion to the pH measured by the analyzer in each AQCS sump or the H2S Monitor/Controller System by varying the pump speed or stroke length. These pumps shall be the diaphragm type and shall be sized to meet the chemical dosages as determined by the scrubber system manufacturer. Two (2) new metering pumps shall be added for the proposed AQCS. The existing Process 62 metering pumps will not be modified.

b. The existing sodium hydroxide metering pumps shall remain on-line at all times during the addition of the new metering pumps.

1.02 QUALITY ASSURANCE

A. The chemical feed systems specified herein shall be supplied by equipment manufacturers having experience in the design and manufacture of equipment of similar size and capacity and shall present proof of successful operations involving each piece of equipment operating under similar conditions.

B. The manufacture, furnishing, installation, startup, and initial operation of the sodium hydroxide feed systems shall be coordinated with the manufacturer of the aeration and air quality control systems specified under Section 11305: Forced Draft Aeration Modifications.

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. 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. Letter from the Manufacturer verifying chemical compatibility of all products to be used in chemical feed systems.

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 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 PRODUCT DELIVERY, STORAGE AND HANDLING

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

1.06 WARRANTY AND GUARANTEES

Provide equipment (system) warranty per Section 01740: Warranties and Bonds.

PART 2 - PRODUCTS

2.01 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 chemical feed equipment 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 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.

2.02 MATERIAL AND EQUIPMENT

A. Sodium Hydroxide Feed System (Process 62)

1. Chemical Metering Pumps (62-MP-9, 62-MP-10):

a. The Contractor shall furnish and install two (2) chemical metering pumps for the new air quality control system in the Process 60 chemical building, complete with accessories as shown on the Drawings and as specified in Section 11245: Chemical Metering Pumps.

2.03 ACCESSORIES

A. Emergency Shower and Eyewash

1. Emergency shower and eyewash station for indoor use shall be pedestal mounted with a stanchion, a floor flange, a deluge shower, an aerated eye/face wash, an eye/face wash dust cover, stay-open ball valves, interconnecting piping, and a universal emergency sign. The shower shall be stainless steel or ABS plastic with a stainless steel pull rod actuator. The eye/face wash receptor shall be stainless steel with pushplate and foot pedal actuator.

2. Emergency shower and eyewash station for outdoor use shall be pedestal mounted with a stanchion, a floor flange, a deluge shower, an aerated eye/face wash, scald protection stay-open valves, interconnecting piping, and a universal emergency sign. The shower and eye/face wash shall be stainless steel with a stainless steel actuator. The eye/face wash receptor shall be stainless steel with a push plate and foot pedal aerators.

3. Emergency shower and eyewash shall be provided with dust caps and spare dust caps for each unit.

4. Emergency shower and eyewash shall be Haws or approved equal.

5. The emergency eyewash shower shall be painted in accordance with Section 09900 and 09905.

2.04 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 for the first two (2) years of operation.

C. All tools and spare parts shall be furnished in containers clearly identified with indelible markings as to their contents and referenced to the chemical feed system. 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 PREPARATION (NOT APPLICABLE)

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

3.03 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 Contractor.

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 chemical metering pumps, motors, controls, and accessories as specified under Section 11241: Chemical Feed Systems as further 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. 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.

4. Contractor shall furnish variable frequency drives (VFD's) for each metering pump and local control panels as shown on Drawings and as specified in this Specification for a complete system in place.

B. Related Work Described Elsewhere

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

2. Section 01730: Operating and Maintenance Data.

3. Section 11241: Chemical Feed Systems.

4. Section 13300: Instrumentation and Controls.

5. Section 15130: Pressure Gauges.

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

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

C. General Design

1. A complete description of the major components and summary of the operation of each of the chemical feed systems is included in Section 11241: Chemical Feed Systems.

2. All of the equipment specified herein shall be in complete conformity with Section 11241: Chemical Feed Systems and these Specifications. All of the equipment specified herein is intended to be new standard equipment for use in the liquid chemical feed systems and shall include, but not be limited to, the following items of material and equipment:

   a. Mechanically or hydraulically actuated metering pumps.

   b. Calibration chambers.

   c. Pressure relief valves.

   d. Pulsation dampeners with integral pressure gauge.

   e. Backpressure valves.

   f. Pump drives and controls.

3. 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.

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

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 mechanically or hydraulically actuated metering pumps shall be as manufactured by ProMinent, Milton Roy or Pulsafeeder. No substitutions are permitted.

C. The pumps covered by these Specifications shall be new and unused and shall be standard pumping equipment of proven ability as manufactured by a reputable, qualified manufacturer having a successful record of manufacturing and servicing the equipment and systems specified herein a minimum of five (5) years. The pumps furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.

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 and 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. 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.

4. 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.

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. Include gaskets, packing, diaphragms, etc. on the list. List bearings by the bearing manufacturer's numbers only.

7. Complete motor data.

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

9. The recommended summer and winter grades of lubricants along with alternative references to equal products of other manufacturers.

10. Complete wiring diagrams and schematics of each control panel, controllers, control devices and operator's station furnished under this Section.

11. 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.

12. 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.

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. Provide full equipment service/parts 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. 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 316 Stainless Steel for the Sodium Hydroxide pumps and equipment.

C. 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.

D. 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.

E. 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.

F. Engraved laminated nameplates giving the name and function of all selector switches, pushbuttons, alarm lights and control devices shall be securely attached to each panel furnished.

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 or Mechanically Actuated

1. The chemical metering pumps shall be of the single diaphragm design with the diaphragm actuated and balanced hydraulically or mechanically. 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. Mechanically actuated pumps shall include integral motor, oil-lubricated gear reducers. All drive components shall be oil lubricated. The liquid end shall be physically separated from the drive unit by a separate chamber behind the diaphragm creating an air gap.

4. 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.

5. 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.

6. 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.

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

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

B. Motor and Control

1. Each mechanically actuated pump shall be driven by an integrally mounted AC motor. The drive motor shall operate 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 16485. Refer to Instrumentation and electrical drawings for the control requirements of the VFD's and the local control panels.

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. Wall mounted local control panels 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. 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.

d. 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.

e. 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.

2.03 ACCESSORIES

A. Calibration Columns

1. Provide transparent calibration column to be mounted on the suction piping of each metering pump as shown on the Drawings. The calibration column shall be piped such that one (1) metering pump can be calibrated while the other pumps are fully operational. The calibration columns shall be supplied with NPT taps for connection of piping. The calibration column volume and graduations are listed in Table 11245-A.

B. Pressure Relief Valves

1. Pressure relief valves shall be provided on the discharge piping of each metering pump 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 of the pressure relief valve shall match the associated metering pump capacity.

C. Backpressure (Pressure Sustaining) Valves

1. Backpressure valves shall be provided on the discharge piping of the metering pumps 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's capacity.

D. Pulsation Dampeners

1. 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.

E. Spray Shield

1. The sodium hydroxide acid metering pumps shall be equipped with clear plexiglass spray shields.

2. Spray shields shall extend on all sides of the metering pumps as shown in the Drawings.

3. Spray shields located on the front of the metering pumps shall be hinged with latches.

4. Spray shields shall include cut-outs for piping.

5. Design of the spray shields shall be such that the shield can be removed without removal of bolts.

6. Spray shields shall be supported by FRP structures that meet the requirements of Section 06600 – Fiberglass Reinforced Plastic Fabrications.

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 each hydraulically or mechanically actuated metering pump:

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

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

3. Check valve assemblies.

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

C. Contractor shall supply one (1) spare metering pump for each pump specified.

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 PREPARATION (NOT APPLICABLE)

3.02 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. Installation shall include any pipe and fittings necessary to connect the metering pumps to the suction and discharge piping.

3.03 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 and Owner, shall perform a preliminary test of the complete chemical feed system as specified under Section 11241: Chemical Feed Systems.

3.04 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.

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.

C. Manufacturer's Representative: Present at site or classroom at the WSF site as designated by Owner, for minimum person-days listed below, travel time excluded with additional time furnished if required to correct problems or deficiencies:

1. 1 person-day for installation assistance and inspection

2. 3 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

3. 1/2 person-day for prestartup classroom or site training.

4. 1/2 person-day for facility startup.

TABLE 11245-A
FEED PUMP DESIGN REQUIREMENTS

Item	**Sodium Hydroxide (Process 62)**
Equipment Numbers	62-MP-9 and 62-MP-10
Type	Hydraulically or Mechanically Actuated Diaphragm
Number of units	2
Pump Design Capacity (each)	12 gph
Minimum Feed Rate (each)	1.2 gph
Minimum Pump operating pressure	100 psi
Power Requirements	1/2 hp
Approved Pump Models	Milton Roy-MacRoy D, ProMinent-Sigma/2, or Pulsafeeder-PulsaPro 680
Enclosure	TEFC
Controls	Manual
Stroke length control	--
Stroke speed control – –	Flow Proportional 4-20 mA Signal From AQC pH Probe/ H2S Controller
Stroke adjustment	100%
Stroke length adjustment	Manual
Solution Strength	25-50%
Materials:	
liquid end body diaphragm check valve balls seat & O-rings hardware	PVC Teflon Ceramic Teflon 316 Stainless Steel

TABLE 11245-A (CONTINUED)

Item	**Sodium Hydroxide (Process 62)**
Ancillary equip. location:	
pressure relief valves back pressure valves pulsation dampeners calibration column	Discharge Piping Discharge Piping Discharge Piping Suction Piping
pressure relief valve setting back pressure valve setting calibration column size	100 psi 50 psi 1000 mL with 10 mL gradiations
Ancillary equip. settings:	
pressure relief valve setting back pressure valve setting calibration column size	100 psi 50 psi 1000 mL with 10 mL gradiations

END OF SECTION

SECTION 11305

DEGASIFIER AND AIR QUALITY CONTROL SYSTEMS

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, complete and ready for operation two (2) forced draft aerator (FDA) degasifiers and one (1) 2-stage air quality control (AQC) system as specified herein and shown in the Drawings. The degasifier system shall include, but not be limited to, the degasifier towers, blowers complete with enclosure, motors and controls, distribution headers and laterals, packings, packing support structures, manways, piping connections, and lifting lugs. The degasifier system shall provide for the removal of hydrogen sulfide, carbon dioxide and other undesired gases prior to disinfection and storage. The 2-stage AQC system shall treat the off-gas from the degasifiers and shall be designed to use sodium hydroxide to meet the performance requirements specified herein. The AQC system shall include, but not be limited to, the AQC towers, recirculation pumps, instrumentation and controls, vessel internals, interconnecting ductwork, and exhaust stack. The system shall be manufactured and match the existing FDA and AQC systems currently in operation at the plant.

B. Related Work Described Elsewhere

1. Painting: Section 9900

2. Instrumentation and Controls: Section 13300

3. Division 15 Mechanical as applicable

4. Division 16 Electrical as applicable

C. General Design

1. Description of the System

a. The degasifiers and AQC system required under this contract are designed to expand the treatment capacity at the Eastern Regional WSF from 50.0 to 62.5 MGD. Each degasifier shall be rated for 6.25 MGD and each AQC system shall be rated for 12.5 MGD, congruent with the existing system equipment. The degasifiers shall be designed to remove hydrogen sulfide (H_2S) and carbon dioxide (CO_2) from the pre-treated raw water. The contaminated air stream from the degasifiers shall be routed to the AQC system, where the air will be treated with sodium hydroxide to remove the stripped gases before being returned to the atmosphere.

b. The degasifiers shall effectively remove hydrogen sulfide (H_2S) and carbon dioxide (CO_2) from the pretreated water. The system shall be capable of removing 85% of H_2S at 2.0 to 4.5 mg/L influent at a pH of 6.3. If the H_2S concentration is less than 2.0 mg/L on the influent, then the effluent H_2S shall be 0.3 mg/L or less. All components within the degasifier that come into contact with potable water shall be fabricated of NSF approved materials in accordance with Standard 61. The degasifier shall be licensed to receive the NSF label.

c. The air quality control system shall remove undesired gases from the degasifier airstream. The system shall have a rated air flow capacity of 40,000 cfm each and be capable of continuously providing a treated exhaust air stream having a H_2S concentration not greater than 2.0 ppm at the rated capacity and/or a guaranteed H_2S removal efficiency of greater than 98 percent based on design capacity for each unit. This is based on an influent loading of 103 ppm H_2S in the airstream.

i) Evaporation and other water loss makeup shall be accomplished by an automatic level control system in the bottom of the scrubber towers in conjunction with a continuous water make-up. The system shall be capable of operating in either mode.

ii) The equipment supplier shall be responsible for providing automatic monitors and controllers to maintain sufficient chemical in the tower to effectively remove hydrogen sulfide gas from the air stream.

2. Degasifier Design Requirements

a. <u>Item/Design Conditions</u>

Number of Degasifiers	2
Minimum Diameter (feet):	13
Maximum Flow Rate, Water, each (mgd):	6.5
pH, Inlet Water, Minimum:	6.3
Ambient Temperature Range (°F)	30-100
H_2S Inlet Water (mg/L):	< 4.5
H_2S Outlet Water, Maximum (mg/L):	0.675
H_2S Removal Efficiency, Minimum (%):	85
Packing Manufacturer:	Jaeger Products, Inc.
Minimum Packing Size (inches):	2
Maximum Packing Size (inches):	3.5
Minimum Packing Height (feet):	12
Mist Eliminator Manufacturer:	Jaeger Products, Inc.
Minimum Mist Eliminator Height (feet):	1
Minimum Air-Water Ratio:	32:1
Maximum Water Loading (gpm/ft^2):	34
Number of Blowers:	2
Airflow (scfm) per blower	20,000
Static Pressure (inch of H_2O)	10"

3. AQC System Design Requirements

a. Item/Design Conditions:

Number of Scrubbers:	2
Minimum Diameter (feet):	11
Minimum Recirculation Rate (gpm):	600
Total H_2S Removal Efficiency, Minimum (%):	98%
Packing Manufacturer:	Jaeger Products, Inc.
Minimum Packing Size (inches):	2
Maximum Packing Size (inches):	3.5
Minimum Packing Height (feet):	13
Mist Eliminator Manufacturer:	Jaeger Products, Inc.
Minimum Mist Eliminator Height (feet):	1

4. Structural Design Criteria:

a. Wind Loads

Wind Loads:	ASCE 7-98
Category:	IV
Basic Wind Speed (mph):	V=140
Exposure:	C
Importance Factor:	I=1.15

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. Prior to any exterior gel coating or equivalent of the vessel, notification must be given to the Engineer. 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."

   The design windload for the FDA and AQC system shall be per the Florida Builder Code.

2. Commercial Standards:

   ASTM C 581 Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures intended for Liquid Service

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 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. System Supplier

1. TSC-Jacobs North
2. Indusco Environmental Services, Inc.
3. Heil Engineered Process Equipment

1.03 SUBMITTALS

A. Materials and Shop Drawings

1. The Contractor shall submit complete shop drawings of all the equipment as a complete system. The equipment shop drawings submittal shall contain all structural calculations and drawings for the vessels, deflection of the vessel at the point of connection with the ductwork, thickness, anchor bolt size and location, lifting hooks, and loads imposed by appurtenances such as inlet ducting. All structural drawings, structural calculations and process calculations shall be signed and sealed by a Professional Engineer registered in the State of Florida. Complete master power and control wiring diagram, elementary or control schematics, and suitable outline drawings of the control schematics and control panel shall be furnished as part of the shop drawings.

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.

3. The Contractor shall provide a certificate from the vessel manufacturer listing the nomenclature, composition, and characteristics of the resin, this information shall be supplied with the submittal data, as well as vessel and support calculations as specified.

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.

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 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. All equipment supplied under this section shall be warranted for a period of one (1) year by the manufacturer as specified in Section 01740: Warranties and Bonds. Warranty period shall commence upon completion of the work and Owner final acceptance as specified in the General Requirements.

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 GENERAL

A. The degasifier vessels shall be PVC overlayed with fiberglass reinforced plastic (FRP). The PVC shall be NSF approved Type II, Grade I conforming to ASTM 1784-89 with a minimum 3/8-inch thickness. The FRP overlay shall have a minimum thickness of 1/8-inch at the top to 1/2-inch at the bottom. The final gel coat shall be pigmented with the color selected by the Engineer.

The fiberglass overlay shall contain an ultraviolet absorber to protect the resin from ultraviolet degradation. The degasifier towers shall be manufactured by KCH Engineered Systems, or Engineer approved equal.

B. The degasifiers and AQC system shall be of the forced draft type with random dumped internal packing.

C. The water and air will circulate countercurrently; the air being introduced below the packing. A 6-inch minimum distance shall be provided between the packing support and the top of the air inlet duct to facilitate distribution of air across the packing. The vessels shall have an internal baffle at the air inlet to ensure distribution and act as a liquid redistributor.

D. The degasifiers and AQC system shall be provided with access ports, ladders, and platforms 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. The ladders and platforms shall be manufactured of aluminum and shall be in the general arrangement shown on the drawings.

E. Maximum degasifier tower water loading shall not exceed 34 gpm/sq. ft.

F. The degasifier air/water ratio shall not be less than 32:1.

G. Water distribution laterals shall be fabricated in such a manner that they can be disassembled and removed through a 24-inch manway.

H. The degasifiers shall have an exhaust air outlet at the top of the tower suitable for connections to ducts leading to an air quality control scrubber. The air outlet area shall be designed to ensure that the air maximum outlet velocity does not exceed 50 ft/sec. The air inlet shall include a backdraft damper as shown on the drawings.

I. The degasifiers and AQC system shall have a weir trough distributor. Both shall be arranged to ensure even water distribution on the packing and spray patterns shall overlap to ensure that no dry spots will occur on the surface of the packing.

J. The degasifier and AQC system shall be provided with lifting lugs to provide access for maintenance.

K. A minimum of 12 inches shall be between the weir trough and the top of the packing to facilitate water distribution and provide access for maintenance.

L. All connections 2 inches and larger shall be flanged and shall have ANSI standard dimensions and bolting patterns.

M. Packing for the degasifier and AQC system shall be polypropylene and have a maximum nominal diameter of 3-1/2". The packing shall be as manufactured by Jaeger Products, Inc. or approved equal.

N. Air pressure drop across the degasifier and AQC vessel packing shall be measured by a differential pressure analyzer. Provide a dual channel Rosemount analyzer for each tower to match the existing units.

O. Provide AQC tower overflow outlet and associated waste stream piping as shown on the drawings. Waste stream piping shall include a liquid trap at least 12 inches deep to prevent odorous air from blowing into the waste piping.

P. Provide a drain valve and piping for wasting the contents in the air quality control tower sump to the plant wastewater collection system.

Q. All bolts, fasteners, supports, hinges, lifting lugs, etc., shall be Type 316 stainless steel.

R. Electrical conduits and straps shall be PVC and all electrical boxes shall be Type 316 stainless steel NEMA 4X.

S. Gaskets shall be neoprene.

T. The design windload for the degasifiers and AQC system shall be per the Florida Building Code, specific design criteria as specified in 1.01, C.

2.02 DUAL LAMINATE VESSELS

A. PVC overlayed with FRP, vertical, round vessels shall be suitable for installation in an outdoor environment with climate conditions encountered in the State of Florida (Central Florida). The vessel shall be constructed with an interior PVC shell and an exterior of sprayed on FRP. Each vessel shall have a diameter and height (straight shell) and minimum capacities as specified herein with a flat bottom and dished or conical top (head).

B. Vessel shall be designed in accordance with all applicable codes and regulations. Signed and sealed drawings shall be submitted by an engineer registered in the State of Florida. Drawings and calculations shall illustrate the vessels, ladders, platforms, and anchor bolts' ability to withstand the required windloads. Windloads shall be in accordance with ASCE 7-98 Edition using a basic wind speed of 120 mph (3 second gust), an importance factor of 1.15 and exposure C. Guy wires are not acceptable for vessels, only for exhaust stacks. Vessels shall be freestanding.

C. Nozzles - Support: All nozzles 3-inch and larger shall be gusseted.

D. 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.

E. Manholes: Manholes of vertical vessels shall be the bolted type.

F. Blind Flanges: Blind flanges shall be the same thickness as the flanges to which they are attached. Tolerance on flatness shall be the same as for flanges.

G. Lifting Lugs: Suitable FRP or 316 stainless steel lifting lugs shall be provided for use in transporting and placing FRP vessels.

H. Hold Down Lugs: Hold down lugs on vessels for outdoor service shall be capable of withstanding design wind loads using ASCE Paper 3269 as a reference.

I. Bolting shall be hexhead machine bolts with washers, nuts and gaskets. Bolts, nuts and gaskets shall be Type 316 stainless steel.

2.03 BLOWERS

A. Two (2) blowers, 20-B-3, and 20-B-4 shall be provided at locations shown on the Drawings.

B. Each blower shall include a sound attenuation enclosure as shown on the drawings. The sound attenuation enclosure shall completely house the blower package including the blower, motor and inlet filter housing. The enclosure shall be designed to reduce the blower noise level to 80 dbA at five feet. The enclosure shall be manufactured of weatherproof aluminum and be acoustically lined with 2 inch thick acoustical sound attenuation material. The enclosure shall include at least four doors, a pair of doors on each side, for complete access to the blower packages for maintenance. The blower enclosure shall be designed for 130 mph wind loading. Hardware shall be Type 316 stainless steel. The sound attenuation enclosures shall be Attenu-Pac by Universal Blower, Inc. or equal.

C. The blowers shall be 60 HP maximum, capable of moving 20,000 cfm at 10 inches W.C.

D. The fan wheel shall be the backwardly inclined design and fabricated from 316 stainless steel.

E. The fan housing shall be fabricated from the same material as the degasifier vessels. The housing shall be additionally braced as needed with 316 stainless steel inlet side and drive side plates, fastened to the housing with Type 316 stainless steel hardware.

F. The fan shall be furnished with a sleeved 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.

G. Access door will be gasketed and bolted to the fan housing with Type 316 stainless steel hardware.

H. Bearings shall be grease lubricated ball or roller bearings in housings that allow easy bearing replacement and provided with autogreasers. Fans shall be direct drive. V-belt driven fans will not be allowed. Fans shall be controlled by a VFD.

I. Shaft seal shall be neoprene gasketed FRP plate attached to the fan housing with Type 316 stainless steel hardware.

J. The blower motor shall be 60 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.

K. Support bases shall be 316 stainless steel.

L. Provide easy access OSHA belt guards on all fans.

M. Manufacturers, or Approved Equal:

1. KCH Engineered Systems.

2. Verantis.

3. New York Blower.

2.04 RECIRCULATION PUMPS

A. Four (4) recirculation pumps shall be provided at locations shown on the drawings.

B. The recirculation pumps shall be supplied by the system supplier as part of the degasifier and air quality control system. The recirculation pumps shall pump the scrubbing solution from the reservoirs to the weir trough. The pumps shall be

capable of pumping 600 gpm against the total dynamic head required. The pumps shall be centrifugal design complete with corrosion resistant bases and a maximum 15 HP, TEFC motor. Pumps to be Goulds ITT to match the existing installed units, or Engineer approved equal.

C. Casings shall be high grade glass reinforced vinyl ester of the back pull-out design. The suction and discharge flanges shall be fully gussetted for optimum weir loading capabilities.

D. Stuffing box covers shall be compression molded high grade glass reinforced vinyl ester, rabbet fitted to the casing, and shall accept most mechanical seals recommended for corrosive applications.

E. Impellers shall be compression molded in high grade glass reinforced vinyl ester of the semi-open design. They shall be statically balanced, externally adjustable, driven by a polygon and fitted with square O-rings to assure proper sealing of the pump shaft from corrosive liquids.

F. Shafts shall be high quality heat treated 4140 steel with a replaceable non-metal sleeve. The shaft shall utilize a tapered polygon drive for uniform torque carrying capability and easy impeller servicing. The sleeve shall also feature a polygon cutout to ensure that it is positively driven by the shaft.

G. Bearings shall be oil lubricated with an external oiler. The double row outboard thrust bearing shall be capable of carrying high thrust loads.

H. Baseplates shall be glass reinforced vinyl ester in six ANSI sizes with an integral drain rim and encapsulated mounting inserts.

I. Couplings shall be flexible spacer type to permit disassembly and inspection without disturbing the pump piping, driver or alignment. Coupling guards shall be designed to meet OSHA requirements.

J. Corrosion resistant materials - all wetted parts shall be selected fiberglass reinforced materials for superior corrosion resistance across an exceptionally broad range of applications. Other materials of constructions shall be as follows:

Casing	Fiberglass reinforced vinyl ester
Stuffing Box Cover	Fiberglass reinforced vinyl ester
Impeller	Fiberglass reinforced vinyl ester
Shaft	Heat treated 4140 steel or Type 303 stainless steel
Shaft Sleeve	Fiberglass reinforced vinyl ester
Casing capscrews, gland eyebolts, and nuts	Stainless Steel, Type 316
Drain and vent plugs	Teflon

Baseplate	Fiberglass reinforced vinyl ester

K. All of the above pump motors are to be TEFC, severe duty, 460 volt, 3 phase, 60 Hz, and 1.15 service factor.

2.05 CLEANING PUMP

A. One (1) aerator cleaning pump (20-P-24) shall be provided to pump cleaning solution from the aerator sump to the distribution weir trough. The aerator cleaning pump shall be piped and valved such that a pump can recirculate cleaning solution through one or two aerators at a time.

B. Aerator cleaning pump shall be of the horizontal, end suction, single stage, one piece moulded 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. Aerator cleaning pumps shall be capable of pumping bulky, fibrous solids up to 2 inches in diameter.

C. Aerator cleaning pumps shall be Goulds Model CV3196, 4x6-13 LTX in Hastelloy C construction, rated for 750 gpm against the total dynamic head required. The pumps shall be centrifugal design complete with corrosion resistant bases and a maximum 25 HP, TEFC motor. Pumps to be Goulds ITT to match the existing installed units and supplied by the system supplier.

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.

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. Color of finish coat shall match that of the existing cleaning pumps and baseplates.

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	Goulds Chembase

H. All of the above pump motors are to be TEFC, severe duty, 460 volt, 3 phase, 60 Hz, and 1.15 service factor.

2.06 DUCTWORK

A. All duct and fittings shall be supplied by the Degasifier and AQC Systems supplier and 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 basic 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.

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: 30 to 100 degrees F.

b. Design Vacuum Rating: 7-inch water gauge.

c. Location: Outdoors.

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 Darken 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 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 and Blastgates

1. The dampers on the discharge duct of the blowers shall be of the slide in, swing type and shall be fabricated of the same material as the duct is.

2. All other dampers shall be quadrant type and blastgates shall be slide type and shall be fabricated of the same material as the duct is.

3. The shaft end opposite the handle must be sealed and capped.

4. 316 Stainless steel locknuts or similar corrosion-resistant attachments shall be provided to fix damper position after balancing and adjustment of the system. Seals shall be constructed of Viton or similar chemical resistant material for intended service.

5. Dampers shall be rated for 100% shut-off. Dampers shall be fully adjustable from 0-100% to allow for flow balancing of the degasifier units. At the full closed position the degasifier discharge dampers shall prohibit the entrance of odorous air into the standby units.

2.07 AUTOMATIC CHEMICAL CONTROLLERS

A. The air quality control system shall be controlled by Hach pH controllers and ATI H_2S monitor as specified in Section 2.08. The first stage scrubber caustic feed will be controlled by the pH control system and the second stage scrubber will be controlled by the H_2S control system. These automatic controllers shall provide automatic adjustment of the chemical composition of the scrubbing solution to minimize the possibility of odor breakthrough because of gas flow fluctuation. The air quality control system supplier shall coordinate with the instrumentation system supplier to ensure the correct automatic pacing of the caustic feed systems.

B. The control shall include two (2) pH analyzers mounted in a corrosion resistant NEMA 4X housing mounted at the locations shown on the drawings.

C. The pH controllers shall have a digital display with a 0-14 pH measuring range and a 4-20 mA output with range expand. The controllers shall have a dual alarm relay with two individual adjustable controls to establish low and high alarm points so that the alarm relay is energized whenever the process solution is outside of these points.

D. The pH analyzers shall be as Specified in Section 13300 or approved equal.

E. The pH probes shall be located in the vessel wall of the scrubbers and wired to the control panels as shown in the Drawings.

F. The probes shall be fully encapsulated flow-thru type with wetted materials consisting of vinylester body, ceramic salt bridge, glass process electrode, titanium palladium ground electrode, Viton and RTV sealant.

G. The pH probes shall be as Specified in Section 13300 or approved equal.

2.08 AIR QUALITY CONTROL MONITORING SYSTEM

A. The AQC system supplier shall provide a Hydrogen Sulfide Monitoring System. The monitoring system shall provide 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 1 inlet, Interstage, and Stage 2 outlet streams.

2. Monitoring of the Stage 1 and Stage 2 scrubbing solution pH.

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 for each AQC system.

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 AQC 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 Q455, or approved equal.

2.09 ROTAMETER PANELS

A. Aeration NaOCl Feed Rate Panels - Provide aeration NaOCl feed rate panels in the locations shown on the drawings that matches the existing units. NaOCl feed rate panels shall provide a means of manually controlling the feed rate of a continuous maintenance dose of sodium hypochlorite solution to the Aerator vessel reservoirs. Panels shall be stanchion mounted.

B AQC Makeup Water Feed Panels – Provide AQC makeup water feed panels in the general locations shown on the drawings. Makeup water feed panels shall provide a means of automatically starting, stopping, and manually adjusting the flow rate of makeup water to the AQC vessels. The makeup water feed panel shall contain a motorized ball valve, manual adjustable valves, and rotameters for manual control of the makeup feed water. The makeup water feed system will be equipped with an automatic bypass that is activated when a low liquid level is signaled in the AQC sump. The signal from the liquid level switch shall open a motorized ball valve allowing water to fill the sump. The above controls shall be accessible from outside the unit without taking the scrubber out of service. Refer to plans for details on makeup water panel and drain connections. Panels shall be stanchion mounted.

2.10 ACCESS LADDER

A. Furnish each air quality control vessel and each pair of aerators with an access ladder with cage and a platform to provide access to the hatch designed for loading the packing. Fabricate ladder, cage and platforms from aluminum in accordance with Section 05515, ladders, stairs, nosings and stair treads. Furnish each platform with aluminum handrail in accordance with Section 05520 Handrails and Safety Chains. Support ladders and platforms from the side of the scrubber tower. 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 05520, Part 1.C. General orientation of ladders and platforms shall be as shown on the drawings. Final location of ladders and platforms shall be as designed by the system supplier to meet applicable standards.

2.11 SPARE PARTS

A. The following spare parts shall be provided:

1. One (1) fan bearing set for each blower
2. Two (2) spare pH probes
3. Two (2) spare differential pressure gauges
4. Two (2) spare solenoid valves
5. One (1) set of mechanical seals, radial bearings, shaft sleeves, gaskets, O-rings, and seals for each AQC recirculation pump and each aerator cleaning pump.

PART 3 - EXECUTION

3.01 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. The equipment shall be delivered on-site as fully assembled as transportation will allow.

C. Finished surfaces of all exposed openings shall be protected.

3.02 INSTALLATION

A. All vessels shall be installed in accordance with the manufacturer's technical data and printed instructions, and in the locations shown on the drawings.

3.03 QUALITY CONTROL AND INSPECTION FOR FRP VESSELS

A. Quality Control Procedure

1. The vessel manufacturer shall have quality control procedures adequate to ensure that all vessel fabrications comply with these specifications and ensure that all laminates are at least the equal of the reference samples in laminate quality. Quality control shall include a final inspection by the manufacturer and written record of this final inspection.

The objective of manufacturer's quality control and inspection procedure shall be to ensure that all vessels comply with the specifications after fabrication is complete and prior to shipment of the vessels to the job site to minimize the amount of rework by the manufacturer at the site.

B. Manufacturer's Inspection

1. All vessels shall be tested at the place of manufacture, and the manufacturer shall provide the following information:

   a. Hardness readings.

   b. Thickness measurements.

   c. Measurements showing compliance with dimensions and tolerances in diameters, lengths, squareness of ends, angles of fittings and flanges, and flatness of flanges.

   d. For vessel laminate quality; presence of pits, foreign inclusions, dry spots, air bubbles, pinhole pimples, and delamination.

2. All vessels shall be factory hydrostatically tested for leaks by filling with water after fabrication is complete. Vessels shall be checked for leaks after they have been filled for at least 1 hour. Manufacturer shall run this test prior to the time of shipping for all vessels.

3. A separate inspection record shall be made for each vessel. Inspection records shall be sent to the Engineer for approval prior to shipment of vessels.

4. Unless otherwise specified, the vessels may be inspected at a place of manufacture by a representative of the Engineer. Final acceptance will be contingent upon satisfactory further inspection upon arrival at the job site.

5. If the factory inspection and tests show that any of the vessels do not meet the specifications, corrective measures shall be taken or the defective vessel shall be replaced with a new vessel which satisfies the conditions specified prior to shipment to the job site.

3.04 SURFACE PREPARATION AND SHOP PAINTING

A. All PVC overlayed with FRP vessels and FRP components will be coated with a polyester gel coat on all exterior surfaces at the factory. Other equipment to be supplied under this Section requiring surface preparation and shop priming shall

be performed as part of the work of this Section. Color of the gel coat shall match existing vessels. A sample shall be provided and approved by the Owner.

3.05 FIELD TESTING

A. The system manufacturer shall furnish the service of a factory representative for a minimum of five (5) days who has complete knowledge of proper operation and maintenance of the equipment to inspect the final installation and to supervise the test runs.

B. Each degasifier shall be tested at the approximate design concentration of hydrogen sulfide with the influent water at the site. The equipment supplier shall furnish utilities, labor, after the degasifier is complete, and flow meter for air flow measuring. The test shall be supervised by the equipment supplier and witnessed by representatives of the Engineer and Owner. The system shall provide the specified percentage removal of hydrogen sulfide at design conditions. A minimum of one (1) day shall be required for testing the degasifiers.

C. If the system components or any component thereof fails to operate properly, the necessary changes shall be made or components shall be replaced until the system operates to the satisfaction of the Engineer. Any units that remain unable to meet the operating requirements shall be removed and replaced with satisfactory units at no cost to the Owner.

D. The system manufacturer shall furnish the services of a factory representative for a minimum of three (3) days who has complete knowledge of proper operation and maintenance of the equipment to inspect the final installation, to supervise the test runs, and to provide operations training.

E. The scrubber shall be tested with concentration of hydrogen sulfide generated into the scrubber by pretreated raw water. The equipment supplier shall furnish utilities, labor, flow meter for air flow measuring and portable hydrogen sulfide analyzer. Test shall be conducted using Interscan electro/ chemical gas sampling system. The test shall be supervised by the equipment supplier and witnessed by representatives of the Engineer and Owner. The system shall provide a minimum of 98 percent removal of hydrogen sulfide from the influent air stream at design conditions. Upon completion of the testing, a report summarizing the results of testing shall be submitted. This report shall be signed and sealed by a Professional Engineer registered in the State of Florida.

F. If the system or any component thereof fails to operate properly and to remove odors at the existing hydrogen sulfide concentration, the necessary changes shall be made or components shall be replaced until the system operates to the satisfaction of the Engineer.

G. The system supplier shall have a service company knowledgeable in troubleshooting and proper operation of the system. The service company shall be located in the State of Florida to assure quick response to the Owners' needs. The service company shall have a minimum of ten (10) years in the State of Florida working on this type equipment.

3.06 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.

C. The bid price shall include all related expenses for the Owner’s representative to inspect the FDA and AQC vessel construction at the manufacturer’s headquarters for three (3) days prior to shipment of the equipment.

END OF SECTION

DIVISION 13

SPECIAL CONSTRUCTION

SECTION 13300

INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. The Contractor shall furnish, install and place into service operating process instrumentation, control systems and panels including accessories, related to this facility, all as shown on plans and specified herein.

1. Existing plant systems must remain operational during construction. Nighttime and/or other off hours work may be required to support plant operations and shall be included in the contractor's bid.

2. The instrument contractor is responsible to "As-Built" all existing control panels and to provide all demolition and modification as necessary for the installation of the new I/O in the existing local control panels.

3. Equipment, wires, and cables rendered obsolete by this construction must be removed from the existing panels. Equipment, wires, and cables previously abandoned must also be removed from the panels. Existing programming associated with obsolete and/or abandoned equipment shall be removed from each PLC's program. Functioning equipment present in these panels must remain functional and will be included on the instrument contractor's "As-Built" drawings. Provide new power supplies, surge suppressors, I/O cards, terminal strips, etc. for new I/O. The instrument contractor is responsible to provide completed panels that are clean, functional and present a professional workman-like appearance. Field devices/equipment shall be provided with sunshields. Sunshields shall be rated for the area in which it will be constructed, unless otherwise noted, sunshields shall be rated NEMA-4X.

4. All wires in control panels must be permanently tagged and shown on the as-built drawings. This includes all spare wires and cables. Spare cables are to be taped and left coiled in the panels for future use. Cable and wire numbers are to be assigned by the contractor, documented and controlled to prevent duplicate numbers. The contractor shall turn over to the owner, at the project conclusion, a cable and wire list showing assigned numbers and their physical location in the plant.

5. See electrical drawings and specifications for additional work required of the instrument contractor as part of this project to supply demolition

instructions, relocation and modification instructions for equipment not necessarily shown on the instrument drawings.

6. Contractor shall modify the existing PLC system, SCADA screens, and Report generation requirements at the existing Eastern Regional Water Supply Facility to include all the proposed modifications as part of this project and add Tags to the SCADA system.

7. Provide and install new I/O cards within existing PLC control panels for the Process 20 Building (20-LCP-1), Process 30 Building (30-LCP-3) and Process 50 Building (50-LCP-5) as shown on drawings and as described in the specifications complete in place.

8. Contractor shall obtain a copy of the existing PLC programming for panels 20-LCP-1, 30-LCP-3, 50-LCP-5 and 60-LCP-4 from the Owner. Contractor shall rewrite the PLC logic for all new PLC systems according to the Orange Standard Naming and Tag numbering system. Contractor shall closely coordinate with Owner and Engineer and inform any deviation and get approval from Owner.

9. Refer to I-drawings for the existing PLC network and associated items to be replaced. All PLC panels shall use I/O scanning for program communication. Program 30 spare addresses into the I/O scanner. The existing 30-LCP-3, 50-LCP-5 and 60-LCP-4 shall be re-programmed with Orange Standard Naming and Tag numbering system.

10. The existing PLC program in panels 20-LCP-1, 30-LCP-3, 50-LCP-5 and 60-LCP-4 shall be reprogrammed removing any unused tags.

11. Contractor shall provide and install Hirschmann (or equal) Ethernet Switch in the PLC control panel as shown on instrumentation drawings. Contractor shall include, as part of the bid, factory level training course for the Owner from Hirschmann for the Ethernet Switch Models to be supplied. Contractor shall pay all travel with perdiem and lodging for two individuals from Orlando, Florida to the training site for the duration of the training. Contractor shall also obtain the onsite training from the Hirschmann system integrator for at least four technicians from the Owner for four hours related to the devices installed. Contact Belden representative to arrange training.

12. Contractor shall configure the existing iHistorian Server Computer located at the Eastern Regional Water Supply Facility to collect and store the data. Coordinate with Owner and provide for amount of tags that will be collected and stored at Eastern Regional Water Supply Facility.

B. Work Includes: Engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and OWNER training for a complete Instrumentation and Control System.

Major parts are:

1. Instrumentation including primary elements, transmitters, and control devices.
2. Control Panels.
3. PLC and I/O Rack Control Panels
4. Software and Licensing
5. Acceptance Testing, including 30-day system acceptance test.

C. Instrument and Control (I&C) Supplier work scope:

1. For I&C equipment and ancillaries provide the following:

   a. Complete detail design.
   b. Required Submittals.
   c. Equipment and ancillaries.
   d. Instructions, details, and recommendations to, and coordination with, Contractor for proper installation.
   e. Verify readiness for operation.
   f. Verify the correctness of final power and signal connections.
   g. Adjusting and calibrating.
   h. Starting up.
   i. Testing and coordination of testing.
   j. Training.

2. Verify following work not by I&C Supplier is provided:

   a. Correct type, size, and number of signal wires with their raceways.
   b. Correct electrical power circuits and raceways.
   c. Correct size, type, and number of I&C related pipes, valves, fittings, and tubes.
   d. Correct size, type, materials, and connection of process mechanical piping for in-line primary elements.

3. For equipment not provided under I&C Supplier, but directly connected to equipment required by I&C Supplier:

   a. Obtain from Contractor, manufacturer's information on installation, interface, function, and adjustment.
   b. Coordinate with Contractor to allow required interface and operation with I&C System.
   c. For operation and control, verify that installations, interfacing signal terminations, and adjustments have been completed with manufacturer's recommendations.
   d. Test to demonstrate required interface and operation with I&C System.
   e. Examples of items in this category, but not limited to the following:

1) Valve operators, position switches, and controls.
2) Chemical feed pump and feeder speed/stroke controls.
3) Automatic samplers.
4) Motor control centers.
5) Adjustable speed drive systems.

f. Examples of items not in this category:

1) Internal portions of equipment provided under Division 16, Electrical, that are not directly connected to equipment under I&C System.
2) Internal portions of I&C Systems provided as part of package systems and that are not directly connected to equipment provided under I&C System.

4. Wiring external to equipment provided by I&C Supplier:

Special control and communications cable: Provided by I&C Supplier.

D. Software Engineering work scope:

1. Configuration of PLCs, including:

a. Correct I/O mapping and scaling.
b. Ladder logic implementing defined control strategies.
c. SCADA interface mappings.
d. Specifications/documents including: System External Specification, System Internal Specification, I/O Checklist, Factory Acceptance Test Plan, and Site Acceptance Test Plan.
e. As-built documentation

2. Start-up support, including system testing.

3. System training.

4. Computer based SCADA system (Proficy HMI/SCADA - iFIX). Coordinate with Owner for County's standard current version and provide accordingly.

1.02 SINGLE INSTRUMENT SUPPLIER

A. The Contractor shall assign to the Single Instrument and Control (I&C) supplier full responsibility for the functional operation of all new instrumentation systems. The Contractor shall have said supplier perform all engineering necessary in order to select, to furnish, to program, to supervise installation, to connect, to calibrate, to place into operation all sensors, instruments, alarm equipment, control panels,

accessories, and all other equipment as specified herein. The I&C supplier shall have a maintenance office within a 150 mile radius of the project.

B. The single instrument and controls supplier shall demonstrate his ability to successfully complete projects of similar sizes and nature. Provide references (including phone number and contact name) for at least three projects successfully completed in which the following tasks were performed: system engineering, documentation including panel assembly, schematics and wiring diagram, programming, field testing, calibration and start-up, operator instruction and maintenance training.

The foregoing shall enable the Contractor and the Owner to be assured that the full responsibility for the requirements of this Section shall reside in an organization which is qualified and experienced in the water management field and its process technology on a functional systems basis.

The single I&C supplier shall have a UL approved shop and shall build all panels according to UL 508A.

Instrumentation and Controls supplier shall be **Curry Controls Company or Revere Control Systems, Inc**. Instrumentation and Controls supplier (system Integrator) shall be a Schneider Electric Company Certified Alliance Partner.

C. The single software engineering supplier shall demonstrate his ability to successfully complete projects of similar sizes and nature. Provide references (including phone number and contact name) for at least three projects successfully completed in which the following tasks were performed: ladder logic programming, computer based SCADA system configuration, documentation, field testing, start-up, and operator instruction.

1.03 INSTALLATION WORK

A. Nothing in this part of the Specifications shall be construed as requiring the Contractor to utilize personnel supplied by his assigned instrument manufacturer's organization, or any division thereof, to accomplish the physical installation of any elements, instruments, accessories or assemblies specified herein. However, the Contractor shall employ installers who are skilled and experienced in the installation and connection of all elements, instruments, accessories and assemblies; portions of their work shall be supervised or checked as specified in Part 3, herein.

1.04 PREPARATION OF SUBMITTAL OF DRAWINGS AND DATA

A. It is incumbent upon the Contractor to coordinate the work specified in these Sections so that a complete I&C system for the facility shall be provided and shall

be supported by accurate Shop and record Drawings. As a part of the responsibility as assigned by the Contractor, the Single I&C supplier shall prepare and submit through the Contractor, complete organized Shop Drawings, as specified in Part 2.02, herein. Interface between instruments, motor starters, etc. shall be included in his Shop Drawing submittal.

B. During the period of preparation of this submittal, the Contractor shall authorize direct, informal liaison between his Single I&C supplier and the Engineer for exchange of technical information. As a result of this liaison, certain minor refinements and revisions in the systems as specified may be authorized informally by the Engineer, but these shall not alter the scope of work or cause increase or decrease in the Contract Price. During this informal exchange, no oral statement by the Engineer shall be construed to give formal approval of any component or method, nor shall any statement be construed to grant formal exception to, or variation from these Specifications.

C. In addition, I&C supplier/programmer shall provide a fully documented version of PLC programming and HMI programming on a CD and hard paper copy. The fully documented programs shall include functional descriptions for all areas impacted during construction.

1.05 ADDITIONAL TECHNICAL SERVICES

A. At no separate additional cost to the Owner, the Contractor shall provide the following services of qualified technical representatives of the Single I&C supplier (See Part 3, herein).

1. To supervise installation and connection of all instruments, elements, and components of every system, including connection of instrument signals to primary measurement elements and to final control elements such as pumps, valves, and chemical feeders;

2. To make all necessary adjustments, calibrations and tests; and

3. To instruct plant operating and maintenance personnel on instrumentation. This time shall be in addition to whatever time is required for other facets of work at the site, and shall be during the Owner's normal working days and hours.

4. To terminate and test all fiber optic cable and effected devices.

1.06 GUARANTEE

A. The Contractor shall guarantee all equipment and installation, as specified herein, for a period of one (1) year following the date of final completion. To fulfill this obligation, the Contractor shall utilize technical service personnel designated by

the Single I&C supplier to which the Contractor originally assigned project responsibility for instrumentation. Services shall be performed within two (2) calendar days after notification by the Owner.

1.07 ADDITIONAL PROVISIONS

A. The applicable provisions of the following Sections under Electrical Work shall apply to work and equipment specified herein, the same as if stated in full, herein:

1. Codes and Standards
2. Equipment, Materials and Workmanship
3. Testing
4. Grounding
5. Equipment Anchoring
6. Conductor and Equipment Identification
7. Terminal Cabinets and Control Compartments
8. Process Control Devices

1.08 NEWEST MODEL COMPONENTS

A. All meters, instruments, and other components shall be the most recent field proven models marketed by their manufacturers at the time of submittal of Shop Drawings unless otherwise specified to match existing equipment. All technical data publications included with submittals shall be the most recent issue.

1.09 INSPECTION OF THE SITE AND EXISTING CONDITIONS

A. The instrumentation drawings were developed from past record drawings and information supplied by the OWNER.

D. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and instrumentation and control systems which will, in any way or manner, affect the work required under this Contract. No subsequent increase in Contract cost will be allowed for additional work required because of the CONTRACTOR'S failure to fulfill this requirement.

1.10 RELATED WORK

A. Division 16 - Electrical
B. Division 11 - Equipment
C. Division 13 - Special Construction

PART 2 - PRODUCTS

2.01 INSTRUMENTATION CRITERIA

A. DESIGNATION OF COMPONENTS:

In these Specifications and on the Drawings, all systems, meters, instruments, and other elements are represented schematically, and are designated by numbers, as derived from criteria in Instrument Society of American Standard ANSI/ISA S5.1-1973. The nomenclature and numbers designated herein and on the Drawings shall be employed exclusively throughout Shop Drawings, data sheets, and similar materials. Any other symbols, designations, and nomenclature unique to the manufacturer's standard methods shall not replace these prescribed above, used herein, and on the Drawings.

B. SIGNAL CHARACTERISTICS:

Signals shall be electrical, as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted. Electrical signals outside control panel(s) shall be 4 to 20 milliamperes DC, except as noted. Signals within enclosures may be 1-5 volts DC.

C. MATCHING STYLE, APPEARANCE AND TYPE:

All instruments to be panel mounted at the control panels shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be of one (1) manufacturer.

D. ACCURACY AND REPEATABILITY:

The overall accuracy of each instrumentation system or loop shall be as prescribed in the Specifications for that system or loop. Each system's accuracy shall be determined as a probable maximum error; this shall be the square-root of the sum of the squares of certified "accuracy s" of certain designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual electronic instrument shall have a minimum accuracy of $\pm$0.7 percent of full scale and a minimum repeatability of $\pm$0.4 percent of full scale unless otherwise specified. Instruments which do not conform to or improve upon these criteria are not acceptable.

E. SIGNAL ISOLATORS, CONVERTERS AND POWER SUPPLIES:

Signal isolators shall be furnished and installed in each measurement and control loop, wherever required, to insure adjacent component impedance match or where feedback paths may be generated. Signal converters shall be included where required to resolve any signal level incompatibilities.

Signal power supplies shall be included, as required by the manufacturer's instrument load characteristics, to insure sufficient power to each loop component.

F. ALTERNATIVE EQUIPMENT OR METHODS:

Equipment or methods requiring redesign of any project details are not acceptable without prior approval of the Engineer. Any changes inherent to a proposal alternative shall be at no additional cost to the Owner.
The required approval shall be obtained in writing by the I&C Subcontractor through the Contractor prior to submittal of Shop Drawings and data. Any proposal for approval of alternative equipment or methods shall include evidence of improved performance, operational advantage and maintenance enhancement over the equipment or method specified, or shall include evidence that a specified component is not available. Otherwise, alternative equipment (other than direct, equivalent substitutions) and alternative methods shall not be proposed.

2.02 DETAILED SYSTEMS DRAWINGS AND DATA

A. CONTENT:

The Contractor shall submit detailed Shop Drawings and data prepared and organized by the Single I&C supplier in accordance with Division 1, Shop Drawings, Working Drawings, and Samples. These Drawings and data shall be submitted as a complete bound package at one time within 80 calendar days after date of Notice to Proceed and shall include:

1. Drawings showing definite diagrams for every instrumentation loop system. These diagrams shall show and identify each component of each loop or system using legend and symbols from ISA Standard S5.4, each having the format of ISA Standard S5.1 as used on the Project Drawing. (Each system or loop diagram shall be drawn on a separate Drawing sheet.)

2. Data sheets for each component, together with a technical product brochure or bulletin. The data sheets shall show:

    a. Component function description used herein and on the Drawings;
    b. Manufacturer's model number or other product designation;
    c. Project tag number used herein and on the Drawings;
    d. Project system loop of which the component is a part;
    e. Project location or assembly at which the component is to be installed;
    f. Input and output characteristics;
    g. Scale range and units (if any) and multiplier (if any);
    h. Requirements for electric supply (if any);
    i. Requirements for air supply (if any);

j. Materials of component parts to be in contact with, or otherwise exposed to, process media;
k. Calibration curves as required.
l. Special requirements or features.

A complete index shall appear in the front of each bound submittal volume. A separate technical brochure or bulletin shall be included with each instrument data sheet. The data sheets shall be indexed in the submittal by systems or loops, as a separate group for each system or loop. If, within a single system or loop, a single instrument is employed more than once, one data sheet with one brochure or bulletin may cover all identical uses of that instrument in that system. Each brochure or bulletin shall include a list of tag numbers for which it applies. System groups shall be separated by labeled tags.

3. Drawings showing both schematic and wiring diagrams for control circuits. Complete details on the circuit interrelationship of all devices within and outside each control panel shall be submitted first, using schematic control diagrams. Subsequent to return of this first submittal by the Engineer, piping and wiring diagrams shall be prepared and submitted for review by the Engineer; the diagrams shall consist of component layout Drawings to scale, showing numbered terminals on components together with the unique number of the wire to be connected to each terminal. Piping and wiring diagrams shall show terminal assignments from all primary measurement devices, such as flow meters, and to all final control devices, such as samplers, pumps, valves, and chemical feeders. The Contractor shall furnish all necessary equipment supplier's Shop Drawings to facilitate inclusion of this information by the I&C system supplier.

   Schematic and wiring diagram criteria shall be followed as established in NEMA Standards Publication ANSI/NEMA 1CS-1-1978, "Industrial Control and Systems."

4. Assembly and construction Drawings for each control panel and for other special enclosed assemblies for field installation. These Drawings shall include dimensions, identification of all components, surface preparation and finish data, nameplates, and the like. These Drawings also shall include enough other details, including prototype photographs, to define exactly the style and overall appearance of the assembly; a finish treatment sample shall be included.

5. Installation, mounting and anchoring details for all components and assemblies to be field-mounted, including conduit connection or entry details.

6. Complete and detailed bills of materials. A master Bill of Materials listing all field mounted devices, control panels and other equipment that shall be shipped to the job site. A Bill of Materials for each control panel listing all devices within the panel.

7. Modifications to existing equipment. A complete description of all proposed modifications to existing instrumentation equipment, control panels, control devices, cabinets, etc., shall be submitted with the Shop Drawings complete with detailed Drawings of the proposed modifications.

B. ORGANIZATION AND BINDING:

The organization of initial Shop Drawing submittal required above shall be compatible to eventual inclusion with the Technical Manuals submittal and shall include final alterations reflecting "as built" conditions. Accordingly, the initial multiple copy Shop Drawing submittal shall be separately bound in 3-ring binders of the type specified under Part 2.03, herein, for the Technical Manuals.

2.03 TECHNICAL MANUALS

A. Five (5) final sets of technical manuals shall be supplied for the Owner, and one (1) final set shall be supplied for the Engineer, as a condition of acceptance of the project. Each set shall consist of one (1) or more volumes, each of which shall be bound in a standard size, three-ring, loose-leaf, vinyl plastic hard cover binder suitable for bookshelf storage. Binder ring size shall not exceed 3.0 inches.

B. Initially, two (2) sets of these manuals shall be submitted to the Engineer for favorable review after return of favorably reviewed Shop Drawings and data required under Part 3, herein. Following the Engineer's review, one (1) set shall be returned to the Contractor with comments. The sets shall be revised and/or amended as required and the requisite final sets shall be submitted to the Engineer fifteen (15) days prior to start-up of systems. The Engineer shall distribute the copies.

C. In addition to updated Shop Drawing information to reflect actual existing conditions, each set of technical manuals shall include installation, connection, operating, trouble-shooting, maintenance, and overhaul instructions in complete detail. This shall provide the Owner with comprehensive information on all systems and components to enable operation, service, maintenance, and repair. Exploded or other detailed views of all instruments, assemblies, and accessory components shall be included together with complete parts lists and ordering instructions.

D. Contractor shall also need to provide all technical manuals and shop drawing information in electronic format (searchable PDF, MS words, AutoCAD, etc.) and

combine in a CD or DVD. Provide two copies of CD or DVD with the hard copies as stated above.

2.04 SPARE PARTS

A. The Contractor shall include, as part of the bid package, a list of recommended spare parts covering items required under Section 13300 except PLC's of these Specifications. The total price of these spare parts shall not be less than $3,000.00 and this sum shall be a part of the Contractor's total bid price. PLC spare parts are covered in the PLC section of this Specification, and the $3,000.00 cited above shall be in excess of the PLC spare parts as listed in 2.08 of this specification. The Single I&C Supplier in fact shall be responsible for delivery of the spare parts, as directed by the Owner after plant start-up. Prior to delivery of the spare parts, the Owner shall have the option of adding or exchanging any originally enumerated component based on current list prices for each item. The Contractor shall also submit a list of recommended equipment for maintaining and calibrating equipment furnished under Section 13300.

2.05 CONTROL PANELS

A. GENERAL:

New control panels shall be furnished and installed under this Contract. They shall house the instrumentation, control devices, LED indicating lights, PLC's, alarm chasses, displays, all necessary accessories, wiring and terminal blocks as necessary and as shown on the Drawings and as described herein. Control panel doors shall be equipped with a door latch kit or a fast operating clamp assembly as applicable. 120 volt AC control voltage in a control panel shall be supplied with a line noise suppressing transformer specified elsewhere in this Section. Each control panel shall be properly grounded and as such be provided with a ground terminal block. Control panels shall be properly sized for installation through new and existing entry ways and custom fit for locations as shown on the drawings.

B. CONSTRUCTION:

1. CONTROL ROOM:

Control room panels shall be Nema 12 Gasketed. The enclosures shall be manufactured of 14 gauge steel.

2. BUILDING:

Control panels inside a building (not in a control room) shall be Nema 12 Gasketed, 316 stainless steel 14 gauge construction. Control panels in corrosive areas shall be construed to be outdoors.

3. OUTDOOR:

All outdoor control panels shall be NEMA 4X with drip shield kit, 3 point latch mechanism and 316 stainless steel 14 gauge construction and painted white.

4. COOLING:

Control panels shall have sufficient cooling and/or ventilation not to exceed the maximum operating temperature of any of the internal components. Ambient temperature limits shall be 90 degrees F for indoor and 100 degrees F for outdoor control panels. Outdoor control panels with electronic equipment shall be furnished with sun shields around and on top of the control panels.

5. UPS:

a. UPS: Control Panels shall be furnished with a UPS to provide power to the PLC microprocessor and all PLC support, interface, and communication equipment for a minimum of 45 minutes. UPS shall be manufactured by APC Smart-UPS SC or Owner approved equal.

b. Each UPS shall be the on-line, double-conversion type with true sine wave output. UPS shall provide power conditioning to the load. UPS shall be externally mounted from the PLC cabinet. UPS shall be installed in either an air conditioned or a ventilated building. Each UPS shall be provided with a bypass switch such that the UPS can be taken out for maintenance without disturbing the devices it protects. Each UPS shall provide auxiliary contact outputs connected to the PLC to monitor UPS alarm, UPS fail, lower battery, main power fail, and UPS bypassed.

C. SIGNAL AND CONTROL CIRCUIT WIRING:

1. WIRE TYPE AND SIZES

Conductors shall be flexible stranded copper wire; these shall be U.L. listed Type XHHW and shall be rated 600 volts. Wire for control signal circuits and alarm input circuits shall be 14 AWG. All instrumentation cables shall be shielded twisted pair or triad No. 20 AWG with a copper drain wire. Multiconductor control cabling shall not be used. All special instrumentation cable such as between sensor and transmitter shall be supplied by the I&C supplier. Ethernet cable shall be Category 5E (Enhanced). Ethernet cable used for VFDs and power monitoring shall be capable of shielding data from RFI and EMI interference.

2. WIRE INSULATION COLORS

Conductors supplying 120 volt AC power on the line side of a disconnecting switch shall have a black insulation for the ungrounded conductor. Grounded circuit conductors shall have white insulation. Insulation for ungrounded 120 volt AC control circuit conductors shall be red. All wires energized by a voltage source external to the control board(s) shall have yellow insulation. Insulation for all DC conductors shall be blue.

3. WIRING INSTALLATION

All wires shall be run in plastic wireways except (1) field wiring, (2) wiring run between mating blocks in adjacent sections, (3) wiring run from components on a swing-out panel to components on a part of the fixed structure, and (4) wiring run to panel mounted components. Wiring run from components on a swing-out panels to other components on a fixed panel shall be made up in tied bundles. These shall be tied with nylon wire ties, and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at terminals.

Wiring run to control devices on the front panels shall be tied together at short intervals with nylon wire ties and secured to the inside face of the panel using adhesive mounts.

Wiring to rear terminals on panel mount instruments shall be run in plastic wireways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments.

Shields of shielded instrument cable shall only be grounded on one side of each cable run. The side to be grounded shall always be in the field as applicable.

Care shall be exercised to properly insulate the ungrounded side, to prevent ground loops from occurring.

Conformance to the above wiring installation requirements shall be reflected by details shown on the Shop Drawings for the Engineer's review.

4. WIRE MARKING

Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all Shop Drawings. These numbers shall be marked on all conductors at every terminal using permanently marked heat-shrink

plastic. Instrument signal circuit conductors shall be tagged with unique multiple digit numbers. Black and white wires from the circuit breaker panelboard shall be tagged including the one (1) or two (2) digit number of the branch circuit breaker. Adhesive wire labels are not acceptable.

5. TERMINAL BLOCKS

Terminal blocks shall be molded plastic with barriers and box lug terminals, and shall be rated 15 amperes at 600 volts. White marking strips, fastened securely to the molded sections, shall be provided and wire numbers or circuit identifications shall be marked thereon with permanent marking fluid. Terminal blocks shall be screw-type General Electric Type CR 151A1 with mounting rack, equivalent by Cinch-Jones or equal.

6. TERMINATION OF WIRING

All PLC I/O wiring shall be terminated on removable terminal strips on the individual PLC modules that permit removing I/O modules without disconnecting the wiring. Tag and mark all terminal blocks and individual wiring. All wiring from the field shall terminate on a separate numbered terminal blocks. Separate groups of terminal blocks in discrete inputs, discrete outputs, analog inputs, analog outputs, each different voltages, UPS power, etc. Use different colored wire for all digital inputs and digital outputs to aid in easy identification of signal type.

7. FIBER OPTIC CABLE

New and replaced fiber shall be 12 pair Corning 62.5 multimode fiber optic, or County approved equal. Label each end of the fiber optic cables according with County's standards. All fiber optic cable, including spares, shall be terminated not spliced in fiber optic patch panels. Provide patch cables as required. All patch panel indoors shall be provided with NEMA 12 Gasketed enclosures, all panels outdoors shall be located in NEMA 4X enclosures and shall handle at least 12 pair of fiber. Fiber optic cable manufacturer shall provide a 25 year warranty on fiber cable. Fiber optic cable shall be installed by a Corning or equal certified I&C installer with a 25 year warranty guarantee for the Owner/County. Maximum acceptable signal loss shall be 10dB through the entire fiber path.

D. PAINTING:

Control panels shall be thoroughly cleaned and sandblasted per SSPC-SP-6 (Commercial Blast) after which surfaces shall receive a prime coat (Amercoat 185, Koppers 622HB, or equal) 3-mils dry, followed by two (2) or more finish coats (Amercoat 5401, Koppers 501, or equal) 3-mils dry, for a total thickness of

the complete system of 6 mils. The finished color of the outside surfaces shall be selected by the Engineer. The inside surfaces shall have a white finish coat.

Exterior control panels shall be painted white on the exterior. A durable coating system with a five-year full replacement guarantee shall be used to coat the stainless steel panels. Defects in the coating systems include, but are not limited to, fading, color change, cracking peeling, or otherwise disbonding.

E. PLC CONTROL PANEL REQUIREMENTS

All input/output hardware and interface equipment shall be provided by the computer & PLC system supplier for all specified inputs and outputs. Input/output hardware shall be plug-in modules (or equivalent I/O assembly and associated printed circuit board) in associated I/O rack assemblies.

Signal and control circuitry to individual input/output modules shall be arranged such that any one module failure shall not disable more than one control loop within any group of controlled equipment (eg. one pump out of a group of three pumps, etc.)

All analog and discrete inputs and outputs shall be optically or transformer isolated for voltage surge protection and shall meet peak common mode and 3 kV surge to ground withstand capability (SWC) test as specified by ANSI C37.90A-197A (IEEE Standard 472-1974).

In the event a standard manufacturers product does not satisfy the above surge requirements, additional protective circuitry to suppress contact bounce and to protect transients from being recognized as data. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms which are movable to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals.

The PLC shall be capable of handling the required number of process inputs and outputs as shown on Instrumentation Drawings, plus 25 percent active spares, plus capacity to accommodate 25 percent future inputs and outputs by the addition of the required circuit cards. Input/output modules shall have individual indicators that show the on/off status of each input or output device connected to it. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms which are movable to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. Process interface units shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All terminals shall be provided with unique identification in accordance with approved loop

interconnection diagrams. Furnish analog I/O cards that have 8 analog inputs and 8 analog outputs on the card and digital I/O cards that have 16 digital input and 16 digital outputs on the card. The requirements for each type of I/O are:

1. ANALOG INPUT

The analog input subsystem shall accept 4-20 mA (1-5 volts across 250 ohms) signals which shall be multiplexed into one or more amplifiers and ADC's by one or more analog input multiplexers. The analog input multiplexers shall be of the solid state differential type and shall employ successive approximation or dual slope integration to digitize the sampled analog signals into a 12 bit binary value; with an accuracy of $\pm$0.05% of full scale. Input power supply shall be 24 volts DC from the I/O power supply subsystem where power is not supplied by the associated field instrument. Common mode input protection of 30 VDC minimum shall be provided. Input signal A/D conversion shall be a minimum of 12-bits, with an accuracy of one bit. Isolated DC power for field transmitters shall be provided as required.

2. DISCRETE INPUT

Dry Contact:
The input subsystem shall sense the open or closed status of contacts at each scan interval. Sensing power shall be 24 volts DC from the I/O power supply subsystem. The module inputs shall be optically isolated from the PLC and designed to withstand transients and surges without damage. Input components shall be individually protected to ensure that failure within one component will not interrupt processing of others.

Powered input:
The input subsystem shall sense the status of 120VAC inputs at each scan interval. Power for inputs is derived from the source system or equipment.

3. ANALOG OUTPUT

The analog output subsystem shall accept incremental signals from the process controller. A solid state digital to analog converter (DAC) shall be provided for each analog output. The incremental signals from the process controller shall increment or decrement the 4-20 MA output signal from each DAC. A 24 volt DC power supply shall be provided for analog outputs from the I/O power supply subsystem.

The output of each DAC shall be continuously maintained and shall have a drift rate no greater than 2% in 24 hours. Each DAC shall have a 12 bit resolution and an accuracy of $\pm$0.05% full scale.

4. DISCRETE OUTPUT

The discrete output subsystem shall be of the solid state type and shall generate maintained or momentary outputs as required to operate interposing relays provided in related circuitry. Diode protection (in addition to surge protection) shall be provided on all discrete outputs. The output contacts shall be rated 24 VDC/120 VAC, 5A SPDT.

5. PLC SPARE PARTS

a. 10% spare of each I/O type per control panel including: Analog Input, Analog Output, Digital Input, and Digital Output, with a minimum of two of each Analog type and one of each Digital type.
b. 10% spare of each type of communication module and cable, with a minimum of one of each type and length.

2.06 ACCESSORIES

A. General purpose relays with LED indication in the control panels shall be plug in type with contacts rated 10 amperes at 120 volts AC. The quantity and type of contacts shall be as shown on the Drawings. Each relay shall be enclosed in a clear plastic heat and shock resistant dust cover. Sockets for relays shall have screw type terminals. Relays shall be Potter and Brumfield Type KRP or KUP, Square-D Type K, or equal.

B. Time delay relays shall be solid state on-delay or off-delay type with contacts rated 10 amperes at 120VAC. Units shall include adjustable dial with graduated scale or digital switch setting covering the time range in each case. Time delay relays shall be Agastat Series 7000, Omron series H3, SSAC type TDM or approved equal.

C. Additional slave relays shall be installed when the number or type of contacts shown exceed the contact capacity of the specified relays and timers.

D. All relays shall be provided with LED indication (Opened & Closed) and a test button to show when relay is energized. Relays shall be mechanically latched type where the service is primarily in the hold open or hold closed position to maintain the operating function. Internal intermittent acting relays may be electrically held. Fail safe conditions may also utilize electrically held relays.

E. Switches shall be round 30.5mm configuration and LED indicating lights shall be round 16 mm configuration, heavy duty and corrosion resistant. Legend plate shall be standard size square style laminate with white field and black markings as shown.

F. LED Indicating lights (Pilot lights) shall be rated oil tight/water tight, heavy duty. Miniature type devices are not acceptable. Pilot lights shall be of the transformer

type utilizing low voltage lamps. Pilot lights shall be either the push to test type or a common lamp test button type provided on the panel. Pilot lights shall allow for lens and bulb replacement through the front of the unit. Pilot light shall be new LED technology type, no exception. Pushbuttons shall include full guard with flush button and selector switches shall include a black non-illuminated knob on switch, unless otherwise noted. Contact arrangement and configuration shall be as shown on drawings. Devices shall be Cutler Hammer Type E-30, General Electric Type CR104, Square D class 9001 type Sk, Allen Bradley Bulletin 800 or equal.

G. Selector switches shall be of the rotary type with the number of positions as shown on the Drawings. Color, escutcheon engravings, contact configurations and the like shall be as shown. Devices shall be Cutler Hammer Type E-24, General Electric Type CR104, or equal.

H. Circuit breakers shall be single pole, 120 volt, 15 ampere rating or as required to protect wires and equipment and mounted inside the panels as shown.

I. Nameplates shall be supplied for identification of all field mounted elements, including flow meters and their transmitters. These nameplates shall identify the instrument, or meter, descriptively, as to function and system. These nameplates shall be fabricated from black-face, white-center, laminated engraving plastic. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, each electronic trip, and the like, mounted inside the control panels. These shall be descriptive, to define the function and system of such element. Adhesives shall be acceptable for attaching nameplates. Painted surfaces must be prepared to allow permanent bonding of adhesives. Nameplates shall be provided for instruments, function titles for each group of instruments and other components mounted on the front of the control panels as shown. These nameplates and/or individual letters shall be fabricated from VI-LAM, Catalog No. 200, manufactured by N/P Company, or equivalent by Formica, or equal. Colors, lettering, style and sizes shall be as shown or as selected by the Engineer.

J. Solenoid Valves if not otherwise noted shall be globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation. Materials shall be brass globe valved bodies and Buna-N valve seats. The size shall be 1/4" normally closed. The coil shall be 115 VAC coil, Nema 4 solenoid enclosure. Manufacturer shall be ASCO; Red Hat, or equal.

K. 4 to 20 mA Loop Indicators: For new supplied instruments, include a local digital readout that is integral with the instrument.

L. All fuses used in PLC panels and other control panels shall be of the type that indicates a blow fuse condition.

2.07 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) PROTECTION

A. GENERAL:

TVSS protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, and be maintenance free and self-restoring.

Instruments shall be housed in a suitable case, properly grounded. Ground wires for all TVSS shall be connected to a good earth ground and where practical, each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure or a separate NEMA 4X junction box coupled to the enclosure.

B. POWER SUPPLY:

Protection of all 120 VAC instrument power supply lines shall be provided. Control panels shall be protected by line noise suppressing isolation transformers and TVSS. Field instruments shall be protected by TVSS. For control panels, the line noise suppressing isolation transformer shall be Topaz Series 30 Ultra isolators or approved equal. The suppressor shall be Edco HSP-121, Surge Suppression Incorporated, Current Technology, or Joslyn.

C. ANALOG SIGNALS:

Protection of analog signal lines originating and terminating not in the same building shall be provided by TVSS. For analog signal lines the TVSS shall be Edco PC-642. For field mounted two-wire instruments the TVSS shall be encapsulated in stainless steel pipe nipples, and shall be Edco SS64 series, Phoenix, MTL, or DEHN with a small profile suitable for installation in the RTU's.

For field mounted four-wire 120VAC instruments, the TVSS shall be in a NEMA 4X polycarbonate enclosure, Edco SLAC series, Phoenix, MTL, or DEHN.

2.08 INSTRUMENTATION AND CONTROL EQUIPMENT SPECIFICATIONS

L1: LEVEL ELEMENT AND TRANSMITTER (ULTRA-SONIC)

1. The multi-purpose sonic level system shall operate on the principle of ultrasonic sonar reflection in which acoustic impulses emitted from an ultrasonic transducer are reflected back from the material surface and are received by the transducer. The transit time of pulse travel from generation to echo is measured. The elapsed time is proportional to the distance between

the transducer face and material surface. Systems shall be designed for automatic self-compensation of signal speed due to temperature, humidity and other atmospheric variations. The system shall be supplied with interconnecting cable between sensor and transmitter.

2. Transmitter Design:

   a. Microprocessor-based echo-time measuring transmitter with output signal proportional to distance between sensor and surface of media. The controller shall have an EEPROM memory and shall not require a battery to ensure protection of stored data.
   b. Modular component assembly construction with plug-in electronics for convenient service.
   c. Power: 120 VAC. 60 Hz, 17-Watt maximum power requirements (36-VA).
   d. Isolated 4-20 mA DC output signal into 750 ohms
   e. Operation range and engineering unit selections with local digital display of measured distance shall be able to enter new data via infrared keypad.
   f. Accuracy: +/- 0.25 percent of full scale.
   g. Resolution: +/- 0.1 percent of full scale.
   h. Distance: Maximum allowable distance between sensor and transmitter is 1200 feet.
   i. Total Beam Angle: 6 degrees or less.
   j. Maximum Range: 0 to 50 standard feet.
   k. Process: Level of finished water in storage tank.
   l. Sensor Location Temperature: -40 to 203 degree F.
   m. Transmitter Ambient Temperature: -5 to 122 degree F.

3. The multipurpose sonic level system shall have internal self-diagnostics function and 6 alarm relays for lost echo or temperature, rate of change of level, differential level, time sampling, volume sampling, and pump control. Systems shall be furnished complete with flanged transducer, interconnection cable and indicating transmitter.

4. The transmitter shall include an integral LCD type indicator calibrated in engineering units for local indication. LCD display shall be minimum 100 x 40 mm (4 x 1.5”) multi-field back lit LCD display with individual alarm status lights on LCD display.

5. Provide a hand held keypad programmer or calibrator for startup.

6. Unless shown otherwise on the instrument schedule, provide NEMA 4X corrosion resistant, oil tight, dust tight, and weatherproof housing for indoor or outdoor locations.

7. Provide all stainless steel mounting hardware for surface, panel or handrail mounting as required by location.

8. Provide front mounted visible data display behind clear, shatterproof viewing cover.

9. Systems shall be manufactured by Siemens-Milltronics Model Hydroranger 200 with an Echomax XPS-15 transducer or equal and shall be compatible with the chemical process environment.

L2: LEVEL SWITCH

Level switches shall consist of a non-mercury type switch element encapsulated in a nominal 5 inch diameter PVC float housing. The switch contact shall be single-pole, double-throw, rated 10 amp at 120 V ac. The float shall be supported from a flexible three-conductor 18 AWG cable that also acts as the float hinge. The cable shall be suitable for fixed mount or weighted suspension type installation as indicated on the drawings or in the device schedule. All necessary mounting hardware shall be provided. The hinge-cable length shall be field adjustable in a manner that allows the deadband to be adjusted between 9 inches and 3 feet. The switch shall be Magnetrol "Series T10" float switch.

A1: CHLORINE ANALYZER: FLUORIDE ANALYZER (NOT USED)

A2: pH SENSOR AND TRANSMITTER

The pH sensor and analyzer/transmitter shall be products of the same manufacturer. The cable between the sensor and the transmitter shall be provided by the manufacturer. The sensor shall consist of a kynar, PVC, polypropylene, or other chemical-resistant electrode housing containing a glass pH electrode and a fouling-resistant reference electrode. The pH reference electrode shall be self-contained and shall not require an external electrolyte reservoir. The sensor shall have automatic temperature compensation.

Flow-through type sensors when required, shall have 3/4 or 1 inch NPT process connections and shall be suitable for a working pressure of 1 to 100 psig at 140°F, with a sample flow rate of 0.5 gpm.

Each pH sensor assembly shall be provided with a maintenance kit that shall include a spare pH electrode, a spare reference electrode, and other spare parts as recommended by the manufacturer.

The transmitter shall be enclosed in a corrosion resistant NEMA Type 4X housing. The transmitter shall be microprocessor based, with integral diagnostics, and with non-volatile memory. The transmitter shall be suitable for ambient temperatures of -30 to +60°C and a relative humidity of 0 to 100 percent. The

transmitter shall have an isolated 4-20 mA dc output linearly proportional to the measured range, with an accuracy of ± 0.2 percent of scale. The transmitter shall have a 32 character alphanumeric multiline LCD display that is menu driven. Transmitter range shall be as indicated. The transmitter shall have automatic temperature compensation over a range of 0 to 50°C. The transmitter shall be of the ac-powered type. The transmitter shall be supplied with an appropriate length of signal cable for connecting the transmitter to the sensor. Transmitter shall be furnished with integral lightning surge protection.

The pH analyzer shall be manufactured by Electro-Chemical Devices, Siemens (Depolox), Great Lakes, TBI-Bailey, or Rosemount.

A3: HYDROGEN SULFIDE ANALYZER AND TRANSMITTER

See Specification Section 11305.

F1: FLOW ELEMENT AND TRANSMITTER (MAGNETIC)

Furnish all labor, material, equipment, and incidentals required to install new magnetic flow meters and associated piping and auxiliary equipment as show on the Drawings.

Meter:

All equipment included in the construction of the magnetic flow meters shall be of proven ability for use in measuring total flow and flow rates. The meter shall contain a remote microprocessor based signal converter which will display both rate of flow and total flow using a 4-20 mA DC output signal.

1. General:

    a. Function: Measure, indicate, and transmit the flow of a process liquid in a full pipe.
    b. Type: Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
    c. Parts: Flow element, transmitter, interconnecting cables, mounting hardware, and calibrator.

2. Service:

    a. Stream Fluid: As noted.
    b. Flow Stream Descriptions:

        1) Water:

a) Potable water;
b) Water with slight alkalinity (7.5 to 8 pH) and up to 10 mg/l suspended solids; or
c) Water with up to 20 mg/l of light organic solids, temperature up to 250 degrees F.

The meter shall be of the low frequency electromagnetic induction type and shall produce a pulsed DC signal directly proportional and linear with respect to the liquid flow rate. The output signal from the separately mounted meter electronics shall be 4-20mA DC. The meter shall be designed for operation of a 120 VAC, 60 Hz power consumption of less than 15 watts for sizes through 12-inch, and 5 watts per inch of diameter larger than 12 inches.

The meter shall include a magnetic driver to power the magnetic coils and a signal converter. The metering velocity span shall be continuously adjustable from 0 to 1 and 0 to 33 feet per second, and the meter shall feature complete zero stability. The meter shall be hydraulically calibrated in the United States and the calibration shall be traceable to the National Bureau of Standards.

3. Performance:

a. Flow Range: As noted.
b. Accuracy: Plus or minus 1 percent of rate for all flows resulting from pipe velocities of 0 to 100% flow range.
c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
d. Repeatability: ±0.1% of full scale.
e. Ambient Temperature - 20 to 120 ^{O}F.
f. Range full scale from 0 to 33 ft/sec.

4. Features:

a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
b. No obstructions to flow.
c. Very low pressure loss.

5. Process Connection:

a. Meter Size: As noted.
b. Connection Type: 150-pound ANSI raised-face flanges or wafer style depending on meter size, unless otherwise noted.
c. Flange Material: Carbon steel, unless otherwise noted.

6. Signal Interface:

    a. 4 to 20 mA dc for load impedance 0 to 800 ohms minimum for 24V dc supply.

7. Power: 120V ac, 60-Hz, unless otherwise noted.

8. Element:

    a. Meter Tube Material: 304 stainless steel, unless otherwise noted.
    b. Liner Material: NSF approved fusion boned epoxy liner.
    c. Liner Protectors: Covers on each end to protect liner during shipment.
    d. Electrode Type: non removable 316 stainless steel.
    e. Electrode Material: 316 stainless steel, unless otherwise noted.
    f. Enclosure: NEMA 4, unless otherwise noted.
    g. Grounding Ring/Electrode Material: 316 stainless steel, unless otherwise noted.

9. Transmitter:

    a. Display: Blind or indicating and/or totalizing as noted.
    b. Mounting: Pipe stand, wall, panel, or integral as noted.
    c. Enclosure: NEMA 4X.
    d. Zero and Span: Field adjustable.
    e. Indicator: Digital 16-character display, with scale range as noted.
    f. Totalizer: Digital 16-character display, with totalizer unit digit value as noted.
    g. Terminal Box: NEMA 4X construction mounted on main body of water. Provide splash and dust proof terminal boxes with water cable entrance seals.

10. Cables:

    a. Types: As recommended by manufacturer.
    b. Lengths: As required to accommodate device locations.

11. Calibration System:

    a. Features:

        1) Field programmable electronics.
        2) Self-diagnostics with troubleshooting codes.

3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
4) Initial flow tube calibration and subsequent calibration checks.

h. Equipment:

1) Built-in electronics with each unit provided.
2) Alternatively, one portable calibrator of each type required for the various electromagnetic flowmeters provided on the project.

Provide special tools and spare parts to completely operate and maintain the unit.

Calibration check shall be verified by a simple built in signal injection. The meter shall provide for a constant zero output signal during no flow and other conditions of potential false signals.

Electrical connections shall be 1/2 inch NPT water tight and flush. Manufacturer shall certify the meter is capable of operating under submergence for up to 48 hours in 30 feet of water.

Grounding rings shall be Type 316 stainless steel and placed between the meter and mating flanges at both ends of the meter, or as recommended by the manufacturer.

Meter rangability shall be 100:1. The output signal scale shall be capable of field adjustment. The unit shall be accurate to ±1% of rate. The unit shall have standard radio frequency protection.

The meter shall be Mag-meter manufactured by McCrometer Ultramag 06/08 Series, or Foxboro/Flexim 9100 Series, Siemens Mag 5100W sensor with MAG 6000 transmitter, Rosemount or Orange County approved equal.

Converter:

Microprocessor based signal converter shall accept any linear or squared 4-20 mA DC signal. The unit shall simultaneously display rate of flow and total flow on a half inch (1/2") high liquid crystal display (LCD). The totalizer shall be field programmable for totalization and indicator. The unit shall contain an 8-digit total flow display and be provided with a battery back-up for total flow display, in the event of signal interruption or loss of signal. The total flow display, prior to signal interruption, shall not be lost or zeroed out. Power requirements shall be 120 VAC. The Indication Flow display shall be 3-digit, 1/2 inch high LCD. Converter shall be supplied with empty pipe detection feature.

The accuracy of the Total Display shall be ±0.5 percent of rate over the full scale. The accuracy of the rate display shall be ±0.5 percent of rate over the full scale.

The housing shall be a fire retardant glass-reinforced polyester plastic with provisions for surface mounting. The case shall be NEMA 4X rated suitable for outdoor installations. The window shall be tempered glass. Provide internal illumination for night reading.

Provide two output signals linear and directly proportional to flow as follows: 4-20mAdc isolated into 0-600 ohms. 0-10 kHz scaled pulse.

Low Flow Cutoff Limit: Drive the output to zero when the measured flow rate is 1-10 percent (adjustable) of full scale and when fully developed flow no longer exists.

High Impedance Sensing: Provide sensing amplifiers with high impedance to minimize effects of deposit build-up on the electrodes.

Interchangeable Electronics: Provide converter/transmitter that is interchangeable with all flow meter sizes of manufacturer's same model.

The converter shall be manufactured by Ultramag, or Foxboro/Flexim, Orange County (Owner) Approved equal.

F2: FLOW ELEMENT AND TRANSMITTER (ULTRASONIC)

Flowmeters shall be of the diagonal traversing transit time type. The flow tube assembly shall consist of a completely obstruction-less steel pipe with flanged ends. Flange diameter and bolt drilling pattern shall comply with ANSI B16.5, Class 150. Meters shall be suitable for the maximum working pressure range of the adjacent piping. The flowmeter shall use a pair of ultrasonic transducers designed to measure the sound velocity in both directions with respect to the flow. The transducers shall be mounted through special windows in the flow tube assembly and shall not sense through the pipe wall.

Each flowmeter shall be calibrated in the laboratory, and copies of the calibration data shall be included in the operation and maintenance manual submittals.

The ultrasonic flow transmitter shall have all solid-state electronic circuitry housed in a corrosion resistant weatherproof NEMA Type 4X enclosure mounted near the flow tube. The transmitter shall be suitable for an ambient temperature range of +32 to +130°F or -20 to +140°F as required, and a relative humidity of 10 to 100 percent. The electronic transmitter shall include interference-rejecting circuitry to maintain a reliable signal in the presence of bubbles, solids, and

disturbances in the flow. The electronic transmitter circuitry shall be interchangeable between flowmeters and shall allow easy field range changes. Circuitry shall include diagnostic indication to assist in troubleshooting and calibrating the transmitter. The transmitter output shall be an isolated 4-20 mA dc signal into 0 to 600 ohms, linear to the calibrated flow range. Accuracy of the transmitted signal shall be ±1 percent of actual flow rate over a range of 10 to 1. The flowmeter shall be of the ac powered type.

The ultrasonic flowmeter shall have a corrosion-resistant weatherproof local electronic indicator mounted near the flow transmitter. The indicator shall be a digital type or a nominal 4 inch scale engraved in engineering units of flow. The indicator accuracy shall be ±1 percent of full scale. All transmitters shall include an integral signal lightning surge protector.

The ultrasonic transducers shall be removable without depressurizing or dewatering the flowmeter body.

The ultrasonic flowmeter shall be Accusonic, Mesa Labs Nusonics, Sparling or Endress Hauser.

P1: PRESSURE ELEMENT AND TRANSMITTER:

Instrument shall utilize a variable capacitance sensor cell to convert process pressure to capacitance with isolating diaphragms to separate the process fluid from the internal fill fluid. The electronic circuit shall convert capacitance change into a proportional 4-20mA output signal. The enclosure shall meet intrinsically safe, explosion proof (NEMA 7) and weatherproof (NEMA 4X) certifications. The operating range shall be configurable with 40:1 rangeability up to 5800 psi. The accuracy shall be $\pm$ 0.1% of span. The output shall be two-wire 4-20mA with superimposed digital communication using HART protocol. Unit shall operate on loop-power from 12 to 45 VDC. The unit shall have configurable 4 ½ digit numerical plus 5-character alphanumeric displays to indicate PV and output in Engineering Units. Configuration shall be performed using digital HART protocol with PC laptop software or using a HART hand-held configurator or through local adjustment. Provide configurator as part of package. Unit shall be Rosemount or Foxboro.

P2: PRESSURE GAUGE

As per specification 15130.

P3: PRESSURE SWITCH (DIAPHRAGM SENSOR)

Pressure switch shall employ a diaphragm sensor and a Belleville disc spring for setpoint stability and vibration resistance. Wetted parts are to be 316SS with BUNA-N "O" rings. Two setpoints shall be adjustable over selected range with an

internal slotted adjustment with range scale. The enclosure shall be epoxy painted and meet the requirements of NEMA 4X. Pressure connection shall be ½" x 14 FMPT. Switch contact shall be 10A, 120VAC DPDT implying SPDT for each setpoint. Pressure switch shall be ITT NeoDyn Series 132P or Owner approved equal

P4: DIFFERENTIAL PRESSURE TRANSMITTER

Transmitters shall have "smart" electronic circuitry and shall be of the two-wire type. Process fluid shall be isolated from the sensing elements by Type 316 stainless steel, Hastelloy-C, ceramic, or cobalt-chromium-nickel alloy diaphragms, and the transducer may use a silicone oil fluid fill as required by process conditions. Transmitters shall be enclosed in a NEMA Type 4X housing and shall be suitable for operation at temperatures from 0° to 180°F, with relative humidity of 5 to 100 percent. All parts shall be stainless steel, or other corrosion-resistant materials. Vents shall be provided on the sides of the diaphragm housing body. Transmitters shall have positive over-range protection. Accuracy of the transmitters shall be 0.10 percent of span, and the effect on accuracy caused by static pressure changes shall be negligible. Transmitter output shall be 4-20 mA dc without the need for external load adjustment. Transmitters shall not be damaged by reverse polarity. Each transmitter shall be provided with three-valve manifold and a mounting bracket as required. Manifolds shall have test ports on the instrument side of the valves and shall be Anderson-Greenwood "M4T". All transmitters shall be furnished with integral lightning surge protection.

Transmitters shall be factory calibrated to the required range and provided with the manufacturer's standard hand-held communications/calibration device. One device shall be furnished for all transmitters provided by a single manufacturer.

Transmitters shall be furnished with LCD type digital indicators calibrated to display in engineering units.

Transmitters shall be Rosemount “Model 3051C”, or Foxboro "Model IDP10-D only no equals.

T1: THERMAL DISPERSION FLOWMETERS

Flowswitch shall utilize a thermal dispersion type, explosion-proof, Hastelloy-C sensing element installed in the process piping. The insertion length of the element shall be approximately one-half of the pipe diameter, and all mounting accessories shall be provided. The sensor shall have a 1-1/4 inch NPT retractable packing gland mounting connection with isolation valve that allows insertion and removal while the piping is under pressure.

The electronic transmitter shall be remotely mounted within 25 feet of the sensor with interconnecting cable provided. The transmitter shall be of the ac-powered type. The unit shall be housed in an explosion-proof enclosure suitable for hazardous locations. Flow switches shall have a dual DPDT field configurable relay with 6 amp resistive rating 115vac or 24vdc.

Accuracy shall be +/- 5% reading (or +/- 2 sfps; +/- .61 smps) whichever is larger. Repeatability shall be +/- .5% reading. Flowswitch shall be FC FlexSwitch Model FLT93F as manufactured by Fluid Components Intl., or approved equal.

2.09 LOOP DESCRIPTIONS

A. See I-Drawings.

2.10 CONTROL STRATEGY SCHEDULES

The control strategies are written descriptions of the programming required to implement regulatory and sequential control of the unit processes. Control strategies shall fully reside in the memory of the designated PLC. Coefficients pertaining to control strategies shall be modifiable through the operator interface in the monitoring / control mode.

The I&C supplier shall include an additional 160 hours on-site to fine tune control systems and make minor software modifications in order to resolve any logic discrepancies encountered during start-up, and supply the Owner with a complete functional system. This shall be part of the bid package with no additional cost to the owner.

A. Control Strategy:

See Section 13610 for Control Strategy

2.11 INSTRUMENT LIST

TAG NO.	COMPONENT CODE	COMPONENT TITLE	COMPONENT OPTIONS	REMARKS
20-FE/FIT-3	F2	Raw Water Inlet Flow 20-FDA-3	0-5,000 gpm	
20-FE/FIT-4	F2	Raw Water Inlet Flow 20-FDA-4	0-5,000 gpm	
20-AE/AIT-2	A2 A-1	Scrubber Recirculation Water pH, 20-AQC-2A	0-14 pH	
20-AE/AIT-2	A3 A-2	Inlet Hydrogen Sulfide, 20-AQC-2A	0-100 ppm	

20-AE/AIT-2	A3 B-1	Inlet Hydrogen Sulfide, 20-AQC-2B	0-20 ppm	
20-AE/AIT-2	A3 B-2	Exhaust Hydrogen Sulfide, 20-AQC-2B	0-20 ppm	
20-AE/AIT-2	A2 B-3	Scrubber Recirculation Water pH, 20-AQC-2B	0-14 pH	
20-LSHL-2A	L2	Low/High Level Switch, 20-AQC-2A		
20-LSHL-2B	L2	Low/High Level Switch, 20-AQC-2B		
	P2	Pressure Gauge	0-60 psi	
	P2	Pressure Gauge	0-60 psi	
	P2	Pressure Gauge	0-60 psi	
	P2	Pressure Gauge	0-60 psi	
	P2	Pressure Gauge	0-60 psi	
	P2	Pressure Gauge	0-60 psi	
	P2	Pressure Gauge	0-60 psi	
20-LSH-3	L2	High Level Switch, 20-FDA-3		
20-LSH-4	L2	High Level Switch, 20-FDA-4		
20-DPT-3	P4	Differential pressure transmitter, 20-FDA-3	0-2”WC	
20-DPT-4	P4	Differential pressure transmitter, 20-FDA-4	0-2”WC	
	P2	Pressure Gauge	0-60 psi	
30-PSHL-6	P3	Low/High Pressure Switch, 30-P-6	15 psi	
	P2	Pressure Gauge	0-60 psi	
30-PSH2-7	P3	Low/High Pressure Switch, 30-P-7	10/40 PSI Trip	
	P2	Pressure Gauge	0-60 psi	
30-PSH2-8	P3	Low/High Pressure Switch, 30-P-8	10/40 PSI Trip	

30-FE/FIT-1	F1	Transfer Pump Station Discharge Flow	0-80 MGD	
30-LE/LIT-3	L1	Clearwell No. 2 Level	0-20 feet	
30-LE/LIT-4	L1	Clearwell No. 2 Level	0-20 feet	
	P2	Pressure Gauge	0-150 psi	
50-PSHL-7	P3	Low/High Pressure Switch, 50-P-7	50/100 PSI Trip	
	P2	Pressure Guage	0-150 psi	
50-PSHL-8	P3	Low/High Pressure Switch, 50-P-8	50/100 PSI Trip	
50-FE/FIT-1	F1	High Service Pump Station Discharge Flow	0-120 MGD	
62-PI-9 62-PI-10	P2	Pressure Gauge	0-60 psi	
1-spare analog input card for each kind, 1-spare analog output card for each kind, 1-spare digital input card for each kind, 1-spare digital output card for each kind, 1-spare power supply for PLC. 1-spare Hirschmann 6K8 Ethernet Switch, or equal.				

2.12 PROGRAMMING SOFTWARE

The Contractor is responsible for using the ProWorx NXT PLC software that the County is currently using for the PLC type specified under specification 13300. No PLC software license is required for this project for the Owner.

2.13 TAGGING AND NUMBERING SYSTEMS

A. A consistent tag convention shall be used in the HMI/SCADA database, HMI/SCADA graphics, and PLC programs.

B. The tag convention shall use the facility code with a user defined abbreviated process, unit identifier, and status for development of the tag name. The user defined abbreviations shall be consistent throughout all facilities.

C. The description field of the tag should be an English text description that clearly describes the facility, process, instrument type/unit number, and status. For example, Tag Name: EAST_FLU_P1_VENT-ST; this represents facility “EAST”,

process “FLU”, pump “P1”, device “VENT”, and status “ST”. All tags developed for this project shall follow this tag convention.

2.14 NEW PLC RACKS AND I/O CARDS

A. 20-LCP-1 rack layout consists of the following items in addition to items required for the fuel system, coordinate with fuel system manufacturer for exact I/O and provide cards and spares as necessary for a fully functional system:

Existing 20-LCP-1 16-Slot Rack Layout		
Rack 1	Slot 1	Existing Power Supply
Rack 1	Slot 2	Existing CPU
Rack 1	Slot 3	Existing NOE Module
Rack 1	Slot 4	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 5	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 6	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 7	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 8	Existing 16-point relay output isolated module (140 series)
Rack 1	Slot 9	Existing 16-point relay output isolated module (140 series)
Rack 1	Slot 10	Existing 16-point relay output isolated module (140 series)
Rack 1	Slot 11	Existing 16-point relay output isolated module (140 series)
Rack 1	Slot 12	New 16-point relay output isolated module (140 series)
Rack 1	Slot 13	New 16-point relay output isolated module (140 series)
Rack 1	Slot 14	New 8-point analog input module (140 series)
Rack 1	Slot 15	New 8-point analog input module (140 series)
Rack 1	Slot 16	New Extender Module

New 20-LCP-1 16-Slot Rack Layout		
Rack 2	Slot 1	New Power Supply
Rack 2	Slot 2	New Extender Module
Rack 2	Slot 3	New 16-point discrete input non-isolated module (140 series)
Rack 2	Slot 4	New 16-point discrete input non-isolated module (140 series)
Rack 2	Slot 5	New 16-point discrete input non-isolated module (140 series)
Rack 2	Slot 6	New 16-point discrete input non-isolated module (140

		series)
Rack 2	Slot 7	New 16-point discrete input non-isolated module (140 series)
Rack 2	Slot 8	New 16-point discrete input non-isolated module (140 series)
Rack 2	Slot 9	New 16-point discrete input non-isolated module (140 series)
Rack 2	Slot 10	New Empty Module
Rack 2	Slot 11	New Empty Module
Rack 2	Slot 12	New Empty Module
Rack 2	Slot 13	New Empty Module
Rack 2	Slot 14	New Empty Module
Rack 2	Slot 15	New Empty Module
Rack 2	Slot 16	New 8-point analog output module (140 series)

B. 30-LCP-3 rack layouts consist of the following items:

New 30-LCP-3 16-Slot Rack Layouts		
Rack 1	Slot 1	Existing Power Supply
Rack 1	Slot 2	Existing CPU
Rack 1	Slot 3	Existing 16-point relay output isolated module (140 series)
Rack 1	Slot 4	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 5	Existing 8-point analog input module (140 series)
Rack 1	Slot 6	Existing 4-point analog output module (140 series)
Rack 1	Slot 7	Existing 8-point analog input module (140 series)
Rack 1	Slot 8	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 9	Existing 4-point analog output module (140 series)
Rack 1	Slot 10	Existing NOE Module
Rack 1	Slot 11	New 16-point relay output isolated module (140 series)
Rack 1	Slot 12	New Empty Module
Rack 1	Slot 13	New Empty Module
Rack 1	Slot 14	New Empty Module
Rack 1	Slot 15	New Empty Module
Rack 1	Slot 16	New Empty Module

C. 50-LCP-5 rack layout consists of the following items:

Existing 50-LCP-5 16-Slot Rack Layout		
Rack 1	Slot 1	Existing Power Supply
Rack 1	Slot 2	Existing CPU
Rack 1	Slot 3	Existing 16-point relay output isolated module (140

		series)
Rack 1	Slot 4	Existing 16-point relay output isolated module (140 series)
Rack 1	Slot 5	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 6	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 7	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 8	New 8-point analog output module (140 series)
Rack 1	Slot 9	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 10	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 11	Existing 8-point analog input module (140 series)
Rack 1	Slot 12	Existing 8-point analog input module (140 series)
Rack 1	Slot 13	Existing 8-point analog input module (140 series)
Rack 1	Slot 14	Existing 8-point analog output module (140 series)
Rack 1	Slot 15	Existing 8-point analog output module (140 series)
Rack 1	Slot 16	Existing NOE Module

D. 60-LCP-4 rack layout consists of the following items:

Existing 60-LCP-4 16-Slot Rack Layout		
Rack 1	Slot 1	Existing Power Supply
Rack 1	Slot 2	Existing CPU
Rack 1	Slot 3	Existing 16-point relay output isolated module (140 series)
Rack 1	Slot 4	Existing 16-point relay output isolated module (140 series)
Rack 1	Slot 5	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 6	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 7	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 8	Existing 16-point discrete input non-isolated module (140 series)
Rack 1	Slot 9	Existing 8-point analog input module (140 series)
Rack 1	Slot 10	Existing 8-point analog input module (140 series)
Rack 1	Slot 11	Existing 4-point analog output module (140 series)
Rack 1	Slot 12	Existing NOE Module
Rack 1	Slot 13	Existing 4-point analog output module (140 series)
Rack 1	Slot 14	Existing 4-point analog output module (140 series)
Rack 1	Slot 15	Existing 8-point analog input module (140 series)
Rack 1	Slot 16	Existing 16-point discrete input non-isolated module (140 series)

PART 3 - EXECUTION

3.01 INSTALLATION, CALIBRATION, TESTING, START-UP AND INSTRUCTION

A. GENERAL:

Under the supervision of the Single I&C supplier, all systems specified in this Section shall be installed, connected, calibrated and tested, and in coordination with the Engineer and the Owner, shall be started to place the processes in operation. This shall include final calibration in concert with equipment specified elsewhere in these Specifications, including pumps, valves, as well as certain existing equipment.

B. TESTING

All systems shall be exercised through operational tests in the presence of the Engineer in order to demonstrate achievement of the specified performance. Operational tests depend upon completion of work specified elsewhere in these Specifications. The scheduling of tests shall be coordinated by the Contractor among all parties involved so that the tests may proceed without delays or disruption by incomplete work.

1. Unwitnessed Factory Test (UFT)

An unwitnessed factory test shall be conducted to prepare the I&C Supplier to demonstrate compliance with this specification during the Factory Acceptance Test (FAT). The I&C Suppler shall prepare a written procedure detailing every aspect of the UFT. This procedure must be submitted to the ENGINEER for approval prior to the commencement of the UFT. This procedure along with any forms generated during the UFT shall comprise the basis of the FAT.

The I&C Supplier shall inspect and test the Integrated Control System (ICS) to ensure it is ready for the FAT. This test shall take place at the I&C Supplier’s factory. It shall consist of interconnecting computers, PLC control panels, communications links, and other new Control Panels (unless specifically excluded below).

All primary element inputs shall be simulated (inputs shall be adjustable by switch, if discrete; by potentiometer or similar device, if analog). Primary outputs shall be monitored via output devices (LED indication lights, for discrete; a meter, digital display (12-bit min. resolution) or other such analog device, if analog output).

During the UFT, the Contractor shall test the communications links and demonstrate error-free communications to and from each node on the fiber optic network. Verify that each I/O point is consistently mapped at the computer node, at the PLC I/O card, in the PLC memory, and at the I/O simulated device according to the database provided by the software engineer. Verify the proper operation of each of the pilot devices on each of the control panels, if any.

Excluded New Panels: None

2. Factory Acceptance Test (FAT):

The I&C Supplier shall test the entire control system. The test shall take place at the I&C Supplier's factory. The I&C Supplier shall simulate all inputs and outputs as performed in the UFT. The software engineer shall load application programs into each PLC. The software engineer shall load the HMI application into the computer. The I&C Supplier shall provide travel and accommodations for Owner and Owner's Consultant to witness the FAT. Provide a minimum of 2 weeks' notice to the Owner/Engineer before conducting testing.

Prior to commencement of the FAT, the I&C Supplier shall furnish the following documentation to the ENGINEER:

a. All Drawings, Specifications, Addenda, and Change Orders
b. Master copy of the written FAT procedures
c. List of equipment to be tested
d. Shop drawings of equipment to be tested
e. Preliminary Software documentation submittal

Daily Schedule for FAT:

a. Begin each day with a meeting to review the day's test schedule
b. End each day with a meeting to review the day's test results and to review and to revise the next day's test schedule, if required.

The I&C Supplier shall repeat the I/O point mapping consistency check as before, with the addition of verification of mapping on HMI screens. Those variables, which are not I/O but are variables which exist in the PLC and HMI software only (see preliminary software documentation), shall all be checked.

Check the function of each loop, including set points, alarms, displays, and operator interface. Check one loop of each type and 20% (min.) of all loops. Check data logging, alarm logging, and event logging.

Test all non-loop-specific functions including, but not limited to the following:

a. Demonstrate capacity of system for expansion. Include tests for both storage capacity and processing capacity.
b. Include tests for timing requirements.
c. Demonstrate online and offline diagnostic tests, procedures and displays.
d. Demonstrate Failure Mode and Backup Procedures: Power failure, auto restart, disk backup and reload, retentive outputs.

Correct deficiencies found and complete correction of deficiencies prior to shipment to site.

Failed Tests shall be repeated and witnessed by the OWNER and ENGINEER. With approval of the ENGINEER or OWNER certain tests may be conducted by the I&C Supplier and Witnessed by the OWNER and ENGINEER during START-UP.

See section 3.03 supplements for sample "Loop Status Report" and "Functional Acceptance Test Sheet".

C. INSTALLATION AND CONNECTION:

1. The Contractor shall install and connect all field-mounted components and assemblies under the criteria imposed in Part 1, 1.03, herein. The installation personnel shall be provided with a final reviewed copy of the Shop Drawings and data.

2. The instrument process sensing lines and air signal tubing shall, in general, be installed in a similar manner to the installation of conduit specified under Section 16050. Individual tubes shall be run parallel and near the surfaces from which they are supported.

Supports shall be used at intervals of not more than 3 feet of rigid tubing.

Bends shall be formed with the proper tool and to uniform radii and shall be made without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at all panels.

3. The Contractor shall have a technical field representative of the I&C supplier to instruct these installation personnel on any and all installation

requirements; thereafter, the technical field representative shall be readily available by telephone to answer questions and supply clarification when needed by the installation personnel.

Where primary elements (supplied by I&C supplier) shall be part of a mechanical system, the I&C supplier shall coordinate the installation of the primary elements with the mechanical system manufacturer.

4. Fiber optic cable shall be furnished by the I&C Supplier and installed by the Corning or equal certified I&C provider with a 25 year warranty guarantee. The I&C Supplier shall provide the services of an experienced fiber optic cable terminator and tester. The I&C Supplier shall supervise the cable installation and shall carry out all terminations at the I/O racks, repeaters, and data concentrators at PLC's and computers. Fiber optic cable termination shall be carried out using the appropriate connectors and termination kit. All fiber optic system components shall be products of one manufacturer.

   Fiber optic cable splicing shall be strictly prohibited. Test all new fiber optic cables with an Optical Time Domain Reflectometer (OTDR) bi-directionally to verify loss does not exceed 0.2 dB. Pull new fiber optic cables which do not conform to Specifications. Provide fiber optic budget loss report for all new fiber optic cables via OTDR test to ENGINEER and OWNER.

   After the fiber optic data link is in place, test the attenuation from hub to hub bi-directionally and document test results. Provide a complete fiber optic report showing all losses from newly installed and modified runs. Attenuation in excess of 3.5 dB/km at 850 nm wavelength or 1.0 dB/km at 1300 nm wavelength shall require the I&C supplier to replace the defective sections and retest until the attenuation is below the attenuation allowed per kilometer at the wavelengths cited.

   The I&C Supplier is responsible for the satisfactory performance of all fiber optic data links. Demonstrate and document error free bi-directional data files transfer from each host computer to each PLC node.

5. Finally, after all installation and connection work has been completed, the technical field representative shall check it all for correctness, verifying polarity of electric power and signal connections, making sure all process connections are free of leaks, and all such similar details. If the initial inspection finds no deficiencies, the technical field representative shall proceed to the certification to the Contractor. Any completed work that is found to have deficiencies shall have those deficiencies corrected by installation personnel at no additional cost to the Owner. The technical field representative shall then recheck the work after the identified

deficiencies are corrected. If the technical field representative finds deficiencies in the follow-up inspection, then remedial action shall be taken by the Contractor at no cost to the Owner. This pattern shall be repeated until the installation is free from defect. The technical field representative shall then certify in writing to the Contractor that for each loop or system that he has inspected is complete and without discrepancies.

6. The field representative of the Single I&C supplier shall coordinate all work required to interface the new equipment and control devices with the existing equipment, including all required modifications to existing equipment and related devices.

D. CALIBRATION

1. All instruments and systems shall be calibrated after installation, in conformance with the component manufacturer's written instructions. This shall provide that those components having adjustable features are set carefully for the specific conditions and applications of this installation, and that the components and/or systems are within the specified limits of accuracy. Defective elements which cannot achieve proper calibration or accuracy, either individually or within a system, shall be replaced. This calibration work shall be accomplished by the technical field representatives of the I&C system supplier who shall certify in writing to the Contractor that for each loop or system all calibrations have been made and that all instruments are ready to operate. See section 3.03 supplements for sample "Instrumentation Calibration Sheet".

2. Proof of Conformance - The burden of proof of conformance to specified accuracy and performance is on the Contractor using its designated Single I&C supplier. The Contractor's designer shall supply necessary test equipment and technical personnel if called upon to prove accuracy and/or performance, at no separate additional cost to the Owner, wherever reasonable doubt or evidence of malfunction or poor performance may appear within the guarantee period.

E. PRE-COMMISSIONING

The I&C Supplier shall test each loop (discrete and analog) to determine if it is functioning correctly. The I&C Supplier shall furnish a loop sheet for each loop to be tested. The loop sheet shall represent the actual “as-built” condition of the loop. The I&C Supplier shall perform a field functional loop test which shall be witnessed by the ENGINEER and OWNER. If the loop fails the functional test, the I&C Supplier shall coordinate repairs for the CONTRACTOR to correct whatever is wrong with the loop at no additional cost to the OWNER. The I&C Supplier shall retest the loop until it is approved.

Each loop shall be tested and approved by ENGINEER and OWNER until all loops have been approved.

F. START-UP AND INSTRUCTION

When all systems are assessed by the Contractor to have been successfully carried through complete operational tests with a minimum of simulation, and the Engineer concurs in this assessment, plant start-up by the Owner's operating personnel can follow. For a minimum of three times for (4) hours prior to start-up, operating and maintenance personnel shall be instructed in the functions and operation of each system and shall be shown the various adjustable and set point features which may require readjustment, resetting or checking, re-calibration or maintenance by them from time to time. This instruction shall be scheduled at a time arranged with the Owner at least two (2) weeks in advance. Instruction shall be given by qualified persons who have been made familiar in advance with the systems. All equipment shall be checked during the first year of operation at intervals of three months for a period of not less than one day or as may be required to correct any defects to the satisfaction of the Owner.

G. MODIFICATIONS TO EXISTING FACILITIES

The Contractor shall make all modifications to existing equipment and control devices which are required to successfully install and integrate all new instrumentation equipment. All costs for any required modification and rehabilitation effort shall be included in the Contractor's original bid amount and no additional payment shall be allowed.

H. PLANT SHUTDOWNS

The Single I&C supplier shall carefully examine all work to be performed relative to existing I&C equipment and the installation of new equipment and control devices. Work shall be scheduled to minimize required plant shutdown times. Plant shutdown times shall be scheduled with Owner with a minimum of 2 weeks' notice given to the Owner.

I. COORDINATION WITH OTHER CONCURRENT PROJECTS

The single I&C supplier shall coordinate extensively with other I&C suppliers of concurrent projects. Some of the equipment shown in this contract as existing might be installed while this contract is underway.

3.02 TRAINING

A. General:

1. Provide an integrated training program to meet specific needs of Owner's personnel.

2. Provide instruction on one working shift as needed to accommodate the Owner's personnel schedule.

3. Owner reserves the right to make and reuse video tapes of training sessions if applicable.

B. Operations and Maintenance Training:

1. Include a review of O&M manuals, expendables, and test equipments.

2. Training session duration shall be minimum 4 hours. Provide training schedule with outlines at least one week before the training to the Owner.

3. Training shall include a minimum understanding of loop functions, loop operation, component calibration, adjustments such as controller tuning, switch trip point, etc., and periodic maintenance.

C. Hirschmann (or equal) Technical Factory Level Hand-on Training Class (5-Day Networking Course)

1. Contractor shall pay all travel with perdiem and lodging for two individuals from Orlando, Florida to the training site for the duration of the training (Fremont, CA). Belden training location may change and contact Belden representative before bidding.

2. The focus of this training shall include a minimum of technical knowledge and the use and the setup of switches, routers/terminal servers. Confirm with Owner before registering the training class.

D. Hirschmann (or equal) Ethernet Switch Onsite Training:

1. In additional to the factory level training, provide an onsite training for the Hirschmann Ethernet switch models that are installed as part of this project. The training shall be by a system integrator (either from Belden or certified by Belden) and shall include a minimum of switch configuration, troubleshooting, connection, etc. as recommended by Belden.

3.03 SUPPLEMENTS

A. Supplements listed below, following "END OF SECTION" are part of this Specification.

1. Instrumentation Calibration Sheet
2. Loop Status Report
3. Functional Acceptance Test Sheet

END OF SECTION

PROJECT NAME: _____
PROJECT NO.:_____

FUNCTIONAL REQUIREMENTS

COMPONENT STATUS

TAG NO.	DELIVERED*	TAG/IDENTIFI-CATION CHECK*	INSTALLATION CHECK	TERMINATION WIRING*	TERMINATION TUBING*	CALIBRATED*

REMARKS

LOOP READY FOR START-UP

BY

DATE

* INITIAL AND DATE WHEN COMPLETE

FUNCTIONAL ACCEPTANCE TEST SHEET

PROJECT NAME: _____

PROJECT NO. :

FUNCTIONAL REQUIREMENTS AND
SUMMARY OF COMPONENTS:
(ATTACH XEROX OF LOOP SPECIFICATION FROM THE CONTRACT DOCUMENTS)

VERIFICATION OF LOOP STATUS REPORT AND BY:_____

INSTRUMENT AND VALVE CALIBRATION SHEETS DATE:_____

DEMONSTRATION TEST(S): FOR EACH FUNCTIONAL REQUIREMENT OF THE LOOP:

REQUIRED PERFORMANCE

(a) LIST AND NUMBER THE REQUIREMENT

(b) BRIEFLY DESCRIBE THE DEMONSTRATION TEST

(c) CITE THE RESULTS THAT WILL VERIFY THE

(d) PROVIDE SPACES FOR INITIAL AND DATE OF TEST WITNESS.

PERFORMED BY:	LOOP ACCEPTED BY (OWNER)
WITNESSED BY:	BY
COMPLETED DATE:	DATE
CHECK IF REMARKS ON REVERSE SIDE	LOOP NO.

INSTRUMENTATION CALIBRATION SHEET

COMPONENT	MANUFACTURER:	PROJECT
CODE:	MODEL:	NUMBER:
NAME:	SERIAL:	NAME:

	RANGE	VALUE	UNITS		
☐INDIATE/ RECORD	CHART	_____	_____	☐COMPUTE	☐ CONTROL ACTION (DIRECT/REVERSE) MODES (P/I/D)
	SCALE	_____	_____	FUNCTIONS	☐ SWITCH UNIT RANGE (VALUE/UNITS)
☐TRANS/ CONVERT	INPUT	_____	_____		DIFFERENTIAL (FIXED/ADJUSTABLE)
	OUTPUT	_____	_____		RESET (AUTOMATIC/MANUAL)

ANALOG							DISCRETE					
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		REMARKS
IN	SCALE	OUT	SCALE	OUT	SCALE	OUT	NUMBER	TRIP PT	RESET PT	TRIP PT	RESET PT	CODE
C. MODE SETTINGS: P			I		D							

	COMPONENT CALIBRATED AND READY FOR START-UP
	BY DATE
	TAG NO.

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 13300: Instrumentation and Controls.

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 and interfacing to existing equipment, calibrations and services that are required to successfully interface and interconnect 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 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.

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 for successful operation and maintenance of the integrated control system.

6. Upgrade the existing Intellution iFix workstations with the latest version of iHistorian

7. Modify all existing local HMIs to reflect the proposed graphics and control system modifications.

8. Modify the fiber optic loop topography as shown in the Contract Drawings of Phase 3A as necessary.

B. Related Work Described Elsewhere:

1. Instrumentation and Controls: Section 13300.

2. Process Instrumentation and Controls - Products: Section 13615

3. Electrical: Division 16.

C. General Description of the System:

1. Add new I/O cards as shown in the Contract Drawings to monitor and control all I/O associated with the new FDA/AQC area in Control Panel 20-LCP-1.

2. Utilize existing spare I/O as shown in the Contract Drawings to monitor and control all I/O associated with the new Transfer Pumps in Control Panel 30-LCP-3.

3. Utilize existing spare I/O as shown in the Contract Drawings to monitor and control all I/O associated with the new High Service Pumps in Control Panel 50-LCP-5.

4. Utilize existing spare I/O as shown in the Contract Drawings to monitor and control all I/O associated with the new Metering Pumps in Control Panel 60-LCP-4.

1.02 QUALITY ASSURANCE:

A. Qualification requirements are specified under Section 13300: Instrumentation and Controls.

1.03 SUBMITTALS:

A. Refer Section 01340 Shop Drawings, Working Drawings and Samples and Section 13300: Instrumentation and Controls.

1.04 DOCUMENTATION:

A. Refer to Section 13300: Instrumentation and Controls.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Refer to Section 13300: Instrumentation and Controls.

1.06 WARRANTY AND GUARANTEES: Refer to Section 01740: 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

2.01 CABLE/MODEM

A. Fiber-Optic Cable: All fiber-optic connection shall be multi-mode 62.5/125µm gel-filled, armored cable (pre-manufactured by a fiberoptic cable manufacturer) furnished by the electrical contractor.

2.02 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.

2.03 REPORTS

A. Update all applicable existing Reports per new construction. Create new Reports as required.

2.04 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. Plant Automation:

1. Forced Draft Aerators and Air Quality Control System (Process 20)

a. The logic and I/O in the existing Area 20 PLC shall be modified to incorporate two (2) new Forced Draft Aerators (20-FDA-3 and 20-FDA-4) and one (1) new two-stage Air Quality Control System (20-AQC-2A and 20-AQC-2B).

b. Each Raw Water Well is assigned to operate in conjunction with a particular Forced Draft Aerator (FDA) through an operator configurable selection matrix. The two new FDA's are associated with the new Air Quality Control Scrubber (AQCS) Train, consisting of a 1st Stage and 2nd Stage AQCS. Each scrubber (a 1st. Stage and 2nd Stage Scrubber per AQCS Train) has two (2) Re-Circulation pumps (20-P-5 and 20-P-6 for 20-AQC-2A and 20-P-7 and 20-P-8 for 20-AQC-2B). Either of the two pumps for each AQCS Scrubber can be configured for AUTO control mode, with the other Re-Circulation pump acting as a stand-by.

c. When a Raw Water Well is requested to start, the selected Re-Circulation pump for each AQCS stage (Stage -A and -B) associated with the assigned FDA will start. The Blast Gate on the assigned FDA opens. When the Blast Gate is fully OPEN, the FDA Blower assigned to the particular well request is started and the FDA Raw Water Inlet Valve is opened to the predetermined set point and modulate based on PLC control to balance the flow rate across the on-line FDAs.

d. The Raw Water Well Pump is started after the FDA Raw Water Inlet Valve is fully OPEN.

e. The existing FDA selection matrix will be expanded to include the additional FDA's and AQCS Trains.

f. The make-up water controls to the AQCS trains shall be PLC control. When an AQC tower goes into service, the 'Makeup Water Valve' shall open. After the AQC tower goes off-line, the Makeup Water Valve shall close. The 'Quick Fill Water Supply Valve' shall open (after an operator configurable time delay) based upon detection of low water level in AQC sump through operation of the 'Low Water Level Switch'. The 'Quick Fill Water Supply Valve' shall close (after an operator configurable time delay) upon water level returning above the low water level switch operating point.

2. Transfer Pump Station (Process 30).

a. The logic and I/O in the existing Area 30 PLC shall be completely rewritten for the existing and new Transfer Pumps including modifications to incorporate three (3) new Transfer Pumps (30-P-6, 30-P-7, and 30-P-8) and a new clearwell with two new level elements (30-LE/LIT-3 and 30-LE/LIT-4). The existing logic and I/O in the Area 30 PLC shall be prohibited from being reused. Transfer Pumps are controlled by the level in the Transfer Pump Station Clearwell and the Ground Storage Tanks. The existing control strategy shall remain except for the additional adjustable speed pumps and the addition of the new operator selectable level transmitters for the second Clearwell.

b. The existing transfer station venturi flowmeter (30-FE-1) shall be replaced with the proposed magnetic flow meter. The existing Area 30 PLC logic shall be modified to select the new flow transmitter for flow display and control functions.

3. High Service Pump Station (Process 50).

a. The logic and I/O in the existing Area 50 PLC (located in 50-LCP-5) shall be shall be completely rewritten for to include the addition of two (2) new High Service Pumps (50-P-7 and 50-P-8). High Service Pumps are controlled by operator setpoint control of plant finished water discharge pressure. The existing control strategy shall remain except for the additional adjustable speed pumps.

b. The existing high service pump station venturi flowmeter (50-FE-1) shall be replaced with the proposed magnetic flow meter. The existing Area 50 PLC logic shall be modified to select the new flow transmitter for flow display and control functions.

4. Sodium Hydroxide Feed (Process 62).

a. AQC Scrubber System No. 3 (20-AQC-2A and 20-AQC-2B): The control system shall automatically control the speed of the 1st and 2nd stage odor control caustic feed metering pumps based upon scrubber sump water pH or hydrogen sulfide concentration in the outlet of each stage.

1. The control sequence shall be as follows:

a.) The operator selects both metering pumps for service. (62-MP-9 and 62-MP-10)

b.) The operator adjusts the desired AUTO pH setpoint (or hydrogen sulfide set point) via a control matrix CRT.

c.) The operator selects either MANUAL or AUTO for control of each pumping unit.

d.) The control system will start and control speed for the pumping unit(s) in software and field AUTO as required based upon feed flow.

2. Pump ready signal shall be generated when the field HOA is in AUTO position.

3. Pump failure signal shall be generated based upon the lack of incremental decrease in hydrogen sulfide concentration, SCR failure or excessive discharge pressure.

5. Plant Communications

a. The control system shall setup watchdog timers in each PLC for monitoring and alarming in the event of the communication failure. Provide a graphic to view Plant communications.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. The computer system, peripherals, and accessory equipment shall be installed in accordance with the requirements set forth under Section 13300: Instrumentation and Controls.

3.02 TESTS AND ACCEPTANCE

A. Field and system tests, and acceptance requirements are specified under Section 13300: Instrumentation and Controls.

3.03 MAINTENANCE CONTRACT

A. Maintenance contract requirements are specified under Section 13300: Instrumentation and Controls.

3.04 WARRANTY

A. Provide a system warranty in accordance with the requirements of Section 01740: Warranties and Bonds.

3.05 INSTRUCTION

A. Personnel training requirements are specified under Section 13300: Instrumentation and Controls.

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 13300 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 13300 - Instrumentation and Controls

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 13300.

1.03 QUALIFICATIONS

A. All System Suppliers shall comply fully with the qualification requirements stated in specification section 13300.

1.04 SUBMITTAL REQUIREMENTS

A. Refer to Section 13300 - Instrumentation and Controls

1.05 FINAL DOCUMENTATION

A. Final Documentation requirements are defined in specification Section 13300.

1.06 QUALITY CONTROL

A. Quality Control requirements are defined in specification Section 13300.

1.07 PRODUCT HANDLING

A. Product handling requirements are defined in specification Section 13300.

1.08 TOOLS AND TEST EQUIPMENT

A. In addition to the general tools and test equipment defined in specification section 13300, 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.

PART 2 - PRODUCTS

2.01 FIELD MOUNTED INSTRUMENTS

See Section 13300

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.

2.03 CONTROL PANELS

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 housekeeping pad, single or 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 – This breaker shall control the supplied 115 VAC primary power to all branch circuits within the panel.

2. Utilities Circuit Breakers – 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. This breaker shall control the supplied 115 VAC power to the UPS power supply.

4. PLC Power Supply Branch Circuit Breaker. This breaker shall control the supplied 115 VAC UPS supplied power to the PLC 24Vdc power supply.

5. I/O and Control Branch Circuit Breaker. This breaker shall control the supplied 115 VAC UPS supplied power to the dedicated PLC I/O and control additional 24V power sources.

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 house keeping 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 12 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 including full range of door swing(s) 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 LED lights, provided with protective shields and a switch box mounted control switch. LED lights shall be capable of illuminating all areas within the control panel. LED light output shall be equivalent to one (1) 30W fluorescent lamp mounted every four (4) 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 subplate or deadfront.

10. Service lights and/or receptacles shall be wired to a separate main disconnect circuit breaker and connected to the 120-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 manufacturer’s 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 Supply

1. The control panel shall operate from an On-line Uninterruptible Power Supply (UPS). Battery-supplied power shall be provided to operate the system for at least 45 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. The UPS shall be located within the control panel and supported by a sturdy rack.

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 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. Signal Distribution within Panels:

a. All signals shall be 24 VDC 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 a 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 by MTL, Phoenix or OWNER approved equal.

3. 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.

c. Switching transients in any associated signal circuit shall not exceed ±0.2 mA or ±0.05V depending on the signal type.

4. 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 MTL model SD150X, MTL model MA15, Edco model HSP121BT-1RU, Phoenix model 1414064, or OWNER approved equal.

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 Quantum programmable logic controller (PLC) 140CPU43412A, 486, 800 Kb, 2 Modbus Ports, 1 Modbus Plus, Key Switch to Start/Memory Protect/ Start Controller.

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

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 (2) groups of eight signals 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 input modules shall be as manufactured by Modicon.

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.

e. Analog Output Module shall be eight 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

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

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 status monitored by the PLC. 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 and sent to the PLC.

j. Serial Port surge protection shall be used on all Serial, Modbus, and Modbus Ethernet 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 and to stop the pump the MMI shall set the same bit to a 0 (zero) at the same address 02001.

f. Programmer shall keep the amount of points needed to control equipment to a minimum necessary.

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 CD and 8.5x11 printout.

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 CD and 8.5x11 printout.

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. (i.e. Pump 101 can only be directly controlled by the MMI system if it is in the manual condition).

k. Provide documentation and CD for all PLC logic.

l. All PLC logic instructions (all coils, contacts and registers), shall be programmed and labeled using "Modicon, ProWORKS - NxT", PLC programming software.

m. System Integrator shall furnish the Owner's Technician 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. Relays shall be equipped with LED indication.

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 Phoenix Contact.

f. Internal Panel Lights and Service Outlets:

1. Panels shall be internally lighted by LED lights, provided with protective shields and a switch box mounted control switch. LED lights shall be capable of illuminating all areas within the control panel. LED light output shall be equivalent to one (1) 30W fluorescent lamp mounted every four (4) feet of panel width.

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 Black for positive and White 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 Black for positive and White for negative polarity, 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 (e.g. DO-00001, DI-10001, AI-30001, & AO-40001).

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, Entrelec, 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 MTL Surge arresters shall be labeled.

2.04 TRANSFER METERING SYSTEM

1. Enclosure:

a. Free-standing panels shall be provided with adequate internal bracing 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, R-6 insulted rated. All doors shall be rubber gasketed.

b. 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.

c. When applicable, free-standing cabinets shall match adjacent free-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.

d. All installation details shall be verified by the Contractor/Supplier. Unless otherwise noted, all panels shall be properly sized to fit in the allotted spaces as noted or shown in the Contract Drawings.

e. 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.

f. 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 subpans and not directly to the enclosures. Subpans shall be painted with a white enamel. Print storage pockets shall be provided on the inside of each panel. Its size shall be sufficient to hold all of the prints required to service the equipment. All control operations and overload reset shall be accessible without opening panel.

g. Each panel shall be provided with full height, fully gasketed access doors where shown. Doors shall be provided with three-point latches. Handles shall be "D" ring, foldable type. All panel access doors shall be provided with full length, continuous, piano type, steel hinges with steel pins.

h. Freestanding panels shall be internally lighted by 30-watt min fluorescent lamps, provided with protective shields and a switch box mounted control switch. One light shall be provided for every 3.0 feet of panel width.

i. Panel shall permit continuous operation of all components with external ambient temperatures of up to 100° F. The supplier shall submit to the Owner a heat dissipation summary with calculations for each panel furnished to support the fact that the panel and internal components have been designed to operate properly in the exposed environment. Heat dissipation shall be maximums and shall be given in BTU/Hr. Internal panel temperatures shall be maintained below 85° F.

j. Panels shall be provided with external conditioners as required to prevent excessive temperature buildup as manufactured by Mclean Midwest "Slimboy" series with coated coils or equal. All temperature control equipment shall be controlled by a thermostat. Panels that are located outdoors shall not have vents open to the atmosphere. Hardware shall be corrosion resistant for outdoor environments.

i. Panels shall be manufactured by Henessy Type TD or Equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Instrumentation and accessory equipment shall be installed in accordance with specification section 13300 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 same 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

DIVISION 14

CONVEYING SYSTEMS

SECTION 14600

CRANES AND HOISTS

PART 1- GENERAL

1.01 DESCRIPTION

A. SCOPE

1. This section specifies bridge cranes and hoisting equipment.

2. Runway rails are included in this section.

B. CRANE SUMMARY

CMAA Class A, indoors, single girder, under running, 6,000 lb. capacity bridge crane with 2-speed hoist lift, 2-speed trolley traverse, 2-speed bridge traverse

Crane #1	High Service Pump Building
Span:	42 Ft., 11 ¾” Inches
Capacity:	7.5 Tons
Crane type:	Under running, single girder
Classification:	Crane shall be designed and constructed to CMAA Specification #74, as applicable, for Class “A” service requirements and operation in a non-hazardous environment.
Power:	460v-3ph-60hz
Crane speed:	100/25 FPM
Crane drive:	Dual motor drive
Trolley speed:	65/16 FPM
Trolley drive:	Motorized
Hoist speeds:	19/3 FPM

Hoist type: Electric wire rope

Hoist lift required: 38 Ft.

Control: Pendant from independent track on bridge

C. WORK INCLUDES THE FOLLOWING:

1. Detailed design of completed crane system, including bridge, end trucks, trolley, hoists, cabling, controls, and all appurtenances specified hereinafter.

2. Shop drawings.

3. Fabrication of a complete crane.

4. Inspection and shop testing.

5. Documentation and schedules.

1.02 REFERENCES

Equipment furnished under this section shall, except as otherwise noted, comply in all respects with the requirements of the following standards:

OSHA Occupational Safety and Health Administration
Part 1926.554 - Overhead Hoists
Part 1910.179 – Overhead and Gantry Cranes

CMAA Crane Manufacturer's Association of America
Specifications for Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley Hoist - No. 74 (2015)

ANSI / ASME
American National Standards Institute /
American Society of Mechanical Engineers
ANSI / ASME HST-4 - 2016 Performance Standard For Overhead Electric Wire Rope Hoists
ANSI / ASME B30.16 – 2017 Overhead Underhung and Stationary Hoists
ANSI / ASME B30.11 – 2010 Monorails and Underhung Cranes

NEMA National Electric Manufacturer's Association

NEC	National Electric Code – 2017 Article 100, Article 240-1, Article 430-31, Article 430-51, Article 610-1, Article 610-31

*Compliance to this standard is limited to the extent such standard is incorporated into and made mandatory by OSHA regulations.

1.03 SUBMITTALS

A. SHOP DRAWINGS AND EQUIPMENT DATA

1. Manufacturer’s catalog data for hoist.

2. Dimensional drawings and details for bridge crane system.

3. Wiring schematics. – ship with crane

B. OPERATIONS AND MAINTENANCE MANUALS (one set of Owner’s manuals in paper and on CD rom)

1. Equipment function, normal operating characteristics, and limiting conditions.

2. Assembly, installation, alignment, and maintenance instructions.

3. Lubrication and maintenance instructions.

4. Guide to “troubleshooting”.

5. Parts list.

6. As-built drawing.

7. Test results.

1.04 APPLICABLE STANDARDS

A. Contractor shall adhere to OSHA, state, and local safety guidelines, laws, rules, and regulations.

B. Contractor shall conform to all applicable ANSI, CMAA, and HMI specifications and/or standards.

C. Comply with CMAA specification 74, as applicable.

1.05 WARRANTIES

A. Provide one-year equipment warranty.

PART 2 - PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Bridge crane system shall be provided by:
J. Herbert Corporation, 1751 S. John Young Pkwy, Kissimmee, FL 34741

B. Hoist shall be electric wire rope type manufactured by ACCO, R&M, Street, Yale, or equal.

2.02 MATERIALS

Components	Material
Bridge beams	Steel, ASTM A36 or A992
End trucks	Steel, ASTM A36 (or equal)
Trolley	Steel, ASTM A36 (or equal)
Wheels	Cast iron or steel
Hooks	Forged steel
Runway Rails	Steel, ASTM A36 or A992

2.03 EQUIPMENT

A. HOIST AND TROLLEY

1. Under-running single girder cranes shall utilize a low headroom electric wire rope hoists.

2. The hoist shall be equipped with an electro-mechanical load-limiting device that shall prevent lifting more than 110% of the rated load.

3. Hoist and trolley motors shall be per 1.01B above, as applicable.

4. Hoisting motor shall be two-speed/two winding squirrel cage type.

5. Hoisting motor(s) shall be totally enclosed, minimum class F insulation, Klixon type bimetal switch for thermal protection and shall have a 60% ED rating.

6. Trolley shall be furnished with an adjustable frequency inverter drive and two-step variable speed control for smooth acceleration and deceleration.

7. Trolley motors shall be inverter duty motors with minimum class “F” insulation and motor enclosures shall be TENV [totally enclosed non-ventilated].

8. Limit switch shall provide upper and lower limit of hoist travel.

9. Hoist motor brake shall be DC or AC disc type with adequate torque to stop and hold over 125% of the hoist rated load.

10. Wire rope shall have a minimum safety factor of 5 to 1.

11. Hoist reeving shall be single reeved.

12. The hoist control enclosure rating shall be at least equivalent to IP55 / NEMA 4 type.

13. Hooks shall be made of forged alloy steel and shall be fitted with a spring-loaded flipper-type safety latch.

14. Hoist shall have a duty rating suitable for the load class and load cycles of the application.

15. AGMA quality machine cut, hardened and precision ground hoist gearing to be provided. The gears inside the hoist gearbox shall be lubricated by semi-fluid grease or oil.

16. Trolleys shall have safety drop lugs and energy absorbing bumpers.

B. BRIDGE GIRDER

1. Bridge girder shall be per 1.01B above, as applicable.

2. Bridge girders shall be constructed from welded box girders or structural beams, steel, ASTM A36 or A992, as required.

C. END TRUCKS AND BRIDGE DRIVE

1. End trucks shall be designed in accordance with CMAA specifications as applicable.

2. Bridge drive shall be dual-motor, A-4 arrangement per CMAA.

3. Bridge drive shall be designed to stop the bridge within CMAA specifications.

4. End trucks shall be equipped with rail sweeps and energy-absorbing rubber bumpers.

5. Bridge shall be furnished with an adjustable frequency inverter drive and two-step or infinitely variable speed control for smooth acceleration and deceleration.

6. Bridge motors shall be inverter duty motors with minimum class “F” insulation and motor enclosures shall be TENV [totally enclosed non-ventilated.

D. RUNWAY RAILS

1. The runway rail system shall be designed to support the underhung bridge crane. The runway rail system to be provided by the crane manufacturer.

2. Runway rails shall be constructed from structural beams, steel, ASTM A36 or A992, as required.

3. The runway rails shall be supported on brackets attached to building frames. Brackets, holes in brackets, and building frames provided by metal building manufacturer and are not part of this specification.

E. POWER SUPPLY

1. Power supply for the hoist shall be 460 volt, 3 ph., 60 Hz. All power required for the operation of the hoist, trolley, and end trucks shall be developed from this source.

2. Runway electrification shall be 4-bar safety type rigid conductors as manufactured by Insul-8, Duct-O-Wire Company or Wampfler. Wall mounted disconnect switch and power to runway conductors provided by Electrical Contractor.

3. Cross bridge electrification shall be flat cable style festoon system with terminal box, multi-conductor cord, plug connectors (when available) and accessories. Cables are to be hardwired when plug connectors are not available.

F. CONTROLS

The following controls shall be used as applicable:

1. Pushbutton pendant suspended from independent festoon track.

2. Pendant shall include Start (momentary) button and Emergency Stop that controls a mainline contactor in the bridge control panel.

3. Pushbutton shall be clearly marked with hoist, trolley and bridge travel directions.

4. Hoist shall be 2 speed magnetic reversing type and the trolley and bridge controls shall be variable frequency inverter control, as required per section 1.01.B.

5. Electrical control enclosures shall be IP55 or NEMA 4 type. Pushbutton enclosure shall have a rating of IP65, NEMA 4X, 4 or 5.

G. LABELING

1. Hoist and bridge beam shall be labeled with load rating.

2. A corrosion-resistant nameplate shall be fixed to the bridge with the following information:

a. Name of manufacturer

b. Mfg.'s model number and serial number

c. Capacity

d. Date of manufacture (month and year)

H. PAINTING

1. Hoist and trolley shall be factory painted per manufacturer's standards.

2. Bridge shall be shop cleaned, primed, and painted per manufacturer's standards.

3. The following items shall not be painted:

a. Rail surfaces in contact with wheels

b. Wheel running surfaces

c. Hoist wire rope

d. Conductor bar, festoon cables and supports

PART 3 - EXECUTION

3.01 INSTALLATION AND INSPECTION

A. Inspect structure and crane rail erection for conformance with reviewed shop drawings and contract documents prior to installation of equipment. Bring nonconforming work to the attention of the customer prior to proceeding with crane installation. Non-conforming runway structure or installation must be corrected prior to load testing of crane system. Costs of delays or additional work due to nonconforming runway structure will be reimbursed by the Owner.

B. Bridge crane shall be installed in conformance with manufacturer's instructions and inspected by a manufacturer's representative. Provide all necessary accessories to make bridge crane complete, usable, and capable of meeting the operating requirements specified in the Operating Requirements. Test, adjust and clean equipment for acceptance by Owner.

C. Crane use by the Cotnractor during construction is prohibited.

3.02 TESTING

A. All crane equipment shall be operated through a complete lift and lowering cycle and through a complete travel of the bridge and trolley to determine that the equipment shall perform smoothly and safely and that pendant cable length is sufficient to permit operation from desired floor levels. All tests shall be carried out with the bridge crane equipment loaded at 125 percent of capacity. The bridge crane provider shall provide the test weight loads. Any defects shall be corrected by the bridge crane provider without any expense to the Owner.

3.03 CLEANUP

A. Upon completion of work, area shall be cleaned and restored to original condition, acceptable to the Owner.

END OF SECTION

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. Where applicable, Manufacturers shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix to these technical specifications.

C. 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.

D. 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.

E. 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.

F. 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.

G. 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.

H. 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 Owner 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.

I. 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 fail 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.

J. 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.

K. 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 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.

L. 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.

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 09900 and 09905. A ll 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 de livery, 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 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 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.

B. All copper and brass piping, fittings, valves and appurtenances shall be lead free.

2.02 MATERIALS AND QUIPMENT

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. Lubrication 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. 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.

4. 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.

5. 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.

6. 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.

7. 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.

      i. Location: Tape shall be laid approximately 12 inches below ground surface and directly over pipe location.

      ii. Manufacturer: Tape shall be as specified in Section 09905.

   c. All pipe shall require insulated locating wire (10 gauge solid copper) capable of detection by cable locator and shall be wrapped with nylon straps to the centerline of the pipe.

8. 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. Underground valves shall be provided with a brass plate glued onto the valve pad.

a. Tag Types:

i. Tags for valves on pipe and tube lines conducting hot medium (steam, condensate, hot water, etc.) shall be brass or anodized aluminum.

ii. Tags for all other valves shall be Type 304 stainless steel.

iii. 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, number of turns, and general location within building.

9. 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 f or fuel contributed, and 50 f or 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. Flame proofing treatments will not be acceptable.

10. 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.

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 PIPING AND STRUCTURES

PART 1 - GENERAL

1.01 DESCRIPTION

This section includes materials and procedures for disinfection of water mains by the continuous feed method and disinfection of structures. Do not use the tablet method to disinfect pipelines. Disinfect piping in accordance with AWWA C651 and disinfect structures in accordance with AWWA C652, except as modified below. Disinfection of piping and structures shall meet the requirements of the County and FDEP.

1.02 JOB CONDITIONS

A. Discharge of chlorinated water into watercourses or surface waters is regulated by the National Pollutant Discharge Elimination System (NPDES). Apply to cognizant 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 cognizant regulatory authorities.

C. Use potable water for chlorination.

D. Submit request for use of water from waterlines of Owner 48 hours in advance.

1.03 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 and use a medium range, drop count, titration kit or the DPD Colorimetric method comparator with wide range color discs. Range 1.0 to 50 mg/l. Products: Hach Chemical or Hellige. Maintain 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 County.

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

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 chlorine concentration in the water leaving the pipe is within 0.5 mg/l of the replacement water.

3.07 BACTERIOLOGIC TESTS

The County inspector will collect one sample per day at each sample point on two consecutive days, and deliver to the County 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 and in each structure after chlorination and refilling. For lines longer than 2 miles, obtain one additional test each mile. Test between all valves in each direction. At each connection to an existing pipeline, take two additional samples.

3.08 REPETITION OF PROCEDURE

If the initial chlorination fails to produce required residuals and bacteriologic tests, repeat the chlorination and retesting until satisfactory results are obtained.

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

A. Disinfect all piping as indicated on the Piping Schedule in the drawings per AWWA.

B. Disinfect (internally and externally) any piping inside the following structures:

1. Transfer Pump Station Clearwells.

3.11 DISINFECTION OF STRUCTURES

A. Disinfect per AWWA C652, Method 2.

B. Disinfect the interior of the following structures:

1. Transfer Pump Station Clearwells.

C. Remove any chlorine solution which accumulates in the bottom of the structure each day.

D. The Owner will provide potable water at no cost to the Contractor for the first disinfection effort. If bacteriological testing shows that the first disinfection effort was not successful, the Contractor will be charged the cost of additional water at the Owner's current rates.

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:

1. Section 15061: Steel Pipe and Fittings.
2. Section 15062: Ductile Iron Pipe and Fittings.
3. Section 15064: Polyvinyl Chloride (PVC) Pipe and Fittings.
4. Section 15066: Stainless Steel Pipe and Fittings
5. Section 15070: Schedule 80 Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings and Valves.
6. Section 15090: Chemical Feed System Piping.

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 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:

i. Date of test.

ii. Identification of pipeline tested or retested.

iii. Identification of pipeline material.

iv. Identification of pipe specification.

v. Test fluid.

vi. Test pressure.

vii. Remarks: Leaks identified (type and location), types of repairs, or corrections made.

viii. Certification by Contractor that the leakage rate measured conformed to the specifications.

ix. 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 wet well 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.

$$L = \frac{SD(P)^{1/2}}{148{,}000}$$

in which:

L	=	allowable leakage (gallons/hour) during the test period.
S	=	length of pipe, in feet
D	=	nominal diameter of the pipe (inches)
P	=	average test pressure during leakage test (psig)

3. 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:

i. At least 6 feet above maximum estimated groundwater level in section being tested.

ii. 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 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 15060

CATHODIC PROTECTION SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The contractor shall utilize the services of a cathodic protection specialist for cathodic protection on all ductile iron and steel pipe to be connected to the existing raw and finished water pipes on site. The cathodic protection specialist shall provide all engineering services, materials, equipment, labor, and supervision for the installation of all anodes, anode test stations, joint bonding, joint test stations, insulating flanges, and polyethylene encasement as required to connect to the existing automatically controlled impressed current cathodic protection system in order to provide corrosion control for the proposed pipes. All work furnished shall be in accordance with A.W.W.A. Standard D104, ANSI/NSF 61 and this specification. The cathodic protection specialist shall be Corrpro Waterworks, or approved equal.

1.02 QUALITY ASSURANCE

A. All engineering services shall be provided by a Corrosion Specialist who is accredited by the National Association of Corrosion Engineers International as a Senior Corrosion Technologist, Corrosion Specialist or Cathodic Protection Specialist. The system shall be designed by a Corrosion Specialist with experience in cathodic protection for water pipelines. The Corrosion Specialist shall design the system to provide effective corrosion control to prevent pipeline corrosion due to stray currents.

B. The cathodic protection specialist shall have a minimum of five (5) years experience installing and servicing the types of systems described in this specification. The system shall be installed by personnel specifically trained by the cathodic protection specialist to provide all workmanship required for corrosion control performance.

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.

2. The cathodic protection specialist shall submit the following information for approval:

a. Drawings showing system design/configuration.
b. Description of system components.

1.04 WARRANTY AND GUARANTEES

A. All workmanship, equipment, and materials furnished by the cathodic protection specialist shall be guaranteed for one (1) year from final completion.

PART 2 - PRODUCTS

2.01 GENERAL

A. All products used for cathodic protection shall meet the requirements of AWWA, ASTM, NACE, and NSF61.

B. All products shall be supplied and installed in accordance with the recommendations of the Corrosion Protection Specialist.

2.02 HARDWARE

A. All hardware used in conjunction with the system shall be protected against corrosion.

2.03 GALVANIC ANODES

A. Galvanic anodes shall be magnesium alloy anodes. Anode shall be Galvomag or approved equal.

2.04 WIRE

A. Wires utilized for test stations shall be solid single conductor copper wire Type THHN insulation, No. 12 AWG.

B. Wires for joint bonds shall be stranded single conductor copper wire Type HMW/PE insulation, No. 8 AWG. Two joint bonds shall be used for each joint.

C. All wire test leads and anode leads shall extend a minimum of 18 inches above grade after connection to the test station panel board.

2.05 PANEL BOARDS

A. Test station panel boards shall be made of 4-inch x 4-inch x ¼-inch fabric reinforced Micarta. Double-nutted nickel plated brass studs shall be installed on the panel boards as shown on the Drawings. Tinned copper ring terminals shall be soldered to the ends of all wires terminated in the test station.

2.06 SHUNTS

A. Shunts for all sacrificial anode test stations shall be 0.01 ohm, 6-ampere capacity, manganin wire type.

2.07 EXOTHERMIC WELD EQUIPMENT

A. Cable connections to pipe and fittings shall be made with exothermic weld kits specifically designed by the manufacturer for welding the types of materials and shapes indicated by each installation. Connections to ductile iron and cast iron pipe or fittings shall use the weld metal and mold for ductile iron and cast iron pipe or fittings shall use the weld metal and mold for exothermic connections to cast iron pipe. The mold and weld metal shall be supplied by the same manufacturer.

B. All welds shall be made utilizing copper wire sleeves and individual components shall not be interchanged between different manufacturers.

2.08 INSULATING FLANGE

A. Insulating flange gaskets shall be Neoprene-faced phenolic, suitable for the Work as indicated on the details shown on the plans. Sleeves shall be full length and of a material indicated by the manufacturer as suitable for domestic water. Flange bolts, nuts and washers shall be stainless steel and shall fit within the bolt facing of the flange.

B. Contractor shall provide two sets of insulating washers which are 1/8 inch thick laminated phenolic. Insulating washers shall fit within the bolt facing the flange over the outside diameter of the sleeve.

C. Insulating sleeves shall be spiral wound Mylar, 1/32-inch thick.

D. Underground dielectric insulating flanges shall be covered with petrolatum wax tape.

2.09 TEST STATION BOX

A. The traffic valve box for test stations shall be an H10 rated, G5 Utility Box as manufactured by Old Castle Precast or approved equal.

B. The traffic box covers for insulating test stations shall be cast iron with the label **"ANODE"**.

2.10 POLYETHYLENE ENCASEMENT

A. Polyethylene encasement shall be in accordance with ANSI/AWWA C105/A21.5.

PART 3 - EXECUTION

3.01 FOREIGN STRUCTURE INTERFERENCE

A. Prevent electrical contact between the metallic pipe and/or fittings being cathodically protected and other existing buried metal structures at the time of the installation of the cathodic protection system. Where necessary, or required by the Engineer, the cathodic protection specialist shall install appropriately sized micarta sheeting, 1/4 inch in thickness between the two metallic surfaces.

3.02 INSULATED FLANGED JOINTS

A. Insulating components of each insulation flange kit shall be cleaned of all dirt, grease, oil, and other foreign materials immediately prior to assembly. Bolt holes in mating flanges shall be properly aligned at the time bolts and insulating sleeves are inserted to prevent damage to the insulation. After flange bolts have been tightened, each insulating washer shall be inspected and replaced by Contractor if cracked or other damaged.

B. Install insulated flanged joints at flanges connecting above-ground installations, and at other locations shown on plans.

3.03 JOINT BONDING

A. For metallic pipe, joint bond all non-welded rubber gasket joints, mechanical joints, and fusion epoxy coated flanged joints as required to provide electrical continuity between all metallic sections of the facility to be protected where necessary.

B. Joint bonds, for fusion-bonded epoxy coated pipe fittings shall be installed with a wire loop extended above the bonded joint. The overall length of the conductor shall permit sufficient flexibility of each fitting across the joint without transferring any tensile stress to the bond cable. Coat all exposed surfaces of each fitting with liquid epoxy patch kit, as supplied by the pipe coating manufacturer.

3.04 EXOTHERMIC WELDS

A. Coating materials shall be removed from the surface over an area just sufficient to make the connection. The steel surface shall be cleaned to white metal by grinding or filing prior to welding the conductor. Resin impregnated grinding wheels will **not** be allowed.

B. No connections to the structures or piping shall be buried until the Engineer has inspected the connections and given permission to backfill.

C. Exothermic welds shall be tested by the Contractor for adherence to the pipe and for electrical continuity between the pipe and wires.

D. After welding, protect all exposed wires and welds.

3.05 WIRES

A. Wires buried in the ground shall be laid straight, without kinks, and provide a minimum cover of 24 inches. Keep the bottom of the finished trench free from stones, roots or other materials that might injure the insulation of the conductors.

B. Each cable run shall be continuous in length and free of joints or splices. Care shall be used during installation to avoid punctures, cuts and similar damage to the insulation. Any damage to insulation will require replacement of the entire cable length by Contractor. Copper ring terminals shall be crimped and soldered to the ends of the test leads, drain wires and anode leads terminated in the test station.

C. At least 18 inches of slack shall be left for each conductor at each test station housing. Slack shall be that amount of wire which, when the cover is removed and the wire extended, protrudes beyond the opening of the box or enclosure. No wire bend shall have a radius of less than eight (8) times the diameter of that wire. Copper terminal rings sized for wire and stud shall be used to make all wire connections to terminal studs.

3.06 GALVANIC ANODES

A. Excavate a hole to a minimum of 3 inches larger than the packaged sacrificial anode diameter, and to a depth 1 foot below the fittings to be protected. Excavate

the lead wire trench to the depth indicated on the details shown on the plans, and backfill in conformance with these specifications.

B. Exercise care to preclude damaging the cloth bag and lead wire insulation on the sacrificial anode. Do not lift or support anode by the lead wire. Plastic or paper bags shall be removed from the anode before lowering into the hole.

3.07 ANODE TEST STATION

A. Anode test stations shall be installed at the locations recommended by the cathodic protection specialist. Two test leads shall be connected at the nearest pipe joint to the test station.

B. All connections of test lead wires to metal surfaces at the point of connection shall be cleaned by grinding or filing prior to welding the conductor.

C. Anode test station boxes shall be installed using a concrete collar satisfactory to prevent settlement. Set this concrete collar level and flush with the top of curb or finish grade.

D. No more than one test station is allowed in each test station box.

3.08 SYSTEM TESTING

A. System testing shall be performed by the cathodic protection specialist and witnessed by the Owner and Engineer.

B. Testing shall be conducted to verify proper operation of the cathodic protection system. This testing shall include, and not be limited to the following: bond continuity tests, sacrificial anode current output, pipe-to-soil potentials and other tests deemed necessary to verify proper operation of the systems.

C. Upon completion of testing, a detailed written report shall be submitted to the Engineer describing any deficiencies detected. All such deficiencies shall be corrected at no expense to the Owner.

D. Upon completion of any corrections or repairs, the system shall be re-tested.

END OF SECTION

SECTION 15061

STEEL PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment, and incidentals required and install, complete, ready for operation and field test all steel pipe as shown on the Drawings and specified herein.

2. Steel pipe shall include black steel and galvanized steel pipe and fittings.

3. Provide steel pipe only where specifically called out on the Drawings.

B. Related Work Described Elsewhere:

1. Pressure Testing of Piping: Section 15044.

2. Cathodic Protection System: Section 15060.

3. Chemical Feed System Piping: Section 15090.

4. Valves and Appurtenances: Section 15100.

5. Pipe hangers and supports: Section 15126.

6. Couplings and Connectors: Section 15129.

C. General Design (Not Applicable)

1.02 QUALITY ASSURANCE

A. All steel pipe shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the steel pipe to be furnished. The equipment shall be designed, constructed, installed in accordance with the best practices and methods and shall comply with all these specifications.

B. Steel pipe and fittings shall conform to all applicable standards of ASTM, ANSI, and AISI.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Submit to the Engineer for approval in accordance with the General Conditions and Section 01340, shop drawings to include dimensions and technical specifications for all piping to be furnished.

B. Additional Information (Not Applicable)

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. Provide equipment warranty in accordance with Section 01740 - Warranties and Bonds.

PART 2 - MATERIALS

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 Florida Administrative Code.

2.02 MATERIALS AND EQUIPMENT

A. Steel Pipe and Fittings:

1. Steel piping shall be Schedule 80 black steel as shown on the Drawings or required in the Specifications.

2. Steel Pipe shall meet the following standards:

a. Pipes: ASTM A-53, extra strong Type S.

b. Nipples: ASTM A-733, seamless, extra strong Schedule 80; "close" nipples will be permitted only by special authorization in each case.

c. Forced Steel Fittings: ANSI B16.11; Bonney, Crane, Ladish, Vogt, or equal.

i. Socket Welding Class 3000.

ii. Threaded Class 2000 or Class 3000.

2.03 ACCESSORIES

A. Steel Pipe Sleeves:

1. Sleeves for pipes passing through floors and walls shall be galvanized Schedule 40 steel pipe conforming to ASTM Designation A120. Sleeves dimensions shall conform to the details shown on the Drawings. Sleeve ends shall be cut and ground smooth. Sleeves shall be flush with walls and ceiling but shall extend above the floor as shown on the Drawings. Sleeves for use with mechanical type seals shall be sized in conformance with the seal manufacturers requirements. Mechanical type seals are specified in Section 15100.

B. Pipe supports, anchors, blocking and hangers shall be fabricated in accordance with the details shown on the drawings and shall be installed complete with all accessories required for proper operation of the system. Should it be necessary to modify the details for proper installation, all such modifications shall be subject to approval by the Engineer. Lugs required for anchorage of the piping system shall be attached in the shop and coated as the adjacent pipe.

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.

PART 3 - EXECUTION

3.01 PREPARATION (Not Applicable)

3.02 INSTALLATION

A. Steel pipe shall be installed true to alignment, and rigidly supported anchors shall be provided where indicated.

B. Sleeves of the proper size shall be installed for pipes passing through floors and walls as indicated on the Drawings. Sleeves shall be given a prime coat of rust inhibitive primer as specified in Section 09900.

C. Threaded Joints:

1. Ream the ends of threaded pipe to remove all burrs.

2. Cut threads clean with long tapers.

3. Remove all dirt and chips from the inside of the pipe and fittings and from the threads.

4. Make up joints with an approved pipe joints compound or tape applied to the male threads only.

5. When connecting pipes to recessed drainage fittings, seat them against the shoulder of the fittings.

6. When required to back off joints, entirely disjoint, wipe the threads of both the pipe and fittings clean, apply new joint compound, and reassemble the connection.

D. Welded Connections:

1. All welding shall conform to ANSI B31.1

2. All field welding shall be in accordance with the American Welding Society Standards. The strength of the field weld shall develop the strength of the pipe. Welds shall receive a field coating of paint as specified in Section 09900 and as approved by the Engineer.

3. All welders shall be certified for types and classes of welds being performed.

4. All welds shall be inspected for quality and suitability. Repair or replace all unsatisfactory welds.

E. Flanged Joints:

1. Tighten flange bolts so that the gaskets are uniformly compressed and sealed.

2. Do not distort flanges.

3. Leave flange bolts with the ends projecting 1/8-inch to 3/8-inch beyond the faces of the nuts after tightening.

4. Gasket material shall be compatible with pipeline fluid.

F. Grooved Joints:

1. Follow manufacturer's instructions.

2. Utilize manufacturer approved pipe grooving machines.

3. Lubricate all gaskets.

4. Torque all bolt as required by manufacturer.

G. Cutting:

1. Cut pipe from measurement taken at the site; not from the Drawings.

2. When cutting of pipe is required, the cutting shall be done by machine in a neat workmanlike manner without damage to the pipe. Cut ends shall be smooth and at right angles to the axis of the pipe.

H. To permit convenient disassembly for alterations and repairs, install unions or flanges where shown on the Drawings and:

1. In long runs of piping;

2. In bypasses around equipment;

3. In connections to traps, tanks, pumps, and other equipment;

4. Between shutoff valves; and

5. In other locations as directed by the Engineer, and as indicated on the Drawings.

I. Painting:

1. Pipe and fittings exposed to view, except stainless steel, shall receive a prime coating of rust inhibitive primer specified in Section 09900. Prior to prime coating, all surfaces shall be cleaned of all mill scale, rust, dirt, grease and other foreign matter.

2. All piping and fittings exposed to view except stainless steel pipe shall be painted as specified in Section 09900. Pipe marking is included in Section 09905.

3.03 INSPECTION AND TESTING (See Section 15044 - Pressure Testing of Piping)

3.04 DISINFECTION (See Section 15041 – Disinfection of Piping and Structures)

3.05 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: Furnish all labor, materials, equipment and incidentals required and install, in the locations inside, and under buildings and structures as shown on the Drawings, all ductile iron piping, cast or ductile iron fittings, and appurtenances as specified herein.

B. Related Work Specified Elsewhere:

1. Pressure Testing of Piping: Section 15044.
2. Cathodic Protection System: Section 15060.
3. Valves and Appurtenances: Section 15100.
4. Pipe hangers and supports: Section 15126.
5. Couplings and Connectors: Section 15129.

C. General Design: The equipment and materials specified herein is intended to be standard types of ductile iron pipe and cast or ductile iron fittings for use in transporting sewage, sludges, and water. All materials that contact drinking water or drinking water chemicals shall comply with AWWA Standards and NSF Standard 61.

1.02 QUALITY ASSURANCE

A. Qualifications: All of the ductile iron pipe and cast or ductile 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.

B. Standards

1.	Ductile Iron Pipe Thickness: ANSI A 21.50/AWWA C150	5.	Ductile Iron Compact Fittings for Water Service: ANSI A-21.53/AWWA C153
2.	Ductile Iron Pipe Centrifugally Cast: ANSI A-21.51/AWWA C151	6.	Polyethylene Encasement for Ductile Iron Pipe: ANSI A-21.5/AWWA C105
3.	Cement Mortar Lining for Water: ANSI A-21.4/AWWA C104	7.	Installation of Ductile Iron Water Mains: AWWA C600
4.	Cast and Ductile Iron Fittings: ANSI A-21.10/AWWA C110	8.	Disinfection of Water Mains: AWWA C651

C. Factory Tests: The manufacturer shall perform the factory tests described in ANSI A-21.51/AWWA C151.

D. Quality Control

1. The manufacturer shall establish the necessary quality control and inspection practice to ensure compliance with the referenced standards.

2. In addition to the manufacturer's quality control procedures, the Owner may select an independent testing laboratory to inspect the material at the foundry for compliance with these specifications. The cost of foundry inspection requested by the Owner will be paid for by the Owner.

E. Manufacturers: Manufacturers shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications.

1.03 SUBMITTALS

A. Materials and Shop Drawings

1. Submit shop drawings, including pipeline layouts, within and under buildings and structures. Shop drawings shall include dimensioning, methods and locations of supports and all other pertinent technical specifications. Shop drawings shall be prepared by the pipe manufacturer. Shop drawings for piping within and under buildings and structures shall be submitted within 30 days of Execution of Contract.

2. For all pipes in contact with potable or raw water, submit certification that pipe and fittings meet the requirements of NSF 61.

B. Operating Instructions: Submit Operation and Maintenance Manuals in accordance with Section 01730. Pipe dimensions and liner thickness shall be provided in the Operation and Maintenance Manuals.

C. Manufacturer's Certification: Submit certification of compliance with the following, sworn by a corporate officer of the manufacturer and witnessed by a notary:

1. Factory tests and results

2. Dimensions and weights of fittings per respective AWWA Standard.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Storage: Delivery and storage of the materials shall be in accordance with the manufacturer's recommendations.

B. Handling: Care shall be taken in loading, transporting and unloading to prevent damage to the pipe or fittings and their respective coatings. Pipe or fittings shall not be rolled off the carrier or dropped. Unloading shall be done by lifting with a forklift or crane. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Ductile Iron Pipe

1. Standards: ANSI A-21.50, AWWA C150 and ANSI A-21.51, AWWA C151

2. Thickness

a. Below ground piping: Pipes shall be the following minimum thickness class unless otherwise noted or specified.

1) 4 through 12-inch diameter	Class 350
2) 14 through 24-inch diameter	Class 250
3) 30 through 64-inch diameter	Class 200

b. Above Ground Piping
1) Flanged, Class 53 (Minimum)

3. Joints

a. Push-on or Mechanical Joints (below ground piping):

1) Standards: ANSI A21.11/AWWA C111
2) Class: The working pressure of the joint shall be equal to or exceed the rated working pressure of the pipe.
3) Gaskets: SBR (Styrene Butadine Rubber)

b. Flanged (above ground or inside below ground vaults):

1) Standards: ANSI A21.15, ANSI B16.1

2) Class: 125 lb factory applied screwed long hub flanges, plain faced without projection.

3) Gaskets

(a) Spans less than 10 feet: full face 1/8-inch thick neoprene rubber

(b) Spans greater than 10 feet: Toroseal gaskets as manufactured by American Cast Iron Pipe or equal.

c. Restrained Joints

1) Restrained joints shall be selected from one of the specified "Manufacturers" and types specified in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications, or approved equal.

2) Class: 250 psi (minimum) design pressure rating

3) Standard mechanical joint retainer glands will not be acceptable.

d. Joint Accessories

1) Mechanical joint bolts, washers and nuts: Ductile iron or Corten steel.

2) Flanged joint bolts, washers and nuts:

(a) Above Ground: Hot dipped galvanized, Grade B, ASTM A-307

(b) Below Ground: 304 stainless steel

e. Pipe Length (below ground installation): 20 feet maximum nominal length.

B. Fittings

1. Materials: Ductile iron or grey cast iron, AWWA C 110

2. Pressure Class

a. Mechanical Joint, Restrained Joint

1) 4-inch through 48-inch minimum 250 psi pressure rating

2) 54-inch through 64-inch minimum 150 psi pressure rating

b. Flanged Joint: Class 125, plain

3. Compact Fittings:

    a. Mechanical Joint, restrained joint 4-inch through 64-inch: ANSI/AWWA A21.53/C153

    b. Flanged Joint 4-inch through 48-inch: ANSI/AWWA C110/A21.10

    c. Flanged Joints 54-inch through 64-inch: ANSI/AWWA A21.53/C153

4. Manufacturers: Manufacturers shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications, or approved equal.

C. Wall Penetrations

1. Wall Pipes

    a. Material: Ductile iron or cast iron

    b. Type: Welded-on wall collar/water stop located in the center of the wall.

    c. Design: Full thrust at 250 psi transmitted to the structure wall. Tapped mechanical joint wall pipes may be used to facilitate concrete form work.

2. Wall Sleeves

    a. Material: Galvanized Schedule 40 Steel Pipe, ASTM A120

    b. Design: as manufactured by Thunderline Corporation, "Link Seal" or equal.

2.02 COATINGS, MARKINGS AND LININGS

A. Exterior Coatings

1. Below ground or in a casing pipe

    a. Type: Asphaltic coating, 1.0 mil DFT

    b. Markings: (continuous 2-inch wide stripe within top 90 degrees of pipe - min. drying time 30 minutes before backfill). All ductile iron pipe shall be marked with a continuous stripe located within the top 90 degrees of the pipe. Said stripe shall be a minimum 2 inches in width and shall be oil based paint, blue in color for potable water, green for wastewater and purple for reuse. Backfill shall not be placed for 30 minutes following paint application. At the

Contractor's option, the pipe may be stripe marked prior to pipe installation as follows:

Up to 8-inch diameter:	(2) 2-inch wide @ 180°
10 to 16-inch diameter:	(3) 2-inch wide @ 120°
18 to 24-inch diameter:	(4) 2-inch wide @ 90°
30 to 54-inch diameter:	(6) 2-inch wide @ 60°

Alternately, all ductile iron pipe may be marked along the crown of the pipe with an adhesive Underground Utility marking tape. Said tape shall be a minimum 6 inches width with a minimum 4.0 mil overall thickness inert plastic film formulated for extended use underground. Tape shall be specified and supplied in accordance with the A.P.W.A. national color code and shall be imprinted with the appropriate legend to define the type of utility line it protects.

c. Color: Potable Water: blue
Wastewater: green

2. Above Ground

a. Not subject to non-potable water submergence or splashing: See Division 9.

b. Subject to non-potable water submergence or splashing: See Division 9.

c. Color: See Division 9.

B. Interior Lining (Applied by pipe manufacturer)

1. Potable Water: Cement-mortar lining for ductile iron pipe and ductile and gray iron fittings for water service is in accordance with ANSI/AWWA C104/A21.4, and is listed by ANSI/NSF Standard 61 for potable water contact.

C. Polyethylene Encasement (required for all below ground piping, fittings and appurtenances located less than 10 feet from a gas main and as indicated on the Drawings):

1. Standard: ANSI A 21.5/AWWA C105, 8 mil minimum thickness.

2. Color: Color coded per paragraph A.1. above.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Standards: AWWA C600-05

B. Underground Ductile Iron Pipe and Fittings

1. Bedding for Ductile Iron Pipe: Minimum bedding requirements shall be Type 4 as defined in ANSI/AWWA C600, latest revision. Provide proper bedding required, in accordance with thickness class of pipe being laid and depth of cover. Property pipe laying conditions shall be in accordance with ANSI/AWWA C150 and C151, latest revisions, and ANSI/AWWA C600, latest revision.

2. Placement

a. Alignment: In accordance with lines and grades shown on the Drawings. Deflection of joints shall not exceed 75 percent of that recommended by the manufacturer.

b. Polyethylene encasement: Provide polyethylene wrap around piping, fittings and appurtenances located less than 10 feet from a gas main and as indicated on the Drawings.

3. Cutting: When required, cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of the pipe to be used with a push-on bell shall be beveled. All cut ends shall be coated with manufacturer's coating system.

4. Joints

a. Joint Placement

1) Push on joints: Pipe shall be laid with the bell ends facing upstream. The gasket shall be inserted and the joint surfaces cleaned and lubricated prior to placement of the pipe. After joining the pipe, a metal feeler shall be used to verify that the gasket is correctly located.

2) Mechanical Joints: Pipe and fittings shall be installed in accordance with the "Notes on Method of Installation" under ANSI A21.11/AWWA C111. The gasket shall be inserted and the joint surfaces cleaned and lubricated with soapy water before tightening the bolts to the specified torque.

3) All piping joints shall be mechanically restrained. Bells shall be painted red.

C. Above ground and interior ductile iron pipe and fittings

1. Pipe Supports

a. General: All piping shall be properly supported with hangers, supports, base elbows and tees, concrete piers and pads as shown on the Drawings and specified in Section 15126: Hangers and Supports and herein. All pipe and appurtenances connected to equipment shall be supported to prevent any strain from being imposed on the equipment.

b. Support spacing: 8 feet on centers and at each fitting and where shown on the Drawings.

c. Hangers for Horizontal Piping

1) Material: Heavy malleable iron

2) Type: Adjustable, swivel, split ring or adjustable swivel, pipe-roll

d. Hangers for vertical piping

1) Material: Wrought Iron

2) Type: Clamp

2. Placement

a. Alignment: In accordance with lines and grades shown on the Drawings. Each section of pipe shall be cleaned thoroughly prior to installation.

3. Flanged Joints: Joints shall be fitted so that the contact faces bear uniformly on the gasket.

D. Thrust Restraint

1. General: Thrust restraint shall be accomplished by restrained joints.

2. Length of Restrained Joints: Restrained joints shall be provided for all buried piping systems as indicated on the Drawings to restrain system thrust. It is intended that all buried joints be restrained.

E. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or by other means approved by Utilities to ensure absolute cleanliness inside the pipe.

3.02 CLEANING

A. General: At the conclusion of the work, the Contractor shall thoroughly clean the new pipe lines by flushing with water or other means to remove all dirt, stones or other material which may have entered the line during the construction period.

B. Correction of Non-Conforming Work: All non-conforming work shall be repaired or replaced by the Contractor at no additional expense to the Owner. Non-conforming work shall be defined as failure to adhere to any specific or implied directive of this Project Manual and/or the drawings, including but not limited to pipe not laid straight, true to the lines and grades as shown on the drawings, damaged or unacceptable materials, misalignment or diameter ring deflection in pipe due to bedding or backfilling, visible or detectable leakage and failure to pass any specified test or inspection.

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 inspections 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 fracture 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.

F. Hydrostatic Testing: Test in accordance with Section 15044: Pressure Testing of Pipe. Test pressures are shown in the Piping Pressure Test Schedule, Table 15044-A of Section 15044.

3.04 DISINFECTION (See Section 15041 – Disinfection of Piping and Structures)

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.

C. General Design:

1. 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.

B. Manufacturers: Manufacturers shall be selected from one of the specified “Manufacturers” in the Orange County Utilities “List of Materials and Approved Manufacturers” as presented in an appendix of these technical 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. Provide equipment warranty in accordance with Section 01740 - Warrantees 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 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 Pressure Piping:

1. Polyvinyl chloride pipe with nominal diameters of 4 to 12 inches in size shall conform to the requirements of AWWA C 900 with a dimension ratio of DR 18, pressure class 150, and gasketed integral bell ends. Pipe shall be designed for maximum working pressure of not less than 150 psi and with not less than a 2.5 to 1 sustained hydrostatic pressure safety factor.

2. Polyvinyl chloride pipe with nominal diameters of 14 to 30 inches in size shall conform to the requirements of AWWA C905 with a dimension ratio of DR-18, pressure rating 235, 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.

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: W here 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: Manufacturer shall be selected

from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix to these technical specifications. 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 A 242.

b. Cast iron mechanical joint fittings used with PVC pipe: Manufacturer shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix to these technical specifications. 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 A 242.

C. Fittings:

1. All fittings for use with PVC pipe three (3) inches and larger in size shall be gray cast iron or 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 A 242.

2. Fittings as noted on the piping schedule, shall be constructed of PVC with a minimum dimension ratio of DR18 and meet the pressure requirements as described in Section 15044.

3. All cast iron and ductile iron fittings for use with PVC pipe shall be coated and lined as specified for ductile iron pipe in Section 15062 intended for similar service, as noted on the piping schedule.

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 PVC pressure 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 35. 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 green in color.

2.03 ACCESSORIES (Not Applicable)

2.04 SPARE PARTS

A. Special tools, solvents, lubricants, and caulking compounds 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 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. No deflections will be allowed on PVC pipe or joints.

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. I f 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. Contractor shall verify reference point on pipe is correct in the presence of the RPR.

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 Painting Section 09900. 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 piping shall be hydrostatically pressure tested and flushed in accordance with Section 15044.

3.04 DISINFECTION (See Section 15041 – Disinfection of Piping and Structures).

3.05 START-UP AND INSTRUCTION (Not Applicable)

END OF SECTION

SECTION 15070

SCHEDULE 80 POLYVINYL CHLORIDE (PVC) AND CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE, FITTINGS, AND VALVES

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 (PVC) and chlorinated polyvinyl chloride (CPVC) piping, fittings and appurtenances specified herein. Schedule 80 PVC and CPVC piping shall be used on all small diameter PVC and CPVC piping systems (3 inches and smaller in diameter) which includes, but are not limited to, non-potable water, potable water and chemical feeds and in all other locations as shown on the Drawings.

B. Related Work Described Elsewhere:

1. Painting: Section 09900.

2. Piping, Valve and Equipment Identification System: Section 09905.

3. Chemical Feed Systems: Section 11241.

4. Mechanical – General Requirements: Section 15000.

5. Pressure Testing of Piping: Section 15044.

6. PVC and CPVC Double Wall Containment Piping: Section 15076.

7. Chemical Feed System Piping: Section 15090.

8. Pipe Hangers and Supports: Section 15126.

9. Couplings and Connectors: Section 15129.

C. General Design:

1. Schedule 80 PVC and 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.

2. All small diameter pipe, 3-inch diameter and smaller, shall be made of polyvinyl chloride unless 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 Charlotte Pipe and Foundry.

B. All plastic valves of similar type shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The valve 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 Asahi/America, Plast-O-Matic, or Hayward.

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. For valves, show valve dimensions, including laying lengths. Show part sizes, show dimensions and orientation of valve activators installed on the valves.

e. For valves, submit Manufacturer's catalog data and detail construction sheets showing all valve parts. Describe each part by material of construction, specification (such as ANSI, ASTM, SAE, or CDA), and grade or type. Identify each valve by tag number and service to which the catalog data and detail sheets pertain.

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. Piping, fittings, valves and appurtenances shall be handled, shipped, and stored in accordance with Section 01600: Material and Equipment.

B. PVC and 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.

C. When it is necessary to store PVC and 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. PVC and 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.

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 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.

B. Valve shall include operator, actuator, operating nut, and accessories for a complete operation.

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.

2.02 MATERIALS AND EQUIPMENT

A. Pipe:

1. PVC Pipe:

a. Pipe shall be made of polyvinyl chloride, Schedule 80 PVC pipe, conforming to ASTM D1784 and ASTM D1785. Schedule 80 PVC pipe shall have solvent welded or threaded joints. Chemical feed lines shall have solvent welded joints.

2. CPVC Pipe:

a. Pipe shall be made of chlorinated polyvinyl chloride, Schedule 80 CPVC pipe, conforming to ASTM D1784 and ASTM F441, Type IV, Grade 1 (Class 23477-B). Schedule 80 CPVC pipe shall have

solvent welded or threaded joints. Chemical feed lines shall have solvent welded joints.

B. Fittings:

1. PVC Fittings:

a. Fittings for Schedule 80 PVC pipe 4 inches and smaller in diameter shall be socket type, solvent welded in conformance with ASTM D 2467 or threaded type in conformance with ASTM D 2464. Solvent welded and threaded joints shall be watertight. Liquid chlorine feed lines shall have solvent welded fittings.

b. Fittings for Schedule 80 PVC 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.

2. CPVC Fittings

b. 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) or threaded type in conformance with ASTM D 2464 (Cell Classification 23447-A). Solvent welded and threaded joints shall be watertight. Liquid chlorine feed lines shall have solvent welded fittings.

c. 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. PVC and CPVC solvent cement in services other than Sodium Hypochlorite shall be in compliance with ASTM D 2564 and F656. Solvent Cement in Sodium Hypochlorite service shall be free of Silica. Products for Solvent Cement in Sodium Hypochlorite service shall be IPS "Weld-On" or Oatey "Lo V.O.C. PVC Heavy Duty Gray."

2. Solvent cement shall be specified by compatibility based on pipe service and size.

3. Manufacturer to provide certification with submittal.

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 and CPVC flanges shall be Type 316 stainless steel in accordance with ASTM F593 and F594, respectively. Flange hardware for PVC and CPVC flanges on Hydrofluosilicic Acid and Sodium Hypochlorite piping shall be Hastelloy C.

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.

E. Ball Valve

1. PVC Ball Valve

a. Valve: Ball valves shall be manufactured of Grade 1, Type I, PVC with Teflon seats. Seals shall be EPDM except for hydrofluosilicic acid service, which shall be Viton. Valve shall be provided with double unions and ball blocking feature.

b. Operator: Handle.

c. Pressure: 150 psi @ 73°F.

d. Service: Water, Sodium Hydroxide.

e. Plast-O-Matic True Blue, Asahi/America Type 21 Ball Valve, or approved equal.

2. PVC Ball Valve with Vent Hole

a. Valve: Ball valve shall be manufactured of Grade 1, Type I, PVC and shall be of true union design with two-way blocking capability. All O-rings shall be Viton and Teflon seats. Teflon seats shall have elastomeric backing cushion of the same material as the valve

seals. Stem shall have double o-rings and be of blowout proof design. The addition of a 1/8 inch vent hole drilled and deburred by the manufacturer is required. The valve shall be installed with the vent hole on the upstream side of the system to keep the cavity of the ball fluidized. The valve handle shall double as carrier removal and/or tightening tool.

b. Operator: Handle.

c. Pressure: 150 psi @ 73°F.

d. Service: Sodium Hypochlorite.

d. Plast-O-Matic True Blue, Asahi/America DuoBloc-21, or approved equal.

3. CPVC Ball Valve

a. Valve: Ball valves shall be manufactured of Grade 1, Type IV, CPVC with Teflon seats. Seals shall be EPDM except for hydrofluosilicic acid service, which shall be Viton. Valve shall be provided with double unions and ball blocking feature.

b. Operator: Handle.

c. Pressure: 150 psi @ 73°F.

d. Service: Hydrofluosilicic acid.

e. Plast-O-Matic True Blue, Asahi/America Type 21 Ball Valve, or approved equal.

F. Check Valves

1. PVC Diaphragm Check Valve

a. Valve: Diaphragm check valve shall be manufactured of Type I, Grade 1 PVC with a Viton diaphragm and shall be provided. 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: Water and sodium hypochlorite.

d. Plast-O-Matic Series CKM or approved equal.

2. PVC Ball Check Valve

a. Valve: Ball check valve shall be manufactured of Type I, Grade 1 PVC with Viton seals except for sodium hydroxide service, which shall be an EPDM diaphragm 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: Water, sodium hypochlorite, and sodium hydroxide.

d. Asahi/America, Hayward True Check, or approved equal.

3. CPVC Diaphragm Check Valve

a. Valve: Diaphragm check valve shall be manufactured of Type I, Grade IV CPVC with a Viton diaphragm. 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: Hydrofluosilicic acid.

d. Plast-O-Matic Series CKM, or approved equal.

4. CPVC Ball Check Valve

a. Valve: Ball check valve shall be manufactured of Type I, Grade IV CPVC 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: Hydrofluosilicic acid.

d. Asahi/America, Hayward True Check, or approved equal.

G. Diaphragm Valves

1. PVC Diaphragm Valves:

a. Valve: Diaphragm valves shall be of solid thermoplastic construction with molded flanged ends, constructed of PVC conforming to ASTM D1784 Cell Classification 12454-A. 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 or 2-inch square nut for motorized actuator where called out in the Drawings.

c. Pressure: 100 psi @ 74°F.

d. Service: Sodium Hypochlorite

e. Asahi/America Type 14, or approved equal.

H. Butterfly Valves

1. PVC Butterfly Valves

a. Valve: Butterfly valves shall be PVC conforming to ASTM D1487 cell classification 12454-A. The valve disc shall be manufactured of PVC of an equal grade to the body material. The valve stem shall be Type 316 and shall engage the disc over the full length of the disc. Valve stem shall be non-wetted. Seats and seals shall be Viton or EPDM and suitable for the intended service. The shaft bearings shall be upper and lower bearings of reinforced Teflon. Valve connections shall be wafer style for insertion between two ANSI B16.5 Class 150 flanges.

b. Pressure: 150 psi at 70°F and 90 psi at a temperature of 140°F.

c. Operator: 6” and below – Lever, 8” and above – Handwheel, over 6’ above floor level – Chainwheel.

d. Asahi/America Type 56, or approved equal.

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 and CPVC pipe and valves where shown on the Drawings and in strict accordance with the manufacturer's technical data and printed instructions.

B. Joints for Schedule 80 PVC and CPVC 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 and CPVC 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.

F. Field Painting:

1. Pipe normally exposed to view shall be painted and marked as specified in Section 09905: Piping, Valve and Equipment Identification System.

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 and CPVC piping shall be hydrostatically pressure tested and flushed in accordance with the requirements in Section 15044: Pressure Testing of Piping.

3.04 DISINFECTION (See Section 15041 – Disinfection of Piping and Structures)

3.05 START-UP AND INSTRUCTION (Not Applicable)

END OF SECTION

SECTION 15076

PVC AND CPVC DOUBLE WALL CONTAINMENT PIPING

PART 1- GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment and incidentals required, and install and test the double wall containment piping, fittings and appurtenances specified herein.

2. Double wall containment piping systems are required for the hydrofluosilicic acid feed lines and the sodium hypochlorite feed lines. The double wall containment piping shall be used when the piping is in contact with the ground or any other location indicated on the Drawings.

B. Related Work Described Elsewhere:

1. Painting: Section 09900.

2. Piping, Valve, and Equipment Identification System: Section 09905.

3. Pressure Testing of Piping: Section 15044.

4. Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings, and Valves: Section 15070.

5. Valves and Appurtenances: Section 15100.

6. Pipe Hanger and Supports: Section 15126.

C. General Design

1. Double wall containment 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 s a part of an equipment “package” or purchased separately by the Contractor.

2. All double wall containment pipe shall be made of polyvinyl chloride or chlorinated polyvinyl chloride, matching the service shown on the Drawings for each chemical.

1.02 QUALITY ASSURANCE

A. All double wall containment piping, 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.

B. Solvent welder shall be qualified in accordance with Chapter VII of the ASME B31.3-93 Code, Part 9, Paragraph A328.

C. Double wall containment pipe shall be as manufactured by Asahi, Ipex Guardian, or R.G. Sloane. The manufacturer should have at least five years experience and proven product reliability.

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.

2. Submit pipe layout with proposed location of each detection sensor.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Double wall containment 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 double wall containment 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. 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.

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 double wall containment piping system components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

2.02 MATERIALS AND EQUIPMENT

A. Carrier Pipe:

1. Polyvinyl chloride pipe shall be Schedule 80 pipe, conforming to ASTM D1784 and ASTM 1785. Schedule 80 pipe shall have solvent welded socket type joints.

2. Chlorinated polyvinyl chloride pipe shall be Schedule 80 pipe, conforming to ASTM D1784 and ASTM F441, Type IV, Grade I. Schedule 80 pipe shall have solvent welded socket type joints. .

B. Containment Pipe

1. Containment pipe shall be made of polyvinyl chloride, Schedule 80, conforming to ASTM D1784. Two-piece clamshell style containment fittings shall not be allowed.

C. Fittings:

1. Fittings for Schedule 80 pipe shall be socket type, solvent welded in conformance with ASTM D2464 or D2467. Solvent welded joints shall be watertight.

D. Solvent Cement:

1. PVC and CPVC solvent cement in services other than Sodium Hypochlorite shall be in compliance with ASTM D2564 and F656. Solvent cement in Sodium Hypochlorite service shall be free of Silica. Products for solvent cement in Sodium Hypochlorite service shall be IPS "Weld-On" or Oatey "Lo V.O.C. PVC Heavy Duty Gray."

2.03 ACCESSORIES

A. Leak Detection System

1. Install in strict accordance with the system manufacturer's instructions and recommendations. Leak detection shall be installed with a leak detector sensor station located at the lowest point in the piping, with all pipe sloping to the location of the leak detection sensor station. The leak detection sensor system shall sound an alarm when a leak event occurs.

2. Signal wires from the low point sensor shall be connected to the local output panel. Contact with any aqueous chemical shall result in an audible alarm and a LED signal. The local output panel shall be housed in a NEMA 4X enclosure. The leak detection output panel shall be located directly outside the chemical feed pumping facility where the pipe first penetrates the ground surface. For any miscellaneous control component data see Division 13/16 Specifications. The output relays shall be capable of interfacing with the SCADA for the proposed plant expansion.

3. The leak detection system shall be Asahi, lpex Centra-Guard, or equal.

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 double wall containment pipe where shown on the Drawings and in strict accordance with the manufacturer's technical data and printed instructions.

B. Joints for double wall containment pipe and fittings shall be solvent welded. All joints shall be made watertight. All pipe cutting, threading and jointing procedures for solvent welded pipe joints shall be in strict accordance with the pipe and fittings manufacturer's printed installation instructions. 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.

F. 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.

G. Field Painting:

1. Pipe normally exposed to view shall be painted and marked as specified in Section 09905: Piping, Valve and Equipment Identification System.

3.03 INSPECTION AND TESTING

A. All PVC and CPVC piping shall be hydrostatically pressure tested and flushed in accordance with the requirements in Section 15044: Pressure Testing of Piping.

B. Following installation and testing:

1. Flush clean the carrier and containment piping system.

2. Purge the annular space of moisture with clean, dry air.

3.04 START-UP AND INSTRUCTION

A. Provide manufacturer's representative to provide recommended installation training and instructions for system tests, containment pipe joint closure, installation and testing of the leak detection system, and training of owner's personnel in the operation and maintenance of the leak detection system. Manufacturer's instructional DVD shall be provided to the installing contractor for training and future reference. Manufacturer's representative shall complete a Manufacturer's Certificate of Proper Installation. Inspection and examination practices shall be according to ASME B31.3-93 for normal fluid service.

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 systems for the sodium hypochlorite feed system, hydrofluosilicic acid feed system, and sodium hydroxide feed system.

2. Piping shall be furnished and installed complete with all fittings, jointing materials, hangers, supports, anchors, and other necessary appurtenances.

3. Material furnished and work performed under this Section shall be coordinated with material and equipment furnished and installed in Section 11241, Chemical Feed System.

B. Related Work Described Elsewhere: Other sections directly related to work covered in this section include the following:

1. Excavating, Backfilling, and Compacting: Section 02220.

2. Painting: Section 09900.

3. Piping, Valve, and Equipment Identification System: Section 09905.

4. Division 15.

C. General Design (Not Applicable)

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers:

1. PVC and CPVC Pipe: As specified in Section 15070

2. PVC CPVC Double Wall Containment Pipe: As specified in Section 15076

3. 316 Stainless Steel Pipe: Swagelok, Ham-let, or engineered approved equal.

1.03 SUBMITTALS

A. Materials and Shop Drawings: Complete specifications, data, and catalog cuts or drawings covering the following items furnished under this section shall be submitted in accordance with Section 01340: Shop Drawings, Working Drawings and Samples.

1. Expansion joints for PVC pipe.

2. Flange gaskets.

3. PVC chemical service pipe and fittings.

4. Pipe sleeves.

5. Pipe supports.

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 coated pipe shall be covered or otherwise protected from exposure to sunlight.

1.06 WARRANTY AND GUARANTEES

A. Provide equipment warranty in accordance with Section 01740 - Warranties and Bonds.

PART 2 - PRODUCTS

2.01 GENERAL (Not Applicable)

2.02 MATERIALS AND EQUIPMENT

A. Polyvinyl Chloride (PVC) Pipe and Fittings:

1. Materials for polyvinyl chloride pipe and fittings shall be as specified in Section 15070; Schedule 80 Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl (CPVC) Pipe, Fittings, and Valves.

2. Joints and jointings shall be as specified in Section 15070; Schedule 80 Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl (CPVC) Pipe and Fittings.

B. Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings:

1. Materials for chlorinated polyvinyl chloride pipe and fittings shall be as specified in Section 15070; Schedule 80 Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings, and Valves.

2. Joints and jointings shall be as specified in Section 15070; Schedule 80 Polyvinyl Chloride and Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings, and Valves.

C. 316 Stainless Steel Pipe and Fittings:

1. Pipe and fittings inside the sodium hydroxide feed room, 1" and smaller, shall incorporate seamless 316 Stainless Steel tubing and shall maximize the use of non threaded fittings where possible. Tubing shall conform to ASTM A276. Approved fittings include Swagelok VCR or VCO series, or Ham-Let Let-Lok series, or engineer approved equal. Gaskets shall be made of stainless steel or Buna N. Other appurtenances shall be supplied as follows:

a. Pressure relief valves shall be constructed of 316 Stainless Steel with screw type adjustment and shall have an operating range of

30-150 PSI. Pressure relied valves shall be manufactured by Jesco or approved equal.

b. Ball valves shall be 2-way vented with quarter turn actuation, rated for a minimum of 150 PSI. Models include Swagelok 60 series, Hamlet 700 series, or approved equal.

c. 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.

2. Pipe and fittings in the sodium hydroxide room greater than 1" shall be PVC in accordance with Section 15070.

D. Piping Schedule:

1. Refer to Table 15090-1 for the Schedule of Materials to be used on each piping system, the conditions of service and hydrostatic testing requirements.

E. 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.

F. Heat Tracing:

1. Sodium Hydroxide feed lines located outside and exposed to the atmosphere, shall have heat tracing to prevent crystallization of the caustic 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.

2. 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 55ºF when outside temperatures fall below this temperature.

3. All heat traced pipe shall be insulated in accordance with Section 15127: Pipe Insulation.

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. All fittings, couplings, specials, and other exterior surfaces of buried piping not protected with plastic coating shall be tape wrapped in the field. All surfaces to be tape wrapped shall be thoroughly cleaned and primed in accordance with the tape manufacturer's recommendations immediately before wrapping. Tape wrapping shall be two ply (half lap) application or as required to provide a total installed tape thickness of not less than 60 mils. Joints in plastic coated pipe shall be cleaned, primed, and tape wrapped after installation.

3.02 INSTALLATION

A. 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 throughout for expansion and contraction. Piping shall not

obstruct openings or passageways. Pipes shall be held free of contact with building construction so as not to transmit noise resulting from expansion.

3. Stuffing box leakage from water sealed pumps shall be piped to the nearest point of drainage collection.

4. Buried PVC piping shall be "snaked" in the trench and shall be kept as cool as possible during installation. PVC pipe shall be kept shaded and shall be covered with backfill immediately after installation and testing.

5. 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 hose or reinforced plastic tubing is connected to rigid piping, a quick disconnect coupling shall be provided.

B. 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.

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.

C. 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.

3.03 INSPECTION AND TESTING

A. All shop applied plastic coatings and tape wrap on pipe or fittings shall be inspected for holidays and other defects after receipt of the pipe or fitting on the job and immediately before installation. All field applied tape wrap on pipe, pipe joints, fittings, and valves shall be inspected for holidays and other defects following completion of wrapping. Inspection of plastic coatings before installation of the pipe or fitting in the sleeve shall be made where, in the opinion of the Engineer, the coating may have been damaged during assembly. Holidays and defects disclosed by inspection shall be repaired in accordance with the recommendations of the coating or tape wrap manufacturer, as applicable.

B. Inspection shall be made using an electrical holiday detector. The detector and inspection procedures shall conform to the requirements of Section 4.5.

C. 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.

D. 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.

TABLE 15090-1
CHEMICAL FEED SYSTEM
PIPING SCHEDULE

Service	Pipe I.D.	Size (in.)	Pipe Material	Class	Specification Section No.	Test Pressure (psig)
Hydrofluosilicic Acid	HSFA	2 & Smaller	CPVC	SCH 80	15070	150
Sodium Hydroxide	NaOH	Larger than 1 1 & smaller	PVC 316SS	SCH 80 Tubing	15070 15090	150 150
Sodium Hypochlorite	NaOCl	3 & Smaller	PVC	SCH 80	15070	150
Vent	V	6 & Smaller	PVC	SCH 80	15070	--

END OF SECTION

SECTION 15100

VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Scope of Work: Furnish, install, support, and test valves, gates, hydrants, strainers, stops, and faucets, (hereinafter referred to as "valves") in the location(s) and of the size(s) and quantities shown on the Drawings. The requirements of this specification apply to all valves specified.

B. General Design

1. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of sewage, water, sludge, chemicals, air, etc., depending on the applications.

2. 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.

3. For all buried valves in which the operating nut is deeper than four (4) feet from the finish ground surface, an extension rod with 2 inch operating nut and upper guide shall be installed permanently in the riser section.

4. All exposed valves shall have "open/closed" position indicators. The position indicators shall be conveniently located for easy visibility. Valves shall open counter clockwise.

5. All valves installed such that actuators are more than six feet above the floor shall have chain wheel operated geared actuators with stainless steel chains. Gear actuators shall be bevel or spur gear as recommended by the manufacturer.

6. All exposed valves 6 inches and larger shall be handwheel operated. Valves over 6 feet above the finished floor shall have chain operator.

7. Valve packing shall be replaceable without removing the valve from service.

8. All valves in water service shall be in accordance with ANSI/NSF61.

1.02 QUALITY ASSURANCE

A. Qualifications

1. All equipment furnished under this Specification shall be new and unused and shall be a standard product which has a successful record of reliable service in similar installations for a minimum of five (5) years.

2. All valves of same type and duty shall be furnished by a single manufacturer.

B. Standards

1. ANSI
2. AISI
3. SSPC
4. AWWA

C. Warranty: Provide manufacturer's warranty in accordance with the General Conditions and Section 01740: Warranties and Bonds.

D. Equipment Manufacturers

1. Equipment manufacturers are named in each individual valve specification and where applicable shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications, or approved equal.

2. 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.

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 and Section 01340: Shop Drawings, Working Drawings, and Samples. Submittals shall include at least the following:

1. Certified shop drawings showing all important details of construction, dimensions (including laying length), and weight.

2. Descriptive literature, bulletins, and/or catalogs showing all valve parts, and describing material of construction by material and specification, e.g., AISI.

3. Schedule of valves, referencing each valve type, end connections and actuators to the proposed location/application on the Drawings.

4. Valve coatings and linings, if any.

5. Valve Tag Identification Schedule (see PART 2).

6. See individual sections for additional requirements.

B. Operation and Maintenance Manuals: For all valves furnished under this Section, the Contractor shall submit operation and maintenance manuals in accordance with Section 01730: Operating and Maintenance Data, to include 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 shut-down procedures, normal operating conditions and emergency situations).
6. Lubrication and maintenance instructions.
7. Troubleshooting guide.
8. Parts list and predicted life of parts subject to wear.
9. Drawings - cross-sectional view, assembly diagrams.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials and Equipment

1. 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.

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

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

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

5. 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.

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

B. Storage of Materials and Equipment

1. Store valves and accessories in an area on the construction site protected from weather, moisture, or possible damage.

2. Do not store valves or accessories directly on the ground or in the open.

C. Handling of Materials and Equipment

1. Handle valves and accessories to prevent damage of any nature.

2. Carefully inspect all materials for:

a. Defects in workmanship and materials.
b. Removal of debris and foreign material in valve openings and seats.
c. Proper functioning of all operating mechanisms.
d. Tightness of all nuts and bolts.

1.05 SPECIAL TOOLS AND SPARE PARTS

A. Special Tools

1. All special tools required for normal operation and maintenance shall be provided in accordance with Division 1.

2. One (1) each tee handle operator shall be provided for every three (3) buried valves.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials shall be as indicated in specific sections, or on the Drawings, and compatible with intended use and shall meet at a minimum OCU Standards.

B. Valves shall have the name of the manufacturer and the size of the valve cast or molded onto the valve body or bonnet or shown on a permanently stainless steel attached plate.

C. Bolts, washers, nuts, and gaskets for flanged valves shall be as described in the specific piping sections.

D. Coat metal valves located above ground or in vaults and structures the same as the adjacent piping. Apply the specified prime coat at the place of manufacture. Apply finish coat in field. Finish coat shall match the color of the adjacent piping. All prime and finish coats shall be in compliance with Division 9.

2.02 VALVE IDENTIFICATION

A. 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.

1. Tag types
   a. Tags for valves on pipe and tube lines conducting hot medium (steam, condensate, hot water, air, etc.) shall be brass or anodized aluminum.
   b. Tags for all other valves shall be color plastic.
   c. Colors for aluminum and plastic tags shall, where possible, match the color code of the pipe line on which installed.
   d. Square tags shall be used to indicate normally closed valves and round tags shall indicate normally open valves.

2. 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.

3. Manufacture:Tags shall be as manufactured by Seton Name Plate Corporation, Floy Tag & Manufacturing Co. or approved equal.

4. Valve Schedule: the Contractor shall provide a typewritten list of all tagged valves giving tag color, shape, letter code and number, the valve size, type, use and general location within building.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install valves and accessories in strict accordance with manufacturer's instructions and recommendations, as shown on the Drawings and/or as directed by the Engineer.

B. Carefully erect all valves and support them in their respective positions free from distortion and strain.

C. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads

with oil and graphite, and tighten nuts uniformly and progressively. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

D. Support all valves connected to pumps and equipment, and in piping systems that cannot support valves.

E. Repair any scratches, marks and other types of surface damages, etc., with original prime coating as supply by the factory.

F. Apply finish coating in accordance with Division 9.

3.02 INSPECTION AND TESTING

A. Check and adjust all valves and accessories for smooth operation.

B. Test valves for leakage at the same time that the connecting pipelines are tested. Protect or isolate any parts of valves, operators, or control and instrumentation systems whose pressure rating is less than the pressure tests.

C. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseat or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints.

END OF SECTION

SECTION 15101

GATE VALVES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Scope of Work:

1. Furnish and install gate valves of the type and size and in the location as shown on the Drawings and/or specified herein.

B. General Design:

1. 2-inches and smaller, above ground, pressure Class 125 bronze.

2. 2½ inches and larger, above ground, iron body, bronze mounted, non-rising stem (NRS).

3. Below ground, iron body, bronze mounted, NRS. Use reducers as necessary to accommodate small buried piping.

4. Comply with the requirements of Section 15100.

1.02 QUALITY ASSURANCE

A. Qualifications: See Section 15100.

B. Standards: See Section 15100.

C. Warranty: See Section 15100.

D. Equipment Manufacturers: Manufacturers shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications.

1.03 SUBMITTALS

A. General: Submittals shall be in accordance with Section 15100.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. General: Product delivery, storage and handling shall be in accordance with Section 15100.

1.05 SPECIAL TOOLS AND SPARE PARTS

A. General: Provide special tools in accordance with Section 15100.

PART 2 - PRODUCTS

2.01 GENERAL

A. General: Valves shall comply with PART 2 - Products of Section 15100.

2.02 MATERIALS

A. General Service - 2-inches and smaller, above ground:

1. Bronze construction - 125 pound steam.

2. Union bonnet.

3. Inside screw, rising stem or non-rising stem.

4. Solid disc, taper wedge.

5. End connections:

a. Threaded

b. Or solder ends for copper pipe systems

6. Malleable iron, or steel hand wheel.

B. General Service – 2½ inches through 30 inches:

1. Gate valves shall be resilient seat gate valves, manufactured to meet or exceed the requirements of AWWA C509, latest revision. Valves shall have an unobstructed waterway equal to or greater than the full nominal diameter of the valve.

2. Cast iron body, bonnet and bonnet cover, ASTM A126 Class B, 250 psi working pressure. 2-inch wrench nut shall be provided for operating the valve.

3. Non-rising stem, made of cast, forged or rolled bronze as specified in AWWA C509. Two stem seals shall be provided and shall be of the o-ring type. The stem nut shall be independent of the gate.

4. Ductile iron gate with vulcanized EPDM synthetic rubber coating (resilient seated). Zero leakage at test and normal working pressure when installed with the line flow from either direction.

5. Valves for buried service shall have mechanical joints conforming to ANSI A21.11, above ground service joints shall be flanged conforming to ANSI B16.1 for Class 125 flanges.

6. All ferrous surface inside and outside shall have a fusion-bonded epoxy coating in accordance with AWWA C550.

7. Valves 16-inches and larger shall have side actuators.

C. General Service - Greater than 30 inches: Valves shall meet the requirements of 2.01 and 2.02.B except as specified otherwise below:

1. Operator shall be bevel or spur geared.

2. In horizontal installations, valves shall be equipped with bevel gear suitable for burled service.

3. Valves 42-inch and greater shall be provided with by-pass gate valve.

4. Working pressure shall be a minimum of 150 psi.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install valves with stem position vertical, unless shown otherwise.

B. Allow sufficient clearance around valve operator for proper operation.

C. Install in accordance with "Valve and Specialties - General" Section 15100.

END OF SECTION

SECTION 15103

BUTTERFLY VALVES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Scope of Work: Furnish and install butterfly valves of the type and size and in the location as shown on the Drawings and/or specified herein.

B. General Design:

1. 3-inches and larger, iron body bronze mounted.

2. Butterfly valves shall be fully operational and disc shall not interfere with adjacent piping/fittings.

3. Comply with the requirements of Section 15100.

1.02 QUALITY ASSURANCE

A. Qualifications: Comply with Section 15100.

B. Standards: Comply with Section 15100.

C. Warranty: Comply with Section 15100.

D. Equipment Manufacturers:

1. Comply with Section 15100.

2. Valves shall be manufactured by:
   a. Henry Pratt Co.
   b. Dezurik
   c. Clow

1.03 SUBMITTALS: Submittals be in accordance with Section 15100.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING: Product delivery, storage and handling shall be in accordance with Section 15100.

1.05 SPECIAL TOOLS AND SPARE PARTS: Provide special tools in accordance with Section 15100.

PART 2 - PRODUCTS

2.01 GENERAL

A. Valves shall meet applicable parts of Section 15100.

B. AWWA Water Service: (Potable)

1. Equal or exceed requirements of AWWA C-504, Class 150B for frequent operation. Conform to Underwriters' Laboratories classification in accordance with ANSI/NSF 61.

2. Suitable for direct burial when required.

3. Bubble-tight shutoff at 150 psi working pressure.

4. Body: Cast or ductile iron ASTM - A126, Class B.

5. Disc: Bronze, cast iron, ductile iron, Ni-resist per manufacturer's standard and valve size. Disc shall not interfere with adjacent piping when operated.

6. Valve Shaft: Valves shafts shall be turned, ground and polished, constructed of 18-8 stainless steel and in compliance with AWWA C504 and designed for both torsional and sheering stresses when the valve is operated under its greatest dynamic or seating torque. Shaft shall be of either a one-piece unit extending full size through the valve disc and valve bearing or it may be of a stub shaft design as applicable.

7. Valve Seat: Natural or synthetic rubber or elastomer material as described in AWWA C504. The valve seats shall be field adjustable and replaceable without dismounting operator disc or shaft and without removing the valve from the line. All retaining segments and adjusting devices shall be of corrosion resistant material.

8. Bearings: Shaft bearings shall be of self-lubricating corrosion resistant sleeve type as specified in AWWA C504.

9. Valve connections shall be as shown on the Drawings or generally as follows:

Acceptable Valve Connections:

a. Ground buried: Mechanical joints, restrained where shown on the Drawings, ANSI A21.11. Where used in existing steel piping, valves shall be flanged.

b. Exposed: Flanged (125 lb. standard), ANSI B16.1, valve neck length shall be sufficient to allow for flange clearance.

10. Testing: All valves shall be hydrostatic and leak tested in accordance with AWWA C504.

11. Working pressure: 150 psi unless otherwise shown on the Drawings.

12. Operator:

a. Ground buried: Wrench nut (two-inch), T-handle wrench, valve box with cover for valves 6 inches in diameter or smaller. Worm gear (AWWA C504), wrench nut, T-handle wrench valve box with cover for valves 8 inches in diameter and greater.

b. Exposed: Lever activator with infinite lockable positioning capability standard on 6-inch and smaller valves, and worm gear with handwheel for valves 8 inches in diameter or greater.

13. Internal and external surfaces shall be shop painted with two (2) coats of asphalt varnish (4 mils per coat) except for bearing surfaces.

C. Stainless Steel

1. Stainless steel valves shall meet the requirements of ANSI B16.1 and ANSI B16.5 Class 150 valves. Valves shall be approved for use in contract with potable water in accordance with ANSI/NSF 61.

2. Bubble-tight shutoff at 150 psi working pressure.

3. Body: 316 stainless steel ASTM A351 Type CF8M.

4. Disc: 316 stainless steel ASTM A351 Type CF8M.

5. Valve Shaft; Solid 316 stainless steel, ASTM A479.

6. Valve Seat: PTFE.

7. Bearings: PTFE.

8. Valve Connections: Fully lugged style.

9. Testing: All valves shall be hydrostatic and leak tested in accordance with AWWA C504.

10. Working Pressure: 150 psi unless otherwise shown on the Drawings.

11. Operator: Level actuators with lockable positioning on 6-inch and smaller valves. Handwheel actuator with external position indicator are safety lockout on valves larger than 6 inches.

12. Manufacturers: DeZurick BHP; Jonesbury Series 815, or Engineer-approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION: Install in accordance with manufacturer's recommendations and Section 15100.

END OF SECTION

SECTION 15110

CHECK VALVES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Scope of Work: Furnish all labor, materials, equipment and incidentals required, and install and test check valves including all appurtenances required as shown on the Drawings and as specified herein.

1.02 QUALITY ASSURANCE

A. Qualifications: Comply with Section 15100.

B. Standards: Comply with Section 15100.

C. Warranty: Comply with Section 15100. See additional requirements under 2.01.B.

D. Equipment Manufacturers: Manufacturers shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications.

1.03 SUBMITTALS: Submittals be in accordance with Section 15100.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING: Shall be in accordance with Section 15100.

1.05 SPECIAL TOOLS AND SPARE PARTS: Provide special tools in accordance with Section 15100.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Check Valves, 2-1/2 inches and smaller:

1. Valves shall be all bronze construction with screwed ends.

2. Minimum valve working pressure shall be 150 psi.

3. Valves shall be as manufactured by American Flow 52SC, Mueller MA 2600, or Nibco.

B. Rubber Flapper Swing Flex/Swing Check Valves (Sewage/Sludge and Low Pressure Effluent Pumping Application; i.e., less than 50 psi).

1. Valves shall have a cast iron body and cover meeting ASTM A126, Class B specifications.

2. Flapper shall be Buna-N reinforced and shall be easily removed without any need to remove the valve from line.

3. Ends shall be flanged, 125 pound ANSI B16.1. The flapper shall be Buna-N having an "O" ring seating edge and be internally reinforced with steel.

4. Valve shall provide drip-tight shutoff.

5. Where shown on the electrical drawings, check valves shall be provided with an NEMA 4X limit switch mounted on the horizontal centerline of the body seat or through the cover mounted on a mechanical position indicator.

6. Provide a manually operated backflow device which shall positively lock open flapper during full backflow.

7. The flex portion of the disc shall have a 20 year warranty.

8. Valves shall be manufactured by Apco Valve and Primer Corp., Series 100, Val-Matic Valve and Manufacturing Corp., Swing Flex, or GA Industries.

C. Cushioned Swing Check Valves (Raw water, potable water and high pressure effluent application greater than 50 psi):

1. All materials of construction shall be as follows:

Description	Material	Specification
Disc seat ring	Aluminum Bronze	ASTM B271
Body and cap	Cast Iron	ASTM A126, Class B
Disc	Aluminum Bronze	ASTM B148
Pivot Pin	Aluminum Bronze	ASTM B505
Body Flange Bolt	Carbon Steel SAE	Grade 5

2. Check valves shall be of the Tilted Disc metal seated, full body type capable of accepting optional bottom or top mounted oil dashpots.

3. The valves shall be provided with drilled flanges in accordance with ANSI B16.1 for Class 125 or Class 250 iron flanges and ANSI B16.42 for Class 150 ductile iron flanges. Iron flanges shall be flat faced.

4 Flanged inspection ports shall be provided upstream and downstream of the valve disc for inspection or use with optional dashpots on 6 inches and larger valves.

5. The valve body shall consist of two sections bolted together as a central diagonal flange inclined at an angle of 55 degrees. The inlet body section shall contain a seat ring positioned and captured by the diagonal flange. The outlet body section shall accept eccentrically located pivot pin trunnions with sealed covers and lubrication grease fittings.

6. The eccentric pivot trunnions shall be located to divide the disc into approximately 1/3 and 2/3 proportions and also allow the seating surface of the disc to rotate away from the seating surface of the seat ring without contact. Clearance shall be provided between the pivot pin and bushing when the disc is seated to prevent binding and to ensure a tight seal. The minimum pivot pin diameter shall be as shown below.

7. The flow area through the valve body inlet and outlet shall be equal to the nominal pipe size and gradually increase to an area 40 percent greater at the valve seat.

8. A position indicator shall be supplied on 6-inches and larger valves and visually show disc position at all times.

9. The valve disc and seat shall have a seating surface finish of 32 micro-inches or better to ensure positive seating at all pressure. The leakage rate shall not exceed one-half of the allowable rate allowed by AWWA Standard C508 or 0.5 oz (15 ml) per hour per inch (mm) of valve size.

10. 6-inches and larger valves should be capable of accepting a field installed Bottom Mounted Oil Dashpot.

11. The valve flow way shall be contoured and unrestricted to provide full flow areas at all locations within the valve. Full flow shall be based on an open stroke of 40 degrees to assure stabilization of the disc when open. Cv flow coefficients shall be equal to or greater than specified below and verified by an independent testing laboratory.

12. The valve body shall be constructed of ASTM A126 Class B cast iron for Class 125 and Class 250 valves up to 10-inches (250mm). 12-inches

(300mm) and larger Class 250 and Class 150 valves shall be constructed of ductile iron ASTM A536 Grade 65-45-12.

13. The disc in sizes up to 10-inches (250mm) shall be one piece construction with integral seat and constructed of ASTM B271 Alloy C95400 aluminum bronze. The disc in sizes 12-inches (300mm) and larger shall be ASTM A-125 Class B cast iron. Discs furnished for 12-inches (300mm) and larger valves with top oil dashpots shall be constructed of ASTM A536 Grade 65-45-12 ductile iron. The disc seating ring shall be ASTM B271 Alloy C95500 centrifugally cast aluminum bronze. The matting seat ring located in the body shall be ASTM B271 Alloy C95400 centrifugally cast aluminum bronze.

14. The pivot pins shall be ASTM B505 Alloy C95500 aluminum bronze and shall be guided by a bushing constructed of ASTM B505 Alloy C95400 aluminum bronze (12-inches and larger valves).

15. A top mounted oil dashpot shall be factory installed in the downstream inspection port when specified to provide independent hydraulic control of the valve opening and closing strokes to reduce water hammer normally associated with pump operation. The dashpot shall consist of a high pressure hydraulic cylinder with a minimum bore size as shown below and with internal cushion adjustment, two external flow control valves, a pressurized oil reservoir with a minimum size as shown below, a stainless steel non-pressurized reservoir and piping. The unit shall independently control the opening and closing stroke in the range of 5-30 seconds. Additionally, the closing stroke shall be two-stage with the last 10% of closing travel dampened with the internal cylinder cushion. A dashpot spacer which connects the cylinder to the valve shall have an air gap to prevent hydraulic fluid from entering the valve and contaminating the water system. A connecting rod with a minimum diameter as shown below and fitted with O-ring seals and rod wiper scrapers shall be linked to an integrally cast clevis on the disc. The connecting rod shall be attached to the cylinder rod with a quick change coupling constructed of 17-4 PH stainless steel. The cylinder rod, connecting rod, and coupling shall be held in place by coupling retainer to allow decoupling of the cylinder while the check valve is under pressure.

VALVE SIZE:	6 in.	8-10 in.	12-14 in.	16-18 in.	20-24 in.	30 in.	26-42 in.	48-60 in.
Cylinder Size:	2.5 in.	3.25 in.	4 in.	5 in.	6 in.	7 in.	8 in.	10 in.
Reservoir Size:	.1 gal	.3 gal.	6 gal.	1.1 gal.	2.5 gal.	6 gal.	6 gal.	10 gal.
Rod Diameter:	1 in.	1.375 in.	1.75 in.	2 in.	2.5 in.	3.5 in.	4 in.	5 in.

16. The valves shall be hydrostatically tested at 1.5 times their rated cold working pressure. Additional tests shall be conducted per AWWA, ANSI, MSS or

API standards when specified. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.

17. The exterior of the valve shall be coated with a universal alkyd primer. The valve interior shall be coated with an epoxy coating approved for potable water.

18. Check Valves shall be Tilted Disc Series 9000T manufactured by Val-Matic, Dezurik, or Henry Pratt Company.

19. Where shown on the electrical drawings, check valves shall be provided with a NEMA 4X limit switch mounted on the horizontal centerline of the body seat or through the cover mounted on a mechanical position indicator.

D. Swing Check Valves (AQC Recirculation Pumps)

1. Swing Check Valves for use in AQC recirculation pump discharge shall be suitable for working pressures of 250 psig.

2. The check valve shall be of the full body type, with a domed access cover and only two moving parts, the flexible disc and the disc accelerator.

3. Standards

a. The valves shall be designed, manufactured and tested in accordance with American Water Works Association Standards ANSI/AWWA C508.

b. The valves used in potable water service shall be certified to NSF/ANSI 61 Drinking Water System Components.

c. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

4. The valves shall be provided with flanged ends in accordance with ANSI B16.1, Class 125.

5. Design

a. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The 4-inch valve shall be capable of passing a 3-inch sphere. The seating surface shall be on a 45 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a

backflow actuator, or oil cushion without special tools or removing the valve from the line.

b. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.

c. The disc shall be of one-piece construction, precision molded with an integral O-ring type sealing surface, and contain alloy steel and nylon reinforcement in the flexible hinge area. The flex portion of the disc shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and a disc accelerator to provide a cracking pressure of 0.3 psig.

d. The disc accelerator shall be of one piece construction and provide rapid closure of the valve in high head applications. The disc accelerator shall be enclosed within the valve and shall be field adjustable and replaceable without removal of the valve from the line. The disc accelerator shall be securely held in place by being captured between the cover and disc. It shall be formed with a large radius to allow smooth movement over the disc surface.

e. The valve disc shall be cycle tested 1,000,000 times in accordance with ANSI/AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures.

6. Materials of Construction

a. The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron.

b. The disc shall be precision molded Buna-N (NBR), ASTM D2000-BG.

c. The disc accelerator shall be Type 302 stainless steel.

7. A screw-type backflow actuator shall be provided to allow opening of the valve during no-flow conditions. Buna-N seals shall be used to seal the stainless steel stem in a Lead-Free bronze bushing. The backflow device shall be of the rising-stem type to indicate position. A stainless steel T-handle shall be provided for ease of operation.

8. A mechanical indicator shall be provided to provide disc position indication on valves 3" (80 mm) and larger. The indicator shall have continuous contact with the disc under all operating conditions to assure accurate disc position indication.

9. A bottom mounted oil dashpot (oil cushion) shall be provided when specified to provide hydraulic control of the final 10% of valve closure and reduce valve slam and water hammer normally associated with rapid flow reversal conditions on pump shut down. The dashpot shall consist of a high pressure hydraulic cylinder, adjustable external flow control valve, oil reservoir, pressure gauge, stainless steel air inlet valve, and piping designed to control the closing speed of the last 10% of travel in 1-5 seconds. A threaded brass dashpot bushing unit with a grease fitting for lubrication shall connect the cylinder to the valve and shall have an air gap to prevent hydraulic fluid from entering the valve and contaminating the water system. A snubber rod fitted with O-ring seals and rod wiper scrapers shall make contact with the lower portion of the disc's stainless steel strike plate.

10. Manufacturer shall demonstrate a minimum of five (5) years experience in the manufacture of resilient, flexible disc check valves with air and hydraulic cushions.

11. All valves shall be hydrostatically tested and seat tested to demonstrate zero leakage. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.

12. The valve body shall be constructed of ASTM A126 Class B cast iron for Class 125 and Class 250 valves up to 10-inches, 12-inches and larger Class 250 and Class 150 valves shall be constructed of ductile iron ASTM A536 Grade 65-45-12.

13. Swing Check Valves shall be SurgeBuster Series #7200 as manufactured by Val-Matic® Valve & Mfg. Corporation, Elmhurst, IL. USA or approved equal.

14. Where shown on the electrical drawings, check valves shall be provided with a NEMA 4X limit switch mounted on the horizontal centerline of the body seat or through the cover mounted on a mechanical position indicator.

PART 3 - EXECUTION

3.01 INSTALLATION: Install valves in accordance with Section 15100 and the manufacturer's instructions.

3.02 DEMONSTRATION AND TESTING: Demonstration, start-up (adjustment) and testing shall demonstrate that all valves have been properly installed and that check valves operate properly.

END OF SECTION

SECTION 15116

VALVE BOXES

PART 1 - GENERAL

1.01 SCOPE OF WORK: Furnish and install valve boxes of type and size and in the location shown on the Drawings and as specified herein.

1.02 QUALITY ASSURANCE

A. Qualifications: See Section 15100.

B. Standards: All curb boxes shall be the product of one manufacturer.

C. Warranty: See Section 15100.

D. Equipment Manufacturers: Manufacturers shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. All buried valves shall have cast iron, three (3) piece valve boxes. Valve boxes shall be provided with suitable heavy bonnets and to extend to such elevation at or slightly above the finished grade surface as directed by the Engineer.

B. The barrel shall be screw type, having 5-1/4 inch diameter shaft. The upper section shall have a flange at the bottom having sufficient bearing area to prevent settling and shall be complete with cast iron covers.

C. Covers shall have "WATER" cast into the top for all water mains and "SEWER" cast into the top of all wastewater force mains and "REUSE" cast into the top of all reclaimed water mains.

D. All valves shall have actuating nuts extended to top of valve boxes.

E. Valve box assemblies are required for any size main that is six feet or greater below finished grade or if mains are greater than 12-inches in diameter. The valve box assembly shall be one complete unit composed of the valve box and extension stem

that attaches to the valve body. All moving parts of the extension stem shall be enclosed in a housing to prevent contact with the soil. The valve box assembly shall be adjustable to accommodate variable trench depths six feet and greater as shown on the Drawings.

F. The stem assembly shall be of a telescoping design that allows for variable adjustment length. The material shall be galvanized square steel tubing. The stem assembly shall have a built-in device that prevents the stem assembly from disengaging at its fully extended length. The extension stem shall be capable of surviving a torque test to 1,000 ft-lb without failure.

G. Valve boxes shall have locking lids, utilizing a five sided nut with a special wrench needed to open. Valve lids shall be as shown on the Drawings.

H. Valve collars shall be made of a fiberglass reinforced concrete polymer material manufactured to the specifications as shown on the Drawings utilizing a test station box made into the valve collar for placement of the locating wire. The locating wire shall be 10-gauge single strand solid core copper wire with insulation. The color of the insulation shall be the same color as the color code for the pipe being installed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as shown on the Drawings and/or as directed by the Engineer.

B. When installation is complete, no pressure shall be exerted by the valve box on either the valve or the pipe.

END OF SECTION

SECTION 15118

BACKFLOW PREVENTION DEVICE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Scope of Work: Furnish and install a backflow prevention device of the type, size, and capacity and in the location shown on the Drawings and as specified herein.

B. General Design: Comply with the requirements of Section 15100.

1.02 QUALITY ASSURANCE

A. Qualifications: See Section 15100.

B. Standards: See Section 15100.

C. Warranty: See Section 15100.

D. Equipment Manufacturers:

1. CLA-VAL
2. Watts
3. Hersey

1.03 SUBMITTALS

A. General: Submittals be in accordance with Section 15100.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. General: Product delivery, storage and handling shall be in accordance with Section 15100.

1.05 SPECIAL TOOLS AND SPARE PARTS

A. General: Provide special tools in accordance with Section 15100.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Valve shall comply with Section 15100 and meet local Building Code requirements.

B. The main valve body shall be cast iron with epoxy coated interior, main valve trim shall be bronze ASTM B-61 and stainless steel 316.

2.02 DESIGN

A. General: Valve shall comply with Section 15100 and meet local building code requirements.

B. Reduced Pressure Backflow Preventer:

1. Backflow preventers shall be of the reduced pressure type with two independently operating check valves.

2. An independent pressure relief valve shall be located between the two check valves.

3. The unit shall include tightly closing shut-off valves located at each end of the device, and shall be fitted with properly located test cocks.

4. All internal parts of the check valves and pressure relief valve must be removable or replaceable without removal of the unit from the line.

5. The total head loss through the complete backflow assembly shall not exceed 10 psi.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with Section 15100, the manufacturer's recommendations and as indicated on the Drawings.

B. Check-Out and Demonstration testing shall be provided in accordance with Division 1.

END OF SECTION

SECTION 15119

ELECTRIC MOTOR ACTUATORS

PART 1 - GENERAL

1.01. SCOPE OF WORK

A. This section includes materials and installation of electric motor actuators for valves and blast gates in accordance with AWWA C540, except as modified below.

1.02. SUBMITTALS

A. Materials and Shop Drawings: Copies of all materials required to establish compliance with Specification 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. Submit manufacturer's catalog data showing motor actuator parts and materials of construction, referenced by AISI, ASTM, SAE, or CDA specification and grade. Show motor actuator dimensions and weights. Show coatings.

2. Show the maximum torque required to open and close each motor operated valve or blast gate.

3. Submit certified factory performance test records.

4. Submit motor data including nameplate data, insulation type, duty rating, and torque output at duty rating.

5. Submit electrical schematic drawings and physical wiring diagrams showing all components.

B. Operation and Maintenance Manuals: For all actuators furnished under this Section, the Contractor shall submit operation and maintenance manuals in accordance with Section 01730: Operating and Maintenance Data, and shall include all required cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operation and maintenance personnel unfamiliar with such equipment.

1.03. PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials and Equipment

1. 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.

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

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

B. Storage of Materials and Equipment

1. Store actuators in an area on the construction site protected form weather, moisture, or possible damage.

2. Do not store actuators directly on the ground or in the open.

PART 2 - PRODUCTS

2.01. GENERAL

A. Motorized valve are identified on the drawings by the suffix letter “M”.

B. Motor actuators shall have the name of the manufacturer cast or molded onto the operator body or shown on a permanently attached plate in raised letters.

2.02. ACTUATORS 6 INCHES AND LARGER

A. General

1. The actuators shall be suitable for use on a nominal 460 volt, 3-phase, 60 Hertz power supply and are to incorporate motor, integral reversing starter, local control facilities, and terminals for remote control and indication connections.

2. Actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve or gate travel with either phase sequence of the three phase power supply connected to the actuator.

3. 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

1. The actuator shall be sized to ensure valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve or gate shall be sufficient to ensure torque switch trip at maximum valve or gate torque with the supply voltage 10% below normal. The operating speed shall be such as to give valve or gate closing and opening at approximately 10-12 inches per minute unless otherwise stated.

C. Ambient Temperature

1. Actuator shall be capable of functioning in an ambient temperature ranging from minus 22°F to 158°F.

D. Motor

1. Motors shall be totally enclosed, nonventilated 480 volts, 3-phase and specifically designed for high torque, low inertia duty. Motors for actuators shall also be specifically designed and rated for 15-minute duty operation at 104 °F, or twice the valve stroking time, whichever is longer, at an average load of at least 33% of maximum valve torque. Motors for actuators shall be designed for 100 start/stops per hour, unless continuous duty actuators are indicated on the Drawings.

2. Output capacity shall be sufficient to open or close the valve against the maximum differential pressure when the voltage is 10% above or below normal at the specified service conditions. Motors shall have Class F insulation system.

3. Electrical and mechanical disconnection of the motor should be possible without draining the lubricant from the actuator gearcase. Plugs and sockets are not acceptable as a means of electrical connection for the motor.

E. Motor Protection:

1. 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. Actuator Torque Requirements

1. The rated output torque of the motor actuator shall be at least 1.5 times the maximum torque required to open or close the valve or blast gate at any position including seating and unseating conditions when subjected to the most severe operating condition including any mechanical friction and/or other restrictive conditions that are inherent in the valve or blast gate assembly. Do not include hammer-blow effect in sizing the actuator to comply with this torque requirement. Coordinate with the valve or blast gate manufacturer to assure that the motor actuator stall torque output does not exceed the torque limits of the valve or blast gate operating stem or shaft.

2. Maximum torque shall include seating or unseating torque, bearing torque, dynamic torque, and hydrostatic torque. Assume that the differential pressure across the valve or blast gate is equal to the pressure or head rating of the valve or blast gate.

3. 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.

4. The electrical 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. A setting tool shall be required for non-intrusive calibration and interrogation of the actuator. This setting tool shall provide speedy interrogation capabilities as well as security in a non-intrusive intrinsically safe watertight casing.

G. Gearing

1. The actuator gearing shall be totally enclosed in an oil filled gearcase suitable for operation at any angle. Gearcase shall be factory-oil lubricated. The power gearing shall consist of helical gears of heat-treated steel. Worm gears shall be alloy bronze accurately cut with a hobbing machine. Worm shall be hardened steel alloy. Where the actuator operates gates, 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 shall be such as to permit the gearcase to be opened for inspection or disassembled without releasing the stem thrust or taking the valve or gate out of service.

2. Gear lubricant shall be as specified and warranted by the actuator manufacturer.

H. Hand Operation

1. The actuators shall have a manually operated handwheel which shall not rotate during electrical operation. In the event electrical power is interrupted, handwheel operation shall be activated by a hand lever attached to the mechanism. While the valve or blast gate is being operated manually, the motor shall not rotate. The hand/auto selection lever should be padlockable in both hand and auto positions. Upon restoration of electrical power, the handwheel shall automatically disengage. 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. Design the handwheel diameter such that hand operation will not damage the valve or blast gate.

I. Drive Bushing

1. 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.

J. Operating Speed

1. Design the actuator to move valves from fully closed to fully open in 60 seconds. Design valve actuators for open/close operation, unless the valve

is specifically noted to require continuous modulating operation to regulate flows.

2. Design actuators mounted on blast gates to move the gates from fully open to fully closed in five minutes or less.

K. Remote Valve/Gate/Actuator Control, Status and Indication

1. 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, 30 V DC.

2. As an alternative to providing valve position, any of the four 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. Motor Tripped on Torque in Mid-Travel

i. Motor Tripped on Torque Going Open

j. Motor Tripped on Torque Going Closed

k. Pre-set Torque Exceeded

l. Valve/Gate Jammed

m. Actuator Being Operated by Handwheel

n. Lost Main Power Phase

o. 24V DC or 120V AC Owner Supply Lost

p. Internal Failure Detected

q. Thermostat Tripped

3. In the event of a main power supply loss or failure, the four position contacts must be self latching to maintain interlock capabilities.

4. 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.

L. Local Position Indication

1. The actuator shall provide a local display of the position of the valve/gate, even when the power supply is not present. The display shall be able to be rotated in 90 degree increments so as to provide easy viewing regardless of mounting position.

2. The actuator shall include a digital position indicator with a display from fully open to fully closed in 1% increments with ± ½% accuracy. 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.

3. The local display shall be large enough to be viewed from a distance of 6 feet when the actuator is powered up.

M. Control Facilities

1. Provision shall be made for connectivity with Discreet I/O or Analog status to PLC as shown in the Drawings.

N. Integral Starter and Transformer

1. The reversing starter, control transformer, and local controls shall be integral with the valve actuator, suitably housed to prevent breathing and condensation accumulation. 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 the 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:

a. 120 volt AC energization of the contactor coils.

b. 24 volt DC output where required for remote controls.

c. Supply for all the internal electrical circuits.

2. The primary and secondary windings shall be protected by easily replaceable fuses.

O. Integral Push Buttons and Selector

1. 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.

2. It shall be possible to select maintained or non-maintained local control.

3. The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.

P. Remote Mounted Push Buttons and Selector

1. When actuator push button controls are mounted more than six feet above floor level, additional push buttons with functionality as specified in paragraph 2.02.L. above shall be supplied mounted in a NEMA 4X enclosure.

2. In addition to local controls for Open, Close and Stop, and local/off/remote selector switch, Open/Close indication lamps shall also be provided for end-of-travel indication.

3. When local/off/remote selector switch control is transferred from actuator to remote mounted push button station, a contact must be provided from the local/off/remote selector switch back to the actuator to indicate actuator has been selected for remote (2-wire) control.

4. The necessary wiring, indication relays and terminals shall be provided in the actuator to accommodate the remote mounted push button control functions.

5. Connections for remote mounted push button controls may be fed from an internal 24 DC supply and/or from external supply of (min. 12V, max. 120V).

Q. Monitoring and Diagnostic Facilities

1. A non-instrusive 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.

2. 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/gate performance. A software tool shall be provided to allow configuration and diagnostic information to be reviewed and analyzed and reconfigured.

3. Diagnostic status screens shall be provided to show multiple functions simultaneously so troubleshooting can be affected rapidly and efficiently. Diagnostic information shall be contained on no more than eight screens so multiple functions can be checked simultaneously.

4. Provision shall be made to display valve/gate torque demand as a percent of rated actuator torque and position simultaneously, so as to facilitate valve/gate troubleshooting and diagnostics.

R. Wiring and Terminals

1. 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.

2. The terminals shall be embedded in a terminal block of high tracking resistance compound.

3. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal.

4. The terminal compartment shall be provided with a minimum of three threaded cable entries. When required, a fourth cable entry shall be provided.

5. All wiring supplied as part of the actuator shall be contained within the main enclosure for physical and environmental protection. External conduit connections between components is not acceptable.

6. Control logic circuit boards and relay boards shall 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.

7. 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.

   e. The identification card shall be suitable for the Contractor to inscribe cable core identification beside the terminal numbers.

S. Enclosure

1. Actuators shall be "O" ring sealed, watertight to NEMA 6, and shall 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 other internal electrical elements of the actuator from ingress of moisture and dust when the terminal cover is removed on-site for cabling.

2. Enclosure shall allow for temporary site storage without the need for electrical supply connection and internal heating elements.

3. All enclosure external fasteners shall be of stainless steel.

4. Provide a separate enclosure with local/remote selector switch, stop-open-close push buttons, and open and closed indicator lights for motor actuators over 6'-6" above floor or deck in lieu of integral controls.

T. Start-up Kit

1. Each actuator shall be supplied with a start-up kit comprising installation instructions, electrical wiring diagram, and sufficient spare cover screws and seals to make good any site losses during the start-up period.

U. Factory Testing of Motor Actuator

1. Test each actuator prior to shipment in accordance with AWWA C540. The application torque shall be the maximum torque required to open or close the valve or blast gate at any position including seating and unseating conditions.

V. Manufactuerers

1. Electric motor actuators shall be Rotork Controls, Inc., Limitorque or Auma.

2.03. ACTUATORS 4 INCHES AND SMALLER

A. Each electric actuator shall be bidirectional type with permanent split capacitor motor drive. Provide built-in motor thermal overload protection. The control housing shall be NEMA 4X construction unless actuator is identified as explosion proof. Explosion-proof actuators shall have housings rated for Class I, Groups C and D, and Class II, Groups E, F, and G locations.

B. Actuator power source shall be 115-volt single-phase a-c.

C. Provide a local-off-remote selector switch, stop-open-close push buttons, and open and closed indicator lights.

D. Actuator housings, supports, and connections to the valve shall be designed with a minimum safety factor of five based on the ultimate strength or three based on the yield strength of the material used.

E. Gear actuators shall be totally enclosed and factory-grease packed. Operators shall have self-lubricating bronze shaft bearings.

F. Position switches shall be integrally geared to the actuator and shall be adjustable. Provide motor actuators with position switches to stop motion at the end of travel in each direction.

G. Provide auxiliary switch contacts for transmitting open and close position.

H. The actuators shall have a manual override to allow operation of valve in case of power failure. Provide disengageable manual override so that the actuator cannot be operated electrically while the manual override is engaged.

I. Provide a space heater mounted in the actuator housing. Heater shall be on at all times.

J. Where valve modulation is indicated on the Drawings, provide an extended duty motor with an electro-mechanical motor brake. A feedback potentiometer shall be furnished in the actuator to provide a feedback signal for the positioning module.

K. The output torque of the motor actuator shall be at least 1.5 times the maximum torque required to open or close the valve at any position when subjected to the most severe operating condition including any mechanical friction and/or other restrictive conditions that are inherent in the valve assembly. Coordinate with the valve manufacturer to assure that the motor actuator stall torque output does not exceed the torque limits of the valve operating stem or shaft.

L. Where valve modulation is indicated on the Drawings, actuator shall be provided with an electronic, analog positioning module capable of accepting a variable D.C. analog signal input. This module shall position the valve with an accuracy of 0.5% to 1.0% of total travel. This device shall also transmit a variable D.C. analog signal for remote indication of valve travel.

M. Actuators in modulating service shall have 100% duty cycle rating at 115 volts AC, single phase.

N. Manufacturers

1. Electric motor actuators shall be Spears Manufacturing company, Dresser Flow Control/Texsteam RCS Series MAR, BI-TORQ, Neles Jamesbury, McCanna Inc. or Hayward Industrial Products.

PART 3 - EXECUTION

3.01. ATTACHING ELECTRIC ACTUATORS

A. The valve or blast gate manufacturer shall mount the electric motor actuator and accessories on each valve or blast gate and stroke the valve or blast gate prior to shipment. Adjust limit switch positions and torque switches.

3.02. PAINTING AND COATING

A. Coat electric motor actuator the same as the valve or blast gate to which it is attached. If the valve or blast gate is not coated, coat actuator per Section 09900 (Class 9 Exposure). Apply the specified prime coat at the place of manufacture. Apply intermediate and finish coats in field. Color of finish coat shall match the color of the valve or blast gate to which the actuator is attached. If the actuator is attached to a submerged valve or to an uncoated valve or blast gate, color of finish coat shall match the color shown in the Piping Schedule in Section 09905 for the particular piping service.

3.03. FIELD INSTALLATION

A. Install the valve or blast gate and actuator as indicated in the drawings in accordance with the manufacturer's instructions. Keep units dry, closed, and sealed to prevent internal moisture damage during construction. Provide additional hangers and supports for actuators which are not mounted vertically over the valve or blast gate or which may impose an eccentric load on the piping system.

B. Test Equipment for Field Units

1. Hand held test equipment shall be available to facilitate the testing of the installed field units and the setting of field unit parameters. Field unit testers shall be able to emulate master station communication on two-wire loop terminals, as well as evaluate status and diagnostic information. Master station test equipment shall be in addition to the master station display and keypad. It shall be connected to the RS232 host communication port and be capable of emulating a host system.

C. Field Testing of Motor Actuators

1. Test equipment shall simulate a typical valve/gate load. Test motor actuators and record the following:

a. Current at maximum torque setting.

b. Torque at maximum torque setting.

c. Flash test voltage.

d. Actuator output speed or operating time.

2. Test motor actuators as installed by measuring the current drawn (in amperes) by each motor for unseating, seating, and running conditions. The measured current shall not exceed the current measurement recorded during the factory performance test.

3. If the measured current drawn exceeds the above value, provide a larger motor or gear drive or adjust the actuator so that the measured amperage does not exceed the value.

4. Assure that limit switches are placed at their correct settings. Open and close valves and blast gates twice and assure that limit switches function.

5. Provide a performance test certificate with results of the tests stated above. In addition, include details of the specification including gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

3.04. CERTIFICATION

A. Provide a written certification as part of the test certificate from the equipment manufacturer that the actuator has been properly installed according to the contract documents and manufacturer's specifications and that the actuator is performing normally. Make all necessary corrections and adjustments including but not limited to labor, parts or freight at no additional cost to the Owner.

B. Provide warranty per Section 01740: Warranties and Bonds.

END OF SECTION

SECTION 15120

PIPING SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: This section includes materials and installation of the miscellaneous piping specialties.

B. Related Work Described Elsewhere:

1. Pressure Testing of Piping: Section 15044.

2. Chemical Feed System Piping: Section 15090.

3. Valves and Appurtenances: Section 15100.

C. General Design:

1. Comply with Section 15100, Article 1.01.B.1, 2 and 3.

2. Specialties shall have a working pressure rating equal to or greater than the piping installed in.

1.02 QUALITY ASSURANCE

A. Qualifications: Comply with Section 15100.

B. Standards: Comply with Section 15100.

C. Warranty: Comply with Section 15100.

D. Equipment Manufacturers: See PART 2.

1.03 SUBMITTALS

A. Submittals be in accordance with Section 15100.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Product delivery, storage and handling shall be in accordance with Section 15100.

1.05 SPECIAL TOOLS AND SPARE PARTS:

A. Provide special tools in accordance with Section 15100.

PART 2 - PRODUCTS

2.01 SOLENOID VALVES

A. Solenoid valves shall be design for not less than 150 psi water working pressure and shall be installed where shown. Electrical operators for solenoid valves shall be in accordance with electrical drawings. Valves shall be two-way pattern, screwed, brass-body type, ASCO No. 8210 through 8223.

2.02 TAPPING VALVES AND SLEEVES

A. See Specification Section 15128.

B. Tapping Valves shall be resilient seated. Tapping valves manufacturer shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications. Tapping valves shall include flush port, piped to above grade with isolation valve. Tapping valve shall hold in both directions with no leaks regardless of pressure differential across the valve.

C. Tapping sleeve for ductile iron pipe shall be mechanical joint; with tapping valves which outlet to a flanged connection for the above ground applications, and outlet to a mechanical joint connection for buried pipe taps. Exact O.D. of pipe to be tapped shall be field measured prior to ordering sleeve. Tapping sleeves manufacturer shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications.

2.03 HOSE BIBS:

A. Hose bibs shall be equal to Watts No. SC-3 or SC-4 of the size shown on the Drawings.

2.04 CORPORATION STOPS

A. Corporation stops shall be threaded on the inlet side and the outlet side fitted with connections to suit connecting pipe or tubing. Manufacturer shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications.

2.05 CURB STOPS

A. Curb stops shall be ball type. Manufacturer shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications.

2.06 QUICK CONNECT COUPLINGS FOR WATER SERVICE

A. Quick connect couplings shall be Model 633-F hose shank adapter and Model 633-C hose shank coupler as manufactured by Dover Corporation OPW Division, Cincinnati, Ohio, equal by Ever-tite Coupling Co., Inc., New York, New York or equal.

2.07 QUICK CONNECT COUPLINGS FOR CHEMICAL SERVICE

A. 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 equal.

2.08 SERVICE SADDLES

A. Service saddles shall be of the double-strap type. Straps and bodies shall be bronze or silicon bronze. Tap sizes on the outlet shall be 3/4-inch through 2 inches to accommodate the connecting piping or corporation stops. Manufacturer shall be selected from one of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented in an appendix of these technical specifications.

2.09 STRAINERS FOR WATER SERVICE

A. Strainers shall be installed as shown on the Drawings and shall be of the "Y" type. Strainers shall have bronze bodies with a removable bronze screen and shall be as manufactured by Mueller Steam, Mineola, New York, Watts Regulator Company, Lawrence, Mass., or equal.

2.10 PVC WYE STRAINERS

A. 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

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install piping specialties of the sizes and types in accordance with the manufacturer's instructions, and in the locations shown on the Drawings or specified herein.

END OF SECTION

SECTION 15122

AIR RELEASE AND VACUUM RELEASE VALVES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Scope of Work: This section includes materials and installation of various types of air and vacuum valves and air release valves for water service and sewage service.

B. General Design:

1. Valves shall have a working pressure rating of 150 psi, minimum.

2. Combination air/vacuum valves shall vent large quantities of air when the pipeline is filling, release small quantities of air when the pipeline is pressurized and allow reentry of air into the pipeline when pumps stop to prevent vacuum. Air release valves shall vent small quantities of air while the pipeline is pressurized.

1.02 QUALITY ASSURANCE

A. Qualifications: All air and vacuum release valves, for the same service, shall be manufactured by one manufacturer and shall be in accordance with Section 15100.

B. Warranty: See Section 15100.

C. Equipment Manufacturers: Manufacturers shall be selected from of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented as an Appendix to these Technical Specifications.

1.03 SUBMITTALS: Submittals be in accordance with Section 15100.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING: Shall be in accordance with Division 1.

1.05 SPECIAL TOOLS AND SPARE PARTS: Provide special tools in accordance with Section 15100.

PART 2 - PRODUCT

2.01 MATERIALS

A. Sewage Service (Force Main)

1. Sewage Combination Air Valves (SCAV)

a. Design: Single body, double orifice to allow large volumes of air to escape or enter pipe.

b. Materials:

(1) Body and Cover: ASTM 126 GRB Cast Iron
(2) Float and Stem: ASTM A-240 Stainless Steel
(3) Needle and Seat: Buna-N Nitrile Rubber
(4) Plug: ASTM B-124 Bronze
(5) Leverage frame: Delrin or Cast Iron ASTM D-1233

c. Isolation Valve: Cast iron plug valve or resilient seated gate valve.

d. Accessories: Blow-off valve and backflushing capabilities.

e. Manufacturer: Manufacturers shall be selected from of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented as an Appendix to these Technical Specifications, or approved equal.

2. Sewage Air Release Valves (SARV)

a. Design: Automatically releases air, gas or vapor under pressure through small venting orifice during system operation.

b. Materials:

(1) Body and Cover: ASTM A48 Cast Iron
(2) Float and Stem: ASTM A240 Stainless Steel
(3) Needle and Seat: Buna-N Nitrile Rubber
(4) Plug: ASTM B124 Bronze
(5) Leverage Frame: ASTM D2133/ASTM A48 Delrin/Cast Iron

c. Isolation Valve: Resilient seated gate valve or stainless ball valves

d. Accessories: Blow-off valve and backflushing capabilities

e. Manufacturer: Manufacturers shall be selected from of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented as an Appendix to these Technical Specifications, or approved equal.

B. Clean Water Service (Final Effluent) (Reuse Water) (Potable Water)

All air release and vacuum release valves shall be isolated from the service line with a bronze gate valve for valves up to 3 inches, and a flanged body butterfly valve for valves greater than 3 inches (provide a spacer plate if required to clear the rotation of the butterfly disc).

1. Air Valves (ARV)

a. 3/4-inch and smaller:

(1) Direct acting type or simple lever type.
(2) Cast iron body with stainless steel float, Buna N seat, and stainless steel linkage.
(3) Manufacturers shall be selected from of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented as an Appendix to these Technical Specifications, or approved equal.

b. 1-inch and larger:

(1) Float actuated compound lever type with linkage mechanism to release air.
(2) Float shall withstand external pressure of 1000 psig without collapsing.
(3) Cast iron body with flanged top cover and replaceable orifice. Synthetic rubber needle or disc actuated by float and linkage mechanism.
(4) 1/2-inch threaded outlet and bronze plug for top cover and body drain.
(5) Stainless steel float with bronze or stainless steel linkage and Buna-N needle.
(6) Manufacturers shall be selected from of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented as an Appendix to these Technical Specifications, or approved equal.

2. Air and Vacuum Valves (not intended for use on potable water service)

a. General: Float assembly and large venting orifice to exhaust large quantities of air, or admit large quantities of air.

(1) Cast iron body with flanged top containing air release orifice.
(2) Float shall rise with the water level in the valve body to close the orifice by sealing against a synthetic rubber seal.
(3) Float shall withstand and external pressure of 1000 psig without collapsing.
(4) Designs having levers and weights attached to the float will not be permitted.
(5) Float shall have one-piece guide rod extending out of the bottom and to engage the guide bushings in the valve body at all times.
(6) Cast iron body and cover with stainless steel float, guide rod and bushings with Buna-N seat.

b. Three (3) inches and smaller:

(1) 1/2-inch threaded outlet and bronze plug for top cover and body drain.
(2) Manufacturers shall be selected from of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented as an Appendix to these Technical Specifications, or approved equal.

c. Larger than 3 inches:

(1) 1-inch threaded drain outlet and bronze plug.
(2) 1-inch threaded outlet with bronze plug on the side of the valve body above the minimum water level in the valve, which forces the float against the valve seat.
(3) Steel protector hood.
(4) Manufacturers shall be selected from of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented as an Appendix to these Technical Specifications, or approved equal.

3. Combination Air Release Valves (not intended for use on potable water service):

a. Combination of 2.01, B, 1 and 2 above. The air and vacuum valve serves to release and admit large quantities of air when the pipeline is filled or drained. The attached air release valve serves to release small quantities of air that accumulate during pipeline operation.

b. Connect attached air release valve to air and vacuum valve with standard weight steel piping (ANSI B36.10) and an isolation gate valve.

4. Vertical Turbine Pump Air Release Valves (combination air release valve with slow closing surge check valve):

   a. Shall allow large quantities of air to escape out of orifice when the pump is started and close water tight when the liquid enters the valve. The air valve shall also permit large quantities of air to re-enter through the orifice when the pump is stopped to prevent a vacuum from forming in the pump column.

   b. A baffle shall protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely in the valve. The seat shall be fastened into the valve cover, without distortion, and shall be easily removed, if necessary.

   c. The entire float and baffle assembly must be shrouded with a perforated water column entering the valve from slamming the float shut and eliminate water hammer in the system.

   d. The discharge orifice shall be fitted with an adjustable throttling device to regulate the flow of air escaping to establish a pressure loading on the rising column of water to minimize shock to the pump and check valve.

   e. The float shall be center guided stainless steel, designing to withstand a minimum of 1000 psi.

   f. Cast iron body, cover, and baffle, with Buna-N seat, brass diffuser, and all other parts shall be stainless steel or bronze.

   g. Install ARV with unions to facilitate removal.

   h. Manufacturers shall be selected from of the specified "Manufacturers" in the Orange County Utilities "List of Materials and Approved Manufacturers" as presented as an Appendix to these Technical Specifications.

C. Valve End Connections:

1. Valves smaller than 4 inches shall have threaded ends. Valves 4 inches and larger shall have flanged ends.

2. Flanges for Class 150 valves shall comply with ANSI B16.1, Class 125. Flanges for Class 300 valves shall comply with ANSI B16.1, Class 250.

3. Threaded ends shall comply with ANSI B2.1.

D. Bolts and Nuts for Flanged Valves:

1. Bolts and nuts for flanged valves located indoors and in vaults and structures shall be carbon steel, ASTM A-307, Grade B.

2. Bolts and nuts for flanged valves located outdoors above ground shall be Type 316 stainless steel conforming to ASTM A-193, Grade B8M or bolts, and ASTM A-194, Grade 8M for nuts.

E. Gaskets: Gaskets for flanged end valves shall be as described in the detail piping specifications.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install valves in accordance with the manufacturer's instructions and recommendations and as shown on the Drawings. Direct tapping may be utilized in lieu of service saddles with ductile iron pipe for tapping sizes up to 1-inch tap size provided that the D.I.P. wall thickness will effect three full AWWA C-800 Standard threads.

B. Install all valves in the vertical position and allow sufficient clearance around valve for proper maintenance and removal.

C. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen and remove the nuts and bolts, reseat or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

D. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

E. Valve Pressure Testing: Test valves at the same time that the connecting pipelines are pressure tested. Protect or isolate any part of valves, operators, or control and instrumentation systems whose pressure rating is less than the test pressure.

3.02 STARTUP: Check-out all valves and demonstrate all valves for proper operation in accordance with Division 1.

END OF SECTION

SECTION 15126

PIPE HANGERS AND SUPPORTS

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 Section 05500.

3. Painting is included in Section 09900.

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 the General Conditions and Section 01340, 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 - Material 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 Anvil International, 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	Anvil 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 Anvil Fig. No. 229, and for rod sizes 7/8-inch through 1-1/4 inches shall be equal to Anvil 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:

i. 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.

ii. 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.

iii. 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 Anvil Fig. No. 230.

2. Wall or column supported pipes shall be supported by welded steel brackets equal to Anvil 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 Anvil 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. l 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 Anvil 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 Anvil 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 09900 - Painting.

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 and climate controlled conditions, in accordance with applicable project specifications and drawings, subject to the terms and conditions of the contract:

B. Related Work Described Elsewhere:

1. Chemical Feed Systems: Section 11241.

2. Heat Tracing included in Chemical Feed System Piping: Section 15090.

3. 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 15128

WET TAPS & TEMPORARY LINE STOPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: The work included under this Section consists of work performed on pressurized pipelines by the approved wet tap and line stop method and the immediate installation of various piping, valves, and instrumentation in accordance with the Contract Documents.

B. The Contractor shall take all safety measures necessary to prevent shutting down or depressurizing the water main system and shall coordinate all work to accommodate the needs of the existing treatment facility operations. Interruptions to the facility's operations will not be permitted during wet tap or line stop activities; however the Contractor shall notify the Owner in advance of such activities in accordance with Section 01041 of the Contract Documents.

1.02 QUALITY ASSURANCE

A. The Contractor shall employ the services of a wet tap and line stop specialist to perform wet taps and line stops as shown the Drawings and necessary in the completion of the work. The specialist shall be experienced in performing such work on potable water pipelines, and shall have previously performed at minimum of five (5) line stops of equal or greater size on potable water systems within the last five (5) years to be considered qualified for this project.

B. Wet Tap and Line Stop Technician Qualifications:

1. Wet tap and line stop technician actually operating the machinery shall have a minimum of five (5) years of continuous employment history with the wet tap and line stop specialist. The Contractor shall be required to furnish employment history for this technician along with a safety and other operational training summary.

C. Potential wet tap and line stop specialists that may meet the qualifications requirements as noted above include the following:

1. TDW Services

2. International Flow Technologies

3. Rangeline Tapping Services

1.03 SUBMITTALS

A. Submit shop drawings in accordance with the Section 01340: Shop Drawings and Submittals and the following.

B. Qualifications for the wet tap and line stop specialist, including representative projects and technician qualifications as required in paragraph 1.02, A and B above.

C. Contractor shall submit a plan outlining the estimated schedule, method of construction and restoration of the wet taps and line stops. This shall include, but is not limited to detailed drawings and a written description of the entire construction procedure to install, bypass, and reconnect the water main.

D. Contractor shall submit certification of workmen training for installing wet taps and line stop fittings.

E. Contractor shall provide submittals for all materials and equipment to be installed during the performance of the work.

1.04 PRODUCT, DELIVERY, STORAGE AND HANDLING

A. If proposed or existing pipe and fittings become damaged before or during installation, it shall be repaired as recommended by the manufacturer or replaced as required by the Engineer or Owner at the Contractor's expense, before proceeding further.

B. The Owner reserves the right to reject the work performed on any portion of the project in which there is evidence that the materials have not been handled in accordance with the manufacturer's recommendations.

1.05 WARRANTY AND GUARANTEES

A. The Contractor is responsible for replacing any portion of the work found to be installed in a way that stresses the material beyond the manufacturer's recommendations.

B. The Contractor shall provide all warranties and guarantees relative to workmanship and materials as required by the Contract Document, General Conditions and supplementary Conditions.

PART 2 - PRODUCTS

2.01 GENERAL

A. The equipment used in the installation of wet taps and line stops installation shall be of adequate commercial size and satisfactory working condition for safe operation, and will be subject to approval by the Engineer. Such approval, however, will not relieve the Contractor of the responsibility for making a satisfactory installation satisfying all criteria of the project.

B. The Contractor shall provide all materials for completing the installation and for adequate protection of the work.

C. Line stop and wet tap minimum pressure rating shall be equal to that of the pipeline in which they are to be installed.

2.02 MANUFACTURER TESTING

A. Test for compliance with this Specification shall be made as specified herein and in accordance with the applicable ASTM Specification. A certificate with this inspection shall be furnished upon request by the manufacture for all material furnished under this Specification. Equipment, valves, and fittings may be rejected if they fail to meet any requirements of this Specification.

2.03 FITTINGS

A. The wet tap fitting to be used for this type work shall be manufactured in two sections. The back (bottom) section will be of the full encirclement type and conform to the measured pipe outside diameter. The front (top) section will also be full encirclement type with a factory installed nozzle and flange outlet. Wet tapping saddles will be fabricated from approved carbon steel materials. The body run sections (top and bottom) shall be made of ASTM A-283 grade steel as a minimum. Steel run sections will conform to and re-enforce the existing pipe.

B. Fittings will have a recess for installation of a Buna-N rubber gasket around the hot tapping outlet. Bolts and nuts shall be a corrosion resistant alloy material per AWWA C-111 and ANSI 21.11.

C. A ¾” female NPT threaded test outlet will be placed into the nozzle branch outlet, at the factory, for the purposes of site pressure testing after the fitting has been installed around the pipe.

D. Outlets in sizes 4” to 60” in diameter shall have a minimum pressure rating of 150 psi.

E. Body:

1. ASTM A 283 grade C or ASTM A-36. Saddle plate thickness shall be in accordance with the design criteria for the entire fitting. The minimum wall thickness for saddle plates shall be 0.375". All welding of materials shall be in accordance with applicable code standards. Saddle plates shall be designed to permit longitudinal bolting of the top and bottom halves around the pipe.

F. Hot Tap Nozzle

1. Nozzles attached to the saddle plates shall be constructed of A-106 grade B steel or ASTM A-283 or A-36 steel. All weldments will be suitably stressed relieved when required by code or by common practice. Nozzle thickness shall be a minimum of standard steel pipe size or schedule 40 pipe wall thickness in compliance with the maximum working pressure of the system.

G. Nozzle to Pipe Sealing Gasket

1. Shall be molded from elastomeric compounds that resist compression set and are compatible with potable water in the temperature range of 32 to 140 degrees F. Buna-N rubber is recommended for use with potable water.

H. Flanges Used For Line Plugging

1. All flanges used for line plugging will be manufactured from ASTM- A-105 grade or equal.

2. Flanges will comply with ASME B16.5 in sizes up to 12". Completion plug locking mechanisms shall consist of ring segments or steel leaves that lock from or into the flange bore.

I. Point Loaded Set Screw

1. The use of point loaded set screw type locks shall be strictly prohibited.

J. Completion Plugs Used For Line Plugging

1. Completion plugs used for line plugging shall be manufactured from steel plate, ASTM A-36 grade material. Completion plugs shall be constructed in such a manner that an "O" ring pressure activated device will permit sealing the completion plug to the flange bore thus permitting the safe recovery of the temporary valve utilized for the line plugging operation.

Locking grooves or locking leaves will be designed to meet the maximum working pressure of the system.

K. Blind Flanges

1. Blind flanges shall be steel grade ASTM A-181 or ASTM A-105 and mate with the line plugging. Minimum blind flange thickness shall comply with AWWA C-207.

L. Flange Gaskets

1. All gaskets shall be of non-asbestos composition and designed to mate to the inner bore and inner bolt circle of the line plugging flange.

2. All gaskets shall be .125" minimum thickness.

M. Fasteners

1. All external bolting, studs and nuts shall be made of 316 Stainless Steel.

N. Pressure Test Port

1. Each fitting shall be furnished with a factory supplied ¾" threaded test outlet and plug attached to the hot tap and stopple nozzle.

O. Finish

1. After completion of fabrication, all fittings shall be coated both internally and externally in accordance with Specification Section 09900.

2.04 EQUIPMENT

A. General

1. All equipment utilized for the wet tapping and line stop operations shall be designed and manufactured to meet the maximum working pressure of the system onto which they are to be used. All equipment that will come into contact with potable water will be suitably chlorinated at the jobsite, under the supervision of the Resident Project Representative, prior to mounting to the valve used for wet tapping or line stops.

B. Wet Tapping Machinery:

1. Wet tapping machinery shall be designed and constructed to withstand the pressure and mechanical forces to be encountered during the wet tapping process. Equipment shall be power operated. The machinery utilized to

perform each wet tap shall have a pressure tight chamber attached to the power rotation portion of the mechanism. The shell cutter utilized for the trepanning process shall have carbide or high strength carbon steel tips to insure a smooth cut. Shell cutter will be inspected by the Resident Project Representative for sharpness prior to mounting the wet tap machine to the valve.

2. The pilot drill shall have a carbide or high strength carbon steel tip and inspected by the Resident Project Representative. The drill shall be furnished with a "coupon catching" device to insure that every precaution has been taken to recover the cut out pipe section. Resident Project Representative will inspect the coupon catching devise. The use of threaded tip pilot drills that act as coupon catching devices is strictly prohibited. The Contractor shall demonstrate calculations that the catching mechanism is of sufficient strength to retain the weight of the cut out pipe section.

C. Pipe Plugging Equipment:

1. All equipment utilized for the pipe plugging operation shall be designed and manufactured to meet the maximum working pressures of the system.

2. All equipment will be pressure rated for a minimum 150 psig working pressure through 54-inch diameter pipe. The pressure ratings will include a suitable safety factor above the operating pressures in the equipment design calculations.

D. Temporary Pipe Plugging Control Valve:

1. Temporary pipe plugging control valve shall be provided by the wet tapping Contractor along with a certificate of pressure test, at the factory, for the maximum pressures to be encountered while working on the pipe. All valves shall have a minimum bore that permits placement and removal of the factory supplied completion plug.

2. All temporary valves shall be provided and returned upon project completion.

E. Pipe Plugging Machinery:

1. The pipe plugging machinery shall consist of an actuator attached to a pressure tight housing. Contained within the pressure tight housing shall be a plugging head with an elastomeric seal captured between steel plates. The design and operation of the plugging head and sealing element shall meet the maximum pressures to be encountered in the water system. The sealing element shall be manufactured of elastomeric material and be non-

toxic. The use of a vegetable base lubricant shall be mandatory for placement of the sealing element into the pipe system.

2. Pipe plugging equipment shall be provided by the tapping Contractor with a flanged outlet on the plugging head housing. The plugging machine flanged outlet shall permit the Contractor to provide and install a temporary by-pass pipe system between the two plugging machines thus facilitating the maintenance of constant service while the primary pipe system under goes alterations.

F. Purge and Equalization:

1. Pipe plugging requires the use of an ancillary fitting for de-pressurization of the pipe system after the pipe plugging head has been placed into the system. The purge and equalization fitting is used to insure the integrity of the pipe plugging mechanism, to insure no other valves in the system might be open or not holding and to safely depressurize and pump the water out of the main prior to modification. This fitting is also required to introduce pressure into the pipe system after alterations are completed. The pipe system pressure must be equalized on both sides of the plugging head to permit its removal from the system. Wherever possible, existing connections shall be used for this purpose. When existing fittings are not available, then the tapping Contractor will provide a completion type fitting for this purpose.

2.05 FITTING TYPE FOR CARBON STEEL PIPING

A. General Description:

1. The wet tap and line stop fittings to be used for this type work shall be a carbon steel full body weld on fitting. The fitting shall be constructed of high strength steel, the nozzle from A-106 grade B material, and the completion flange from A-105 flange material.

PART 3 - EXECUTION

3.01 FITTING INSTALLATION

A. Fitting Field Installation: General

1. Fitting shall be installed in accordance with the manufacturer's recommendation. In no case shall the fitting be retrofitted while it is on the pipe. Any adjustments in fitting installation will require the Contractor to remove the fitting from the pipe and make Engineer and Owner approved alterations.

2. All wet tap and line stop work performed on active water mains shall be done in a sanitary manner to prevent cross connection with non-potable water mains or contamination from groundwater. All materials that may come into contact with water in the pipeline shall be spray disinfected per AWWA standards. If required to perform the work, temporary bypass piping shall be flushed, disinfected, and sampled for bacteriological clearance in accordance with the requirements for new water mains.

B. Suggested Installation Instructions: Cast Iron or Ductile Iron Pipe

1. Pipe Preparation:

The pipe shall be excavated at the location indicated on the plans and specifications. Excavation shall be in accordance with current O.S.H.A safety standards. Excavation shall include necessary sheeting and shoring, gravel base and site de-watering. Proper pipe support and thrust restraint shall be in place prior to the start of wet tap saddle installation. The pipe shall be thoroughly cleaned down to the factory supplied outside diameter. The pipe shall be carefully inspected, especially at the point where the fitting "O" ring must seal to the pipe surface. Any surface pitting shall be filled in with an Engineer approved epoxy or the site moved to an acceptable location.

2. Installation

The bottom half of the fitting shall be placed around the pipe first and properly supported from the bottom of the pipe with wood cribbing. The top half of the fitting shall have the O-ring seal lightly lubricated with vegetable base grease and then place upon top of the pipe. Side seam draw bolts shall be installed and the fitting halves shall be uniformly drawn together, in a loose fashion, starting from the center and working out to each end. The flange will be plumbed using a spirit level. Once the outlet flange is plumb, the sides of the fitting shall drawn together until the O-ring is compressed against the pipe surface. The use of a feeler gauge may be used to determine "O" ring compression.

3. Pressure Testing

A blind flange shall be attached to the fitting flange outlet and a suitable pressure test applied to check the contoured elastomeric O-ring seal. After successful pressure test, the blind flange shall be removed. The field pressure test shall not exceed the internal line pressure.

4. Concrete Encasement and Thrust Restraint

a. After acceptance of the pressure test, concrete support and thrust restraint shall be placed around the fitting and pipe joints to properly support the pipe, including equipment weights, and to prevent lateral movement of the pipe joints when the system is altered downstream of the line stopping process. The size and length of the concrete support shall be based upon the Contractor's calculation and existing site, pressure and soil conditions.

3.02 FIELD PROCEDURES

A. Field Procedures for Wet Taps and Line Stops shall be performed in accordance with the best practices for such work. An example of field procedures for Cast Iron and Ductile Iron Pipe is provided below to establish the level of effort anticipated. A project specific field procedure shall be submitted with the work plan noted in paragraph 1.03, C above.

1. Contractor shall provide a safe work environment in accordance with current OSHA Standards.

2. Contractor shall excavate, expose and clean the outer surface of the main so that the pipe to be tapped or plugged can be measured by a caliper and tape measure prior to manufacture of the required special fitting.

3. The Contractor shall be responsible for proper pipe support and the excavation will be in compliance with current O.S.H.A. safety standards.

4. Pipe plugging fitting drawings shall be prepared and submitted for approval Engineer and Owner prior to manufacture.

5. The Contractor shall properly install the fitting in accordance with the manufacturer's recommendations. After installation, the fitting shall be suitably pressure tested.

6. After fitting installation the Contractor shall provide sufficient concrete support under and around each fitting based upon existing soil conditions, the size and weight of the equipment to be mounted to the fitting, and anticipated lateral thrust that shall be placed on the fittings and pipe sections at the time of the pipe plugging operations and main line alterations. Lateral thrust restraint is required. The Contractor shall also take into consideration the lateral thrust that shall be placed on the pipe and plugging fitting at the time work is to be performed downstream of the line stops. The Contractor shall provide thrust forces on the fitting and equipment based upon operating pressures of the system.

7. Concrete shall reach minimum cure strength as specified by the Engineer prior to the mounting of any tapping-plugging machinery. The use of concrete additives to speed the cure time shall be used with the approval of the Engineer.

8. Upon acceptance of concrete support and thrust cure process, the Contractor shall provide and install the temporary control valve on to the plugging fitting.

9. The wet tap machine shall be field chlorinated and mounted to the temporary control valve. The wet tap will be performed and the cut out pipe section (coupon) will be retracted into the tapping machine's pressure housing. The temporary control valve shall be closed, the tapping machine de-pressurized and removed from the temporary control valve.

10. Wet tap technician shall be required to furnish, to the Resident Project Representative, written calculations for the wet tap and line stop operation. The written calculation shall include pilot drill travel, location of the pilot drill keeper wires in relation to the severed coupon and wet tap shell cutter travel. Wet tap machine shall be provided with a positive travel measurement device and all calculations shall be verified by the Resident Project Representative prior to the start of the tap. Plugging head sealing element sizing data and plugging head travel calculations shall be provided in a written format. Completion plug setting calculations shall also be required.

11. Once the wet tap machine has been attached to the valve, the wet tap pilot drill shall be advanced to the pipe face by hand. Travel calculations will be checked in relation to the previous recorded data. Once the pilot drill has penetrated the pipe wall, the wet tap machine shall be shut down and all joints inspected for leaks. The wet tap process shall be continued to the pre-determined cut completion calculation. The machine shall be shut down and the cutting head retracted by hand back to the start measurement.

12. The coupon shall be removed from the wet tap machine and the coupon shall be measured for the purpose of verification of the pipe line stop sealing element.

13. The plugging machine shall be field chlorinated and mounted to the temporary control valve(s).

14. The plugging sealing element(s) shall be lubricated with vegetable base grease only and prior to retraction into the pressure housing. No petroleum base grease is permitted.

15. Installation of Temporary By-Pass Line Applications

    a. Contractor shall connect temporary by-pass line to each flange connection on each stopple machine housing.

    b. The temporary control valve(s) shall be opened and the plugging head(s) will be inserted to the measured and calculated distance into the main line.

16. The downstream plugging head shall be placed into the system first. Once the line plugging head is seated in the main, the system will be de-pressurized downstream of the plugging head using the special purge fitting provided for that purpose, or through existing system connections.

17. De-pressurization shall be in accordance with the below listed fitting sizes based upon the main size being plugged:

    a) Main size 4" to 20" 2"
    b) Main size 22" to 48" 4"
    c) Main size 54" and larger 6" minimum

18. Once de-pressurization is confirmed then the Contractor may perform alterations to the pipe system as specified.

19. Upon termination of pipe alterations, the pipe system shall be re-sealed and pressure will be introduced into the section of the pipe that has been modified.

20. With system pressure equalized on both sides of the plugging head(s), the plugging head(s) shall be removed from the pipe system and retracted back into the pressure housing on the plugging machine(s). The temporary control valve shall be closed and the line plugging machine de-pressurized and removed from the temporary control valve.

21. Removal of Temporary By-Pass Line Applications

    a) After the plugging head(s) are removed from the pipeline and the control valve(s) are closed the Contractor shall drain the temporary by-pass line and remove it from the stopple machine(s).

    b) A completion machine shall have the completion plug mounted to the tool holder and the completion plug O-ring will be lubricated with vegetable based grease. The completion machine will be installed on the temporary control valve and the valve opened.

22. The completion plug shall be lowered to the pre-measured distance into the special flange on the line plugging fitting. The completion plug shall be securely locked into position and verified locked by the hot tap field technician.

23. The completion machine shall be disconnected from the completion plug tool holder, the machine depressurized to confirm the plug is secure and holding. The completion machine shall be removed from the temporary control valve.

24. The temporary control valve will be removed from the plugging fitting and a gasket and blind flange will be installed on the plugging fitting.

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 and the following.

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 - Material 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 type.

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 follower rings

    c. Two wedge-section gaskets

    d. Sufficient steel bolts to properly compress the gaskets

    e. Acceptable manufacturers

        (1) Smith - Blair, Inc. 470 Series Pipe-Lok

        (2) Dresser Manufacturing Co.

        (3) Romac

2. Buried Couplings (when applicable):

    a. Steel middle ring

    b. Steel or ductile iron follower rings

    c. Two wedge-section gaskets

    d. 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.

    e. Acceptable manufacturers:

        (1) Smith-Blair, Inc. 470 Series Pipe-Lok

        (2) Dresser Manufacturing Co.

        (3) Romac

C. 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: Epoxy

   c. Bolts: Carbon steel

   d. Pipe Restraint: Wedge type restraint

   e. Acceptable manufacturers:

      (1) Smith-Blair Inc. – 911 or 920 Series FlangeLok

      (2) Dresser Manufacturing Co.

      (3) Romac

4. 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.

   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) Smith-Blair Inc.

      (3) Romac

D. Flexible Expansion Joints:

1. Joints designed to permit a nominal maximum deflection of 15 degrees in all directions from the axis of the adjacent pipe length, will prevent pulling apart, and will remain watertight at any angle of deflection under 15 degrees.

2. Material to be manufactured from a composition material suitable for exposure to the liquid, pressure and temperature to be contained within the pipe.

3. Supplied with control rods as required.

F. Transition Couplings: Transition couplings for connecting different pipes having different outside diameters shall be steel: Dresser Style 62 or 162, Rockwell Series 413, or Baker Series 212 or 240.

G. Dismantling Joints

1. Combines flanged coupling adaptor and flanged spigot into one assembly.

2. Longitudinal adjustment is provided by the telescoping action of the spigot inside the flanged coupling adapter. The joint shall accommodate up to 2 inches of longitudinal movement.

3. Materials:

Flanged Adaptor Body and Spigot: Steel– ASTMA53 or A283. Grade C, minimum yield strength of 30,000 psi.
Follower Flange: Steel- ASTMA536, Ductile Iron per ASTMA536, or carbon steel, minimum yield of 30,000 psi.
Gasket: Buna-N

4. Manufacturing Smith Blair, Model 975, Romac DJ 400 Series or Dresser Manufacturing Co.

2.03 ACCESSORIES

A. Joint Harnesses:

1. 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. 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.

3.04 START-UP AND INSTRUCTION (Not Applicable)

END OF SECTION

SECTION 15130

PRESSURE GAUGES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: This section includes materials and installation of pressure gauges and accessories.

B. General Design: Minimum pressure rating shall be equal to that of the pipeline in which they are to be installed.

1.02 QUALITY ASSURANCE

A. Qualifications: The manufacturer shall have a minimum of five (5) years experience in the manufacture of pressure gauges.

B. Manufacturers: Gauges and tools shall be as manufactured by Ashcroft, Trerice, Winters Gauges, Palmer Gauges, or equal.

1.03 SUBMITTALS: Submit shop drawings in accordance with the General Conditions and Section 01340: Shop Drawings, Working Drawings, and Samples.

A. Manufacturer's catalog data and descriptive literature.

B. Materials of construction by ASTM reference and grade.

C. Manufacturer's certificate of compliance with the referenced ANSI standards.

PART 2 - PRODUCTS

2.01 GENERAL

A. Gauge Design: Gauges shall comply with ANSI B40.1, Grade 2A. Gauges shall incorporate the following features:

1. Solid or open front with side or rear blowout relief.

2. Pressure tight.

3. 270 degree arc with adjustable pointer.

4. Stem mounted.

5. Oil or glycerin filled unless specified otherwise.

6. Size of gauge shall be 4-1/2 inches for all process liquid and 6 inches for process air unless otherwise indicated on the Drawings.

7. Stem or connection size shall be 3/8 inch minimum.

8. Provide a gauge having a pressure range determined by the greater of the following two criteria:

   a. Two times the normal operating pressure; and

   b. One and one-third times the test pressure.

9. Gauges of size smaller than 4-1/2 inches shall conform to ANSI B40.1, Grade A. Otherwise, construction shall be as described above.

2.02 MATERIALS

A. Materials of construction shall be as shown in the following table:

Item	Material	Specification
1. Case	Stainless steel	AISI 316
2. Bourdon tube	Stainless steel	AISI 316
3. Windows	Glass	--
4. Ring	Stainless steel	AISI 316
5. Stem	Stainless steel	AISI 316
6. Dial face	Aluminum with clear baked-on acrylic coating	6061-T6, ASTM B 209

2.03 ACCESSORIES

A. Pipe Nipples and Fittings: Nipples for connection gauges to piping shall be Schedule 80S, Grade TP 316 seamless stainless steel, conforming to ASTM A 312. Fittings shall conform to ASTM A 403, Class WP316. Threads shall conform to ANSI B2.1. Size of pipe nipple shall match the gauge connection size.

B. Tools for Gauges: Provide one gauge tool kit, containing a hand jack set, screwdriver, five reamers (minimum), two pin vise holders, wiggler, tweezers, and carrying case.

C. Gauge Protectors (for use in process piping containing liquids having solids concentration greater than 1.0 percent):

1. Gauge protector shall consist of three parts: a flexible, impermeable, elastomer cylinder; a captive sensing liquid; and a stainless steel housing.

2. As process liquid flows through the housing, the cylinder shall transmit pressure through the sensing liquid. An attached 4-1/2 inch pressure gauge, as specified previously, shall indicate the pressure. Gauge outlet in the spool or ring shall be threaded, 1/4 inch, per ANSI B2.1.

3. Spools of sizes 1 inch through 4 inches shall be of the isolation-spool type with flanged ends. Spools of sizes 6 through 10 inches shall be of the isolation-ring type, fitting between two adjacent flanges.

4. Determine the flange rating based on the test pressure. For test pressure 200 psi and less, use Class 150 flanges, ANSI B16.5. For test pressures greater than 200 psi, use Class 300 flanges, ANSI B16.4.

5. Materials of construction shall be as follows:

Item	Material	Specification
Housing	Stainless steel	AISI 316
Flexible cylinder	Buna N. or Neoprene	---
Sensing liquid	Silicone oil	---

6. Protectors shall be manufactured by Ronningen-Petter, Red Valve, or equal.

D. Diaphragm Seals (for use in all processing piping containing liquids, except potable and nonpotable water):

1. Provide diaphragm seals with gauge mountings where shown on the drawings. Material of construction shall be Type 316 stainless steel. Pressure rating shall be at least that of the pressure gauge to which it is attached. Liquid filling shall be silicone.

2. Gauge and diaphragm seal shall be assembled together at the factory, with the liquid fill included. Provide a Type 316 stainless steel plug or cock in the flush connection.

3. Provide one pint of replacement fill liquid for every ten gauges having diaphragm seals or one pint for the entire project, whichever quantity is greater.

E. Pressure Snubbers: Provide pressure snubbers with gauge mountings where shown on the Drawings. Material of construction shall be Type 303 or 316 stainless steel. Inlet and outlet connections shall be 1/2-inch NPT.

PART 3 - EXECUTION

3.01 INSTALLATION: Install gauges before conducting pressure tests. Ream, clean and remove burrs from threaded piping before making up joints. Apply thread lubricant to threaded ends before assembling.

3.02 INSPECTION AND TESTING:

A. Compare pressure readings of permanent gauges with Master test gauge. If reading of installed gauges varies by more than ± 5 percent from the Master gauge the installed gauge shall be replaced.

B. Provide factory certification of testing and calibration for each Annular Seal or Diaphragm Seal Assembly. Unit shall be tested and calibrated in accordance with practice procedures on test equipment traceable to the National Institute of Standard (NIST).

END OF SECTION

SECTION 15400

PLUMBING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Furnish all labor, materials, equipment, services, and incidentals required and install and a complete plumbing system as shown on the Drawings. More specifically the work shall include, but shall not be limited to the following:

1. Installation of sanitary, waste & vents, and equipment drainage systems.

2. Installation of potable hot and cold water systems.

3. Plumbing fixtures, emergency showers and eye wash units with emergency water alarm, floor drains and cleanouts.

4. Potable water heaters with vacuum, temperature and pressure relief valves.

5. Drain outlets left for connections required by miscellaneous mechanical equipment.

6. All parts necessary to make a complete Plumbing System ready for continuous operation.

B. The work of this Section shall also include the installation of valve tags furnished by the Contractor. All valves provided under this Section shall be tagged.

1.02 GENERAL INFORMATION

A. Mention herein or indication on the Drawings of equipment, materials, operation or methods shall require that each item mentioned or indicated by provided to make a complete system of plumbing ready for continuous operation.

B. The location of all equipment, fixtures and piping shall be considered as approximate only and the right is reserved by the Engineer to change at any time, before the work is installed, the position of such equipment and piping to meet structural conditions and to provide proper headroom clearance or for the other sufficient causes and such changes shall be made without additional expense to the Owner.

C. Attention is called to the necessity for elimination of transmission of vibration from mechanical equipment to building structures. All equipment, therefore, shall be carefully selected and installed to meet this condition and isolators shall be provided where required.

D. All piping shall be installed as closely as possible to walls, ceilings and other structural parts (consistent with proper spacing for covering, removal of pipe, and access to accessories, such as valves, strainers, etc.) so as to occupy the minimum space, and all offsets and fittings required to accomplish this shall be furnished without additional expense to the Owner.

E. Any work of this Section, required to penetrate the roof, shall be provided with an offset of sufficient length as required to center the penetration on the flat portion of the roofing panels and centered between ribs.

F. Instruct such persons as designated by the Owner of the care and use of all plumbing equipment and piping systems installed.

1.03 DRAWINGS

A. All work shown on the Drawings is intended to be approximately correct to scale, but figured dimensions and detailed Drawings shall be followed in every case. The Drawings shall be taken in a sense as diagrammatic. Size of pipes and general method of running them are shown, but it is not intended to show every offset and fittings nor every structural difficulty that may be encountered. To carry out the true intent and purpose of the Drawings and all necessary parts to make complete working systems ready for use shall be furnished without extra charge.

B. Refer to the Structural and Architectural Drawings which indicate the type of construction in which the work shall be installed. Locations shown on the Plumbing Drawings shall be checked against the general and detailed drawings of the construction proper. All measurements must be taken at the building.

1.04 SUBMITTALS

A. Furnish to the Engineer for approval, as provided in the General Conditions, and Section 01340: Shop Drawings, Working Drawings and Samples covering details of all equipment, fixtures and accessories being furnished under this Section prior to fabrication, assembly or shipment.

B. Furnish to the Engineer for approval no less than 120 days before start-up, a schedule of all valves installed under this Section. The schedule shall include for

each valve the location, type, a number, words to identify the valve function, and the normal operating position.

1.05 EQUALITY OF MATERIALS

A. Wherever in the Plans and Specifications any item of equipment or material is designated by a particular manufacturer or trade name, it shall be understood that an approved equal product, acceptable to the Engineer, may be submitted.

1.06 CODES, ORDINANCES AND PERMITS

A. Comply with all the laws, ordinances, codes, rules and regulations of the Local, State and Federal authorities having jurisdiction over any of the work specified herein.

B. Obtain all required permits, pay all legal fees for the same and in general take complete charge and responsibility for all legal requirements pertaining to the Plumbing Section of the work.

C. Requirements set forth in this Section and indicated on the Drawings shall be followed when in excess of the required or minimum regulations.

D. If any work is performed and subsequent changes are necessary to conform to the regulations, such change shall be made as part of this work at no additional cost to the Owner.

1.07 ACCEPTANCE OF INSTALLATION CONDITIONS

A. This Contractor shall be fully responsible for the proper execution and performance of the work described herein. It shall be his responsibility to inspect all installation conditions and bring to the attention of the Engineer, prior to commencing any portion of this work, any failure of other contractors to provide suitable installation conditions for his portion of the work.

1.08 SERVICES AND UTILITY CONNECTIONS

A. Sanitary and Waste System:

1. The sanitary and waste systems will terminate at a point 5 feet-0 inches outside the building as shown on the Drawings.

B. Water Services:

1. The source of water for potable and protected use will terminate at a point 5 feet-0 inches outside the building as shown on the Drawings.

C. Gas Service (Propane):

1. None provided.

D. Laboratory Vacuum Service:

1. None Provided.

E. Laboratory Compresses Air Service:

1. None Provided.

F. Gas Services (Argon, CO_2, Oxygen, Acetylene and Nitrogen):

1. None Provided.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

A. Service Weight Cast-Iron Pipe and Fittings:

1. Shall be used for sanitary, soil, waste, and vent, piping, unless noted otherwise, inside building, and to a terminal point outside of the building where shown on the Drawings.

2. Where indicated on the Drawings, the pipe and fittings shall be service weight cast-iron soil pipe, ASTM A-74 and cast-iron pipe institute HS-67. Joints shall be rubber gasket (HSN-68T) compression type below grade and stainless steel No.- HUB (301-69T) above.

3. All pipe and fittings shall be of domestic manufacture and installation shall conform to the recommendations of the Cast Iron Soil Pipe Institute.

B. Steel Pipe and Fittings (Black):

1. Steel pipe and fittings shall be black steel, standard weight, Schedule 40, and shall conform to ASTM A-53.

2. The pipe shall be black and used for propane gas piping. Fittings shall be black gas pattern malleable iron threaded and shall conform to ANSI B-16.3 standard weight and ANSI B-16.19 extra heavy weight. Threaded steel flanges shall conform to ANSI B-16.5 and ASTM A-181, Grade I. Joints shall be made up as described for galvanized steel pipe above with approved type pipe joint compound suitable for heat value of propane gas. Pipe joints shall be welded for sizes 2-in. and larger and installation shall conform to the requirements of all governing authorities.

3. Shall also be used for Carbon Dioxide and Nitrogen piping.

4. Shall also be used for Acetylene piping except pipe shall be Schedule 80, ASTM A106 and fittings shall be Schedule 80 150 lb WSP, ANSI B16.3.

C. Copper Supply Pipe and Fittings:

1. Shall be Type "L" heavy and hard tubing with sweat cast brass fittings and shall be used for all Potable and Protected water, 4-in size and smaller unless noted otherwise. Shall also be used for Laboratory Compressed Air, Vacuum, Argon and Oxygen Piping.

   a. Iron size 85 percent copper pipe with cast pattern brass screw fittings shall be used instead of copper tubing on water piping immediately adjacent to all plumbing fixtures and outlets. Piping adjacent to fixtures where exposed shall be iron size and shall be chrome plated.

   b. Joints for Potable water, compressed air, vacuum, and Argon gas piping shall be made up with 95-5 solder for 1-1/2 inches and smaller tubing; 2 inches and larger tubing solder shall be 50-50. Joints for oxygen service shall be made up with at least 1000 degree silver solder. Note: Tubing for oxygen service must be purchased cleaned for oxygen service and with ends sealed.

   c. Flanged connections for all copper tubing supply piping shall be made with brass or bronze sweated flanges or by means of brass or bronze fittings with integral flanges.

   d. All pipe and fittings shall be of domestic manufacture and shall be equal to American, Bridgeport, Reading, Chase or Revere.

   e. Fittings shall be reducing type in lieu of bushings.

D. Insulating Fittings:

1. Provide insulated couplings or flanges on all connections between cast-iron, wrought iron steel, and copper service lines.

2. Fittings shall be of type to provide control of electrolysis and equal to "Dielectric" as manufactured by Thermo Dynamics Corp. or Watts Regulator Co.

F. Copper Drainage Pipe and Fittings:

1. Shall be Type "L" heavy and hard copper tubing with cast brass recessed drainage pattern sweat fittings and shall be used for equipment drip piping and pressure waste piping.

2. The pipe may be used for all waste and vent piping serving plumbing fixtures and equipment 2-inch size and smaller.

2.02 VALVES

A. General:

1. Valves, in general shall be of the same manufacture throughout unless noted otherwise and shall be the approved equal of those as manufactured by Fairbanks Co., Hammond Co., or Jenkins Bros. All valves except as noted otherwise shall be made for 125 pounds steam working pressure and shall have round iron wheel handles.

2. It is the intention of these Specifications to have control valves at bottom of all potable and protected hot and cold water service risers and as noted on the Drawings.

3. Hose End Valves (HEV) shall be installed on house side of main control valves, at bottom of all risers, at all low points, and where noted on the Drawings. These drawoffs shall consist of a gate valve described below. Drawoff valves shall be fitted with hexagon hose nipples and Jenkins No. 658 or Fairbanks Fig. 025 cap and chain or approved equal.

B. Water Valves:

1. All protected and potable water valves 3 inches and smaller unless noted otherwise, shall be brass body gates and shall be Fairbanks No. 0280, Jenkins No. 1240, or Hammond 1B-647 except adjacent to pumps and tanks where they shall be flanged pattern similar to Fairbanks No. 0202.

2. All water valves, 4 inches and larger, shall be iron body gates, bronze trim, flanged ends, O.S. & Y. pattern, solid wedge, rising spindle, Fairbanks No. 0405, Jenkins No. 651, or Hammond 1R-1140.

3. All check valves 3 inches and smaller shall be similar to Hammond No. lb-940, Fairbanks No. 0600, or Jenkins No. 92a. Check valves 4 inches and larger shall be flanged and similar to Fairbanks No. 0702, Hammond IR-1124 or Jenkins No. 624.

C. Water Valves:

1. All water valves shall be for Schedule 80 pipe, threaded and equal to R&G Sloane PVC True Union Ball Valve of sizes listed on the drawing.

2.03 DRAINS

A. For the purpose of explanation and description only, plate numbers have been given in the following schedule; such numbers, unless otherwise noted, are taken from the catalogs of Zurn Industries, Inc. Those drains as manufactured by Josam Co. and J.R. Smith Co. and determined by the Engineer to be equal in every respect to those specified will be acceptable for installation. All drains shall be of sizes shown on the Drawings.

B. Floor Drains (F.D.):

1. Refer to Architectural floor finish schedule which indicates the floor finish in each room or area where floor drains are to be installed.

2. All floor drains as required shall be fitted with a dep seal cast iron "P" type or "running" type trap to suit drain outlet. Shall be acid resisting material where noted.

3. All floor drains shall have cast iron or acid resisting drainage flanges, seepage control, clamping collar and inside caulk outlet unless noted otherwise to be I.P.S. outlet.

2.04 CLEANOUTS

A. In cast iron bell and spigot pipe, cleanouts shall consist of a cast iron ferrule and extra heavy brass tapered screw cleanout plug with square or hexagonal nuts.

B. In screw pipe, cleanouts shall consist of standard iron pipe size, i.p.s.) brass plug screwed into drainage fittings, in copper tubing they shall consist of copper-to-

copper-I.P.S. tees with I.P.S. brass plugs screwed into female threaded portion of the tee.

C. Acid resisting pipe terminal cleanouts shall be of type and acid resisting material recommended by the manufacturer of the pipe and fittings.

D. Provide C.I. or A.R. quarter bend at each floor cleanout where required.

2.05 SLEEVES AND CASTINGS

A. All sleeves shall be on-piece galvanized Schedule 40 steel pipe as described above, shall be set before slabs are poured and piping installed. The sleeves shall be fitted with flange or clamp to prevent slipping after forms are removed and piping installed.

B. All piping through walls, beams and partitions shall be sleeved. All sleeves shall finish flush with the finish line.

C. All piping passing through the floor slabs shall be sleeved. All sleeves shall finish flush with the finish line.

D. Space between sleeves and piping passing through the floor slabs, walls and partitions for all piping shall be sealed watertight and gastight.

E. Sleeves shall be of size to allow for continuous full thickness of pipe insulation through sleeve.

F. Provide waterproof sleeves or wall casting on each pipe entering or leaving building through foundation walls, tanks, pits, or wet wells. Seal space between each pipe and its waterproof sleeve. Each end of sleeve shall be sealed as described above. Each pipe shall be concentric with sleeve. Sleeves shall be waterproof type with welded or cast flange and of size and length to suit pipe and wall thickness. Sleeves shall be all galvanized after welding.

G. Hanger system supporting laboratory service piping, water, air, vacuum, gases, waste, vent and drain piping below the counter tops for wall and peninsulas laboratory benches shall be equal to Unistrut Corporation Laboratory Metal Framing System as indicated in Brochure No. 500 of Uniform System Division, pages 13 and 14.

1. Vertical supports shall be 1-5/8 inches x 1-5/8 inches, 12 gauge P-100 set 4 ft. on centers maximum.

2. Vertical supports for wall bench piping shall be secured to floor and wall.

3. Vertical supports for peninsula bench piping shall consist of two vertical units with horizontal sections connecting at the top and bottom forming a box frame. Bottom shall be secured to floor in at least two locations.

4. Pipe clamps and hangers shall be of sizes and types required to suit piping and shall be 1/6 inches plastic coated where in contact with copper piping. Clamps and hangers for insulated piping shall be enough to encompass both pipe and insulation. Submit layout of supports and materials in shop drawings form for review and approval.

H. Furnish and erect all light iron work consisting of beams, beam clamps, plates, angles, channels, rods and turnbuckles that may be required for the supporting and hanging of piping and equipment and for the construction of anchors.

I. All rods, hangers, inserts, brackets, and components shall be furnished with galvanized finish where installed in the building except for those items specified above to be copper or plastic coated.

J. Confer with Engineer to determine exact methods, operations, and materials to be used to attach hangers to precast roof structure. Contractor to receive written approval of same prior to any hanger units or component installation.

2.06 INSULATION

A. All insulation shall be applied on clean dry surfaces after test approval. All insulation shall be continuous through walls, floors, ceilings, sleeves and hangers.

B. Rigid pipe insulation inserts shall be installed at each hanger locations between pipe and pipe hangers of thickness equal to adjoining insulation. Rigid pipe insulation inserts shall be of length as recommended by the manufacturer. Insulation jacket over inserts shall be same as adjoining piping.

C. All insulated covering shall be guaranteed for a period of one year. Insulation shall be as specified below.

D. All water piping of every description specified herein, except reverse osmosis protected water piping shall be insulated throughout with Owens/Corning Fiberglass 25ASJ (All Service Jacket) 1-in. thick Heavy Density Pipe Insulation or approved equal with pressure sealing lap adhesive. No metal bans or staples will be allowed. Adhere 3 inches wide butt strips over all end joints between each section of insulation to insure a continuous vapor barrier.

E. All fittings, flanges and valves shall be covered with permanently noncombustible one-piece factory premolded insulated PVC fitting covers. Factory precut 1 inch thick fiberglass insulation shall be applied to the fittings.
The ends of the insulation shall be tucked snugly into the throat of the fitting and the edge adjacent to the pipe covering tucked in, fully insulating the pipe fitting. The one-piece PVC fitting cover shall be secured with stainless steel tack fastening. All seam edges of the cover shall be sealed with pressure sensitive vapor-barrier tape, color to match. The tape shall extend over the adjacent pipe insulation and overlap 2 inches beyond fitting cover.

F. Provide at each individual and trapeze hanger location a 16 gauge galvanized metal covering protector shield. Shields shall be not less than 12 inches long or three (3) times the insulation O.D., whichever is the greater dimension. The protector shield shall cover 120 degrees of the insulation surface arc.

G. Short exposed supply pipe at or immediately near regular plumbing fixtures shall not be covered with insulation but shall be furnished similar as trim for fixtures specified below. All water piping installed below laboratory benches shall be insulated.

H. Insulation shall be continuous through all sleeves, full thickness or insulation.

I. Pressure waste piping from air handling units and air conditioning units shall be insulated same as for cold water.

J. Electric drinking fountain waste arms and water and waste pipe and fittings under handicapped lavatories shall be insulated with 1/2 inch thick Johns-Manville J-M Aerotube or equal.

K. Extreme care shall be exercised to insure the sealing lap adhesive will hold jacket overlap in place during and after painting.

2.07 WATER HAMMER ARRESTERS (SHOCK ABSORBERS)

A. Water hammer arresters shall be equal to J.R. Smith, Jose Mfg. Company, or Zurn Industries shock control.

B. Arresters shall be sized in accordance with the Plumbing and Drainage Institute Standard P.D.I. WH201.

2.08 SIPHON BREAKERS & VACUUM BREAKERS

A. Siphon & Vacuum breakers shall be furnished on supply pipes to water closets, urinals, hose end faucets, fixtures and pieces of equipment having submerged

water inlets or direct connected inlets without air gap. These breakers shall have same finish as piping installed in and shall be located above floor rim level of the unit served.

2.09 THERMOMETERS AND PRESSURE GAUGES

A. Thermometers shall be Moeller, Taylor, Trerice or approved equal, red reading mercury adjustable angle stem type thermometers with 9-in. long or greater scale and shall be installed where shown as specified. Thermometers for installation in insulated piping shall be separable sockets. Sockets for installation in insulated piping shall be of the extended neck type to extend beyond the pipe insulation. The scale divisions shall be one degree F for upper limit of 240 degrees F. They shall be similar and equal to Moeller Series No. 90000 or Series No. 98000.

B. U.S. Gauge, Ashcroft, or approval equal 4-1/2 inches dial pressure gauges shall be installed where shown or specified. They shall be similar and equal to U.S. Gauge Series 5000 general purpose gauges. The expected normal pressure shall be read approximately the midpoint or above the gauge scale.

2.10 WATER HEATERS

A. Water heaters and storage tanks shall conform to the current applicable Building Codes (Provisions for Energy Conservation).

2.11 PLUMBING FIXTURES AND TRIM

A. For the purpose of explanation and description only, plate numbers have been given in the following schedule and are from the catalogs of American Standard Company unless otherwise noted.

B. Fixtures shall be as manufactured by the American Standard Company as specified or shall be as manufactured by Kohler Company, or Eljer Plumbing Div., types to be equal to those specified in the opinion of the Engineers.

C. Attention is particularly called to the fact that written approval of fixtures and trim proposed for purchase shall be received from the Engineer before purchase of any equipment or fixtures.

D. Fixture trim where exposed shall be brass chromium plated unless otherwise noted.

E. Water Closet supply from wall shall be C.P. at all locations.

F. All fixture traps shall be brass C.P. except for Water Closets, Urinals, Service Sinks and as otherwise noted.

G. All supply and waste nipples shall be fitted with one-piece set screw cast brass escutcheons finished in the same manner as pipes they serve.

H. Refer to Architectural and Structural details of partitions and floor finish before placing order for brackets and supports for fixtures.

I. Water closets and urinals shall have angle or straight stops as required on supply.

J. Height of rim of all fixtures from finish floor shall be as shown on the Architectural details. Chair carrier standards shall be of sufficient length to meet these requirements.

K. All fixtures shall have independent stops on hot and cold supplies.

2.12 FREEZEPROOF WALL HYDRANTS (FPH)

A. The Wall Hydrants shall be Zurn Industries or equal Model Z-1335-5 with 3/4 inch ps inlet and 3/4 inch male hose threaded outlet, vacuum breaker, bronze face plate and brass coating.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All the items specified under PART 2 - PRODUCTS of this section, shall be installed according to the applicable manufacturer's recommendations, the details shown on the Drawings and as specified under this Section.

B. Refer to paragraphs titled "SERVICES AND UTILITY CONNECTIONS" which describe locations and types of water services for Potable and Protected Water.

1. Where water piping is installed as copper tubing all valves shall be copper soldered end except as noted above to be threaded ends.

2. Control valves to all equipment and fixtures shall be installed, grouped and located so they will be easily operated, through access panels, doors, or adjacent to equipment.

3. All protected water connections for equipment installed under other sections shall be preceded by a control valve where required.

4. Valves shall be installed in horizontal to upright position and shall not be installed in down position from the horizontal.

C. Special attention shall be given to proper alignment, support and slope of piping buried in or below the lowest floor slabs prior to pouring of concrete slabs.

D. The sanitary system shall be extended to points of termination and installed as described and shown on the Drawings.

E. Hanger rods shall be secured by passing through rough slab and/or structural pre-cast unit above and finishing with plate and nut or rods shall be made fast by means of approved type inserts which shall be set before slab is poured. Hangers shall not interfere with the finish of the floors. Rods, bolts or plates shall not extend through the floor finish.

F. Insulation shall not be applied until pipes have been tested and accepted by all parties taking inspection. All insulated covering shall be guaranteed for a period of one year.

1. Hot and cold water runouts to fixtures in partitioned pipe spaces shall be insulated.

2. Short exposed supply pipe at or immediately near regular plumbing fixtures shall not be covered but shall be finished as trim for fixtures specified in PART 2 - PRODUCTS of this Section.

G. Cleanouts shall be installed at end of each branch soil or waste line, where waste and soil change direction, at the bottom of every riser either as a Dandy pattern above floor or end and cleanout in the horizontal below the floor.

H. Water hammer arresters shall be installed on all potable hot, cold and protected water lines at top of all riser and immediately adjacent to all quick closing mechanical and electrical operating valves. All arresters shall be potential type.

I. Vacuum valves, pressure relief and temperature relief valves shall be installed on all water heaters. Relief valves shall be piped to drain over floor drains.

J. Install all waste, vent, drains, sinks, traps, hot water and cold water piping and make all final connections to the outlets on all Laboratory Furniture and Laboratory Equipment complete with all necessary control valves. Install all traps and make the final connection between the waste piping and tailpieces from the Laboratory sinks and cup sinks.

K. The flow switch as described above for emergency shower units, shall be installed in the horizontal pipe line, it shall be on top of the pipe with the vane vertical.

The flow switch shall be located not less than 6 diameters from any fitting that changes the direction of flow.

3.02 TESTING

A. The various piping systems shall be subjected to water, smoke, or air tests as noted and shall hold tight as pressures stated without extra pumping or water addition for the time intervals stated.

B. All additional tests, methods or materials as may be required by the local ordinances and not specifically mentioned herein, shall be made a directed by the Engineer or the local Inspection Authority.

C. Soil, waste, drain, and vent piping shall be tested as follows:

1. Test rough, drainage or soil, regular and laboratory waste, drain, and vent systems by plugging piping where it enters the disposal terminal points or leaves the building by filling each system completely with water to the outlets on the roof after the outlets in section have been plugged or capped, for at least one hour duration.

2. If it becomes necessary during the construction of the building to test a part of a section for any reason or to cover permanently any soil, waste or vent pipe before piping above the part or section has been completed, there shall be applied a water test to such part or section of the piping by maintaining a 10-foot head of water on the highest section of the piping and the test shall hold tight for one hour.

D. Test all interior potable hot, cold and protected hot and cold water piping to a water pressure of 150 psi at the lowest level, and maintain this pressure without additional pumping for two hours.

3.03 WATER FOR TESTING

A. The Contractor will provide steam and water necessary for testing the piping systems. He shall make all connections for testing and remove all debris resulting therefrom. The water shall be used in an efficient and economical manner.

B. Provide all apparatus and all other supplies or materials which may be necessary for testing the systems and operating the apparatus during the period while test of any kind are being made, or for carrying out the work of the Contract.

3.04 CLEANING

A. At the completion of the work, all fixtures, equipment, apparatus and exposed trim for same included in this Section shall be clean and, where required, polished ready for use.

B. Protect this work during construction and all finished work damaged during construction shall be replaced.

3.05 PROTECTION

A. Materials, fixtures, and equipment shall be properly protected at all times and all pipe openings shall be temporarily closed so as to prevent obstruction and damage.

3.06 DISINFECTION

A. The entire potable and protected water collection and distribution systems shall be thoroughly disinfected with a solution of not less than 50 parts per million of available chlorine. The disinfecting solution shall be allowed to remain in the system for a period of three hours after which time all valves and faucets shall be opened and the system shall be flushed with clean water until the residual chlorine content is not greater than 0.2 parts per million, unless otherwise directed.

3.07 MISCELLANEOUS REQUIREMENTS

A. All hot and cold water supplies to a combination fixture, fittings or equipment shall be fitted with in-line check valves.

B. In general, all final connections to mechanical equipment in all location shall be preceded by union fitting and gate valve.

3.08 PAINTING

A. Surface preparation and shop prime painting shall be as specified in Section 09900: Painting.

B. Field painting shall be as specified in Section 09900: Painting.

3.09 COORDINATION SKETCHES

A. It shall be the responsibility of the Contractor to have in his employ a competent coordinator of mechanical systems and as such to provide all coordination of drawings or sketches as may be required or deemed necessary by the Engineer to obtain the required ceiling heights and eliminate conflicts with all piping, ducts, and electrical installation.

END OF SECTION

SECTION 15800

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work includes all labor, materials and equipment required to provide a complete, safe and workable air conditioning, heating and ventilation system as outlined in the Drawings and hereinafter specified. The following list is included as a guide to the Contractor, but work is not necessarily limited to these principal items briefly mentioned.

1. Ventilation fans.

1.02 QUALIFICATIONS

A. Wherever manufacturer's model and/or catalog numbers are noted on the Drawings or in the Specifications, such numbers indicate the grade, type, quality, physical arrangement, size, performance characteristics and availability of parts and service necessary to perform the function of that item.

B. Substituted equipment will be approved only when the Contractor can demonstrate to the Architect's or Engineer's satisfaction that all of the above listed requirements can be met. Any architectural, structural, mechanical or electrical changes required to adapt substituted equipment to the Drawings and Specifications shall be included in this Contract.

C. Where additional manufacturers are listed in either the Specifications or Drawings, equipment shall be limited to items manufactured by those firms specifically named.

1.03 SUBMITTALS

A. Thoroughly coordinated shop drawings shall be submitted for approval in accordance with Section 01340: Shop Drawings, Working Drawings and Samples where specifically called for on the Drawings, or as specified herein.

1. Submit shop drawings and complete performance data for all major pieces of equipment, showing dimensions arrangement, connection sizes, electrical wiring diagram, power requirements and clearances required for access of service. When equipment being submitted is a substitution, shop drawings shall include factory certification that the equipment has the

required capacity, or shall include copies of manufacturer's published performance data. Any calculations that may be required to prove that the equipment will operate as required shall be submitted together with the factory data.

2. Equipment proposed of different manufacturer, size of arrangement than that shown will require complete shop drawings, which clearly show how the equipment fits the available space and in relation to adjacent equipment, with all connections shown such as piping, duct adjacent equipment, with all connections shown such as piping, duct, work, etc. Plan views shall be supplemented with two sections or more.

3. Provide submittal data for air distribution devices, installation materials and duct work.

B. All shop drawings submitted for approval shall be stamped by the Contractor before submission to indicate that the shop drawings are complete, checked and comply with all aspects of the requirements of all Contract Documents.

C. All shop drawings shall be submitted within 30 days from the date contract is awarded.

D. Shop drawing approvals by the Engineer will not relieve the Contractor from responsibility for his own errors, nor from his responsibility for full compliance with the Contract Documents.

E. All data and drawings shall be submitted simultaneously in an indexed booklet.

F. Coordination with work specified under other divisions:

1. Submit for approval complete power and control field wiring diagrams for all equipment supplied in this Section of the work.

2. Submit for approval a drawing indicating location and sizes of all roof penetrations, curbs and pitch pans required for this work.

G. Warranty for the equipment in accordance with Section 01740: Warranties and Bonds.

1.04 OPERATING AND MAINTENANCE MANUALS

A. When the installation is complete, submit to the Engineer, as required in Section 01730: Operation and Maintenance Data, copies of the following, bound in a hard cover booklet:

1. General operating instructions, including copies of posted specific instructions and automatic control diagrams.

2. Maintenance instructions, followed by tabulated manufacturer's descriptive literature, shop drawings, performance curves and rating data, spare parts lists and manufacturer's maintenance manuals.

3. Names, addresses and telephone numbers of local service representatives of the manufacturers of the installed equipment.

PART 2 - PRODUCTS

2.01 POWER ROOF AND WALL VENTILATIONS

A. The ventilation fans shall be of the type and capacity indicated on the Drawings, and shall be furnished complete with all accessory items specified. Provide back draft dampers, bird screen and integral disconnect switches on all exhaust fans. Belt drives shall have adjustable pulleys and grease fittings. All fans shall be epoxy coated.

B. Acceptable Manufacturer:

1. Loren Cook Company, Springfield, Missouri.

2. Greenheck Fan Corporation, Schofield, Wisconsin.

C. Requirements of Regulatory Agencies: Conform to the requirements of the State of Florida.

D. Source Quality Control: AMCA labeled (Air Moving and Conditioning Association).

E. Backdraft Dampers:

1. Electric Operated:

a. Multiple blade.

b. Interlocked and gasketed aluminum, blades.

c. Nylon or other type rust proof bearings.

d. Tie rod connecting each blade.

e. Located at inlet to unit.

f. Epoxy Coated

g. Provide electric operators with end switch as indicated on the plans

h. Furnished by same manufacturer as power ventilator unit.

2.02 ACCESSIBILITY

A. All equipment requiring adjustment or service shall be fully accessible by means of location, clearance to structure, etc.

2.03 MATERIALS

A. All materials specified herein shall be new and of domestic manufacture.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation of all equipment and materials shall be in strict accordance with the best practice of the several trades and with the respective manufacturer's instructions and recommendations.

B. Install all fans to prevent vibration and drumming and be certain that all fan bearings are properly greased before starting fans.

C. Install ventilator in accordance with manufacturer's instructions.

3.02 TESTING AND BALANCE

A. The Contractor shall obtain the services of an independent test and balance agency that specializes in and whose business is limited to testing and balancing of air conditioning systems. The agency selected shall be fully certified by the Associated Air Balance Council and shall have at least one member of the agency qualified as a certified test and balance engineer that has been issued this certification by the National Examining Board, United States and Canada. All final reports shall be signed by this certified test and balance engineer and shall include his official stamp.

B. Testing and balancing shall be performed in complete accordance with AABC National Standards for Field Measurement and Instrumentation, Form Number 81266, Volume One, section applicable to air distribution and section applicable to hydronic balancing.

C. Instruments used for testing and balancing of air and hydronic systems must have been calibrated within a period of six (6) months and checked for accuracy prior to start of work.

D. The complete test report shall be submitted to the consulting mechanical engineer prior to final acceptance of the project.

E. Selected and approved agency shall submit AABC National Warranty certificate which includes pre-construction plan check and continuous inspection program immediately upon receipt of the test and balance contract.

F. The Contractor shall submit name of the test and balance agency to architect and consulting mechanical engineer for approval within 30 days after receipt of construction contract by air conditioning contractor.

END OF SECTION

DIVISION 16

ELECTRICAL

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 16, ELECTRICAL. Work specified herein shall be performed as if specified in the individual sections.

1.02 DESIGN REQUIREMENTS

A. All electronic boards as part of electrical equipment shall meet the atmospheric conditions of the space the equipment is installed in. All electronic boards that are not installed in a conditioned environment shall be fungus-resistant.

B. All electrical equipment shall be rated for the conditions the equipment is installed in.

1.03 ELECTRICAL COORDINATION

A. Major Work Provided Under this Contract:

1. Provide and install new buckets at the existing 4160V switchgear 30-SWBD-1 and 30-SWBD-2 to power three (3) new Transfer Pumps as shown on drawings and as described in the specifications complete in place.

2. Provide and install new buckets at the existing 4160V switchgear 50-SWBD-1 and 50-SWBD-2 to power two (2) new High Service Pumps as shown on drawings and as described in the specifications complete in place.

3. Provide and install new pad mounted transformers, solid state reduced voltage starters, constant speed starter, variable frequency drives, low voltage transformer, panelboard, etc. as shown on drawings and as described in the specifications complete in place.

4. Provide and install new MCC buckets in 20-MCCs and circuit breakers within panelboards 20-PP-1 and 20-LP-1 to feed new equipment and new

field devices in the FDA/AQC area as shown on drawings and as described in the specifications complete in place.

5. Provide and install new backboards within existing 63-LCP-1. Feed new metering pumps from 63-LCP-1 via existing conduits.

6. Provide and install new lighting systems, convenience power systems, and communication raceway system as shown in the drawings and as described in specifications complete in place.

7. Provide and install all conduit and wire to support instrumentation and control systems, unless otherwise noted in the drawings and specifications, complete in place.

8. Provide and install new lightning protection and grounding systems as shown on drawings and as described in the specifications complete in place.

9. Provide and install new fire alarm system as shown on drawings and as described in the specifications complete in place.

10. Provide all miscellaneous electrical including disconnect switches, terminations, fittings, etc. not specified but obviously necessary for complete working systems in place.

11. Contractor shall perform an arc flash study and a short circuit and protective device coordination study of the new electrical system to determine proper protective device settings and verify expected fault current levels for all new equipment as per specification 16015. Provide arc flash labels on new and existing equipment. Provide electronic versions of arc flash, short circuit, and protective device coordination studies in the original software format (i.e. SKM or equal) and in PDF format to OWNER and ENGINEER.

12. Provide and install all yard conduits, pullboxes, manholes, and spare conduits as described in the drawings and specifications complete in place.

13. Contractor shall coordinate with Process, I&C, Mechanical, HVAC, and Generator Contractor for all required wire, conduit, power and signal requirements for all package system. Contractor shall review all Process, Mechanical, I&C, HVAC and other systems shop drawings for all electrical requirements and provide all materials and labor as necessary.

14. Contractor shall coordinate with other disciplines for demolition of existing equipment. Remove all existing electrical equipment that will be unused after the demolished equipment is removed. Remove conduits and wire back to source.

B. Temporary Power:

1. Contractor shall furnish and install temporary construction power and temporary distribution system to Contractor's and Engineer's trailers. Contractor shall coordinate all construction power with the local power utility.

C. Emergency Power:

Not required unless temporary generator is needed during demolition.

D. Construction Constraints:

1. Refer to specification 01010 and mechanical drawings for project sequence and construction constraints.

2. The Eastern Regional Water Supply Facility shall be capable of pumping 50 MGD at all times. Refer to the Overall Power Distribution Schematic for existing main-tie-main configuration.

3. Contractor shall coordinate with Owner for any shutdown requirements. Notify Owner for shutdown schedule at least 1 week in advance and get written approval from the Owner.

1.04 SUBMITTALS

A. The following information shall be provided for all electrical equipment:

1. A copy of each specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the

specifications. The submittal shall be accompanied by a detailed, written justification for each deviation.

2. Electrical equipment submittals shall be made by specification section. Submit one package per specification section and do not group multiple specification sections under one submittal package.

3. Provide complete conduit and equipment layouts: a scaled plan layout of the electrical room(s) showing spatial relationships of all equipment as well as the overall size of the room. Minimum scale shall be ¼”=1’-0”.

4. Provide a conduit plan for major power, instrumentation and control conduits, both interior and exterior, showing routing, size and stub up locations for buried or in slab conduits.

B. As part of the electrical submittal, the contractor shall provide a minimum of ¼”=1’-0” scaled layout of the electrical equipment in the electrical room or major electrical equipment in a mechanical room showing sizes of all equipment and their spatial relationship. Non-electrical equipment shall be approved before finalizing the electrical layout in mechanical rooms.

C. Provide four (4) copies of the latest Overall Power Distribution Schematic on 24”x36” full-size plots.

1.05 ENVIRONMENTAL CONDITIONS

A. All chemical rooms and areas shall be corrosive areas.

B. All indoor chemical and process equipment areas shall be considered wet locations.

1.06 INSPECTION OF THE SITE AND EXISTING CONDITIONS

A. The Electrical Drawings were developed from past record drawings and information supplied by the OWNER. Verify all scaled dimensions prior to submitting bids.

B. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and electrical system which will, in any way or manner, affect the work required under this Contract. No subsequent increase in Contract cost will be allowed for additional work required because of the CONTRACTOR's failure to fulfill this requirement.

C. Carry out any work involving the shutdown of the existing services to any piece of equipment now functioning in existing areas at such time as to provide the least amount of inconvenience to the OWNER. Do such work when directed by the ENGINEER.

D. After award of Contract, locate all existing underground utilities at each area of construction activity. Protect all existing underground utilities during construction. Pay for all required repairs without increase in Contract cost, should damage to underground utilities occur during construction.

1.07 RESPONSIBILITY

A. The CONTRACTOR shall be responsible for:

1. Complete systems in accordance with the intent of these Contract Documents.

2. Coordinating the details of facility equipment and construction for all Specification Divisions that affect the work covered under Division 16, ELECTRICAL.

3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

1.08 INTENT OF DRAWINGS

A. Electrical plan Drawings show only general location of equipment, devices, and raceway, unless specifically dimensioned. The CONTRACTOR shall be responsible for the proper routing of raceway, subject to the approval of the ENGINEER.

B. The basis of design for the major electrical equipment sizes and characteristics has been **Allen Bradley** for motor starters and VFDs; **Cutler-Hammer** for motor starters, VFDs, and panelboards**; General Electric** for switchgear and MCCs**; Square D** for PLCs, transformers, and panelboards**; Caterpillar** for generators; and **Hubbell** for light fixtures. If the CONTRACTOR chooses to and is allowed to substitute, the CONTRACTOR shall be responsible for fitting all the equipment in the available space as shown on the Drawings and providing any additional hardware and/or software for a fully functional system per the intent of the design. The CONTRACTOR shall be responsible for all costs associated with any modifications to the substitute in order to adhere to the intent of the design. The CONTRACTOR shall provide credit(s) to the OWNER for any cost savings

associated with the substitute. No change orders shall be issued for the use of a substitute.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide materials and equipment listed by UL wherever standards have been established by that agency.

B. Equipment Finish:

1. Provide manufacturers' standard finish and color, except where specific color is indicated.

2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

PART 3 - EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

3.02 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.03 STARTUP

A. Startup:

1. Demonstrate satisfactory operation of all 480-volt electrical equipment. Participate with other trades in all startup activities.

2. Assist the PICS Contractor in verifying signal integrity of all control and instrumentation signals.

3.04 STANDARDS, CODES, PERMITS, AND REGULATIONS

A. Perform all work; furnish and install all materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and specifications of the following:

1. Local Laws and Ordinances.

2. State and Federal Laws.

3. National Electrical Code (NEC).

4. State Fire Marshal.

5. Underwriters' Laboratories (UL).

6. National Electrical Safety Code (NESC).

7. American National Standards Institute (ANSI).

8. National Electrical Manufacturer's Association (NEMA).

9. National Electrical CONTRACTOR's Association (NECA) Standard of Installation.

10. Institute of Electrical and Electronics Engineers (IEEE).

11. Insulated Cable Engineers Association (ICEA).

12. Occupational Safety and Health Act (OSHA).

13. National Electrical Testing Association (NETA).

14. American Society for Testing and Materials (ASTM).

B. Conflicts, if any, which may exist between the above items, will be resolved at the discretion of the ENGINEER.

C. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

D. Obtain all permits and pay all fees required by any governmental agency having jurisdiction over the work. Arrange all inspections required by these agencies. On completion of the work, furnish satisfactory evidence to the ENGINEER that the work is acceptable to the regulatory authorities having jurisdiction.

END OF SECTION

SECTION 16015

ELECTRICAL SYSTEMS ANALYSIS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The requirements of this specification shall apply to the new electrical distribution system at Eastern Regional Water Supply Facility (ERWSF), including new electrical distribution at Process 20 Building, Process 50 Building, and Process 80 Building. The end result shall be a fully protected, and properly coordinated, system with proper arc flash safety labels and personal protective equipment recommendations.

B. Contractor shall furnish short-circuit and protective device coordination studies as described herein. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to, and including, the main breaker and feeder circuit in each 208 Volt panelboard. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.

C. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D. Provide Arc Flash label as shown on section 3.02 of this specification.

D. Contractor shall provide GE Multiline PQM II Ethernet capable power monitoring equipment and Multinet Bridges for all new MCCs and MCCs which are modified.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

a. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems

b. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings

c. IEEE 242: Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

d. IEEE 399: Recommended Practice for Industrial and Commercial Power System Analysis.

e. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems

f. IEEE 1584-2002: Guide for Performing Arc Flash Hazard Calculations.

2. American National Standards Institute (ANSI):

a. C57.12.00, Standard General Requirements for Liquid-immersed Distribution, Power, and Regulating Transformers.

b. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures

c. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis

d. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories

e. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents

3. National Fire Protection Association:

a. NFPA 70E: National Electrical Safety Code Chapter 1.

b. NFPA 70: National Electrical Code.

4. Occupational Safety & Health Administration (OSHA):

a. 29-CFR, Part 1910, sub part S.

1.03 SUBMITTALS

A. Shop drawings: the results of the short-circuit, protective device coordination, and arc flash hazard analysis studies shall be summarized in a preliminary and final summary report. Submit five (5) three-ring binder bound copies of the complete preliminary and final study reports. The preliminary short circuit and device coordination study report shall be submitted within 30 days of notice to proceed and shall be a basis for approval of all other electrical equipment in the power distribution system. The contractor is expected to review the results of the preliminary short circuit and device coordination study report against all other applicable shop drawings, including industrial control panels, prior to shop drawing submittal to coordinate appropriate fault duty ratings of all electrical equipment. The final short circuit and device coordination study report shall incorporate all comments from shop drawing submittals and include the arc-flash hazard analysis. The contractor shall ensure proper arc-flash warning labels are applied to all appropriate electrical equipment when the final study has been approved.

1.04 QUALITY ASSURANCE

A. Short circuit, protective device coordination, and arc flash studies shall be prepared by the manufacturer furnishing the electrical power distribution equipment or a professional electrical engineer registered in the State of Florida, hired by the manufacturer, in accordance with IEEE 242 and IEEE 399.

B. Manufacturer shall have unit responsibility for the equipment and protective device coordination.

1.05 SEQUENCING AND SCHEDULING

A. An initial, complete short circuit and arc flash study must be submitted and reviewed before Engineer will approve Shop Drawings for switchgear, unit sub stations, breakers, MCC'S, switchboard, VFD'S, manufactured industrial control panels and circuit breaker panelboard equipment. Failure to do so will delay the approval of major equipment submittals.

B. The short circuit, protective device coordination and arc flash studies shall be updated prior to Project Substantial Completion. Utilize characteristics of as-installed equipment actual wire run lengths and materials.

PART 2 - PRODUCTS

2.01 GENERAL

A. Contractor shall furnish all field data as required for the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing. Contractor shall contact the Owner for the existing available data from the previous projects and field verify/collect all other necessary for the studies.

B. Source combination may include present and future utility supplies, motors, and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.

D. Equipment and component titles used in the studies shall be identical to the equipment and component titles shown on the Drawings.

E. Perform studies using digital computer with a software package such as SKM Power*Tools for Windows™ DAPPER™, CAPTOR™ and ARC FLASH™, or approved equal.

F. Perform complete fault calculations for all busses on utility and generator power sources. Perform load flow and voltage drop studies for major feeders and loads with long feeder runs. Analysis shall include expected fault currents at industrial control panels manufactured in accordance with UL 508A and NEC article 409.

G. Fault source combinations shall include large motors, large transformers, utility and generator.

H. Utilize proposed and existing load data for the study obtained from Contract Documents and field survey. Coordinate with local power utility for available fault currents from utility services.

I. Existing Equipment:

1. Include fault contribution of all existing equipment including, but not limited to, existing motors, services, distribution equipment, as appropriate, in the study.

2. Obtain required existing equipment data from the field and local power utility.

J. Provide a comprehensive report document containing the short circuit, device coordination and arc flash studies. As a minimum the report structure shall contain the following:

1. Executive Summary.

2. Methodology.

3. One Line Diagram(s).

4. Short Circuit Analysis.

5. Short Circuit Analysis Results/Conclusions/Recommendations.

6. Device Coordination Analysis.

7. Recommended protective devices settings.

8. Arc Flash Analysis.

9. Arc Flash PPE recommendations.

2.02 SHORT CIRCUIT STUDY

A. General:

1. Use cable impedances based on copper conductors. Use actual conductor impedances if know. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.

2. Use bus impedances based on copper bus bars.

3. Use cable and bus resistances calculated at 25 degrees C.

4. Use 600-volt cable reactances based on use of typical data of conductors to be used in this project.

5. Use transformer impedances 92.5 percent of "nominal" impedance based on tolerances specified in ANSI C57.12.00.

B. Provide:

1. Calculation methods and assumptions.

2. Selected base per unit quantities.

3. One-line diagrams annotated with results of short circuit analysis including:

   a. Three phase, line-to-line and single line to ground faults.

   b. Equipment Short Circuit Rating.

4. Source impedance data, including electric utility system and motor fault contribution characteristics.
5. DAPPER™ Short circuit report, demand load report, load flow report and input data reports.

6. Results, conclusions, and recommendations.

C. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed symmetrical three-phase bolted fault, bolted line-to-ground fault, and bolted line-to-line fault at each:

1. Electric utility's supply termination point.

2. Main breakers, generator breakers and feeder breakers.

3. Unit substations and medium voltage switchgear.

4. Low voltage switchgear, switchboard and/or distribution panelboard.

5. Motor control centers.

6. Standby generator.

7. Automatic Transfer Switch (if applicable).

8. All branch circuit panelboards.

9. Variable Frequency Drives.

10. Industrial control panels manufactured in accordance with UL 508A and NEC article 409.

11. Other significant locations throughout the system.

12. Future load contributions as shown on one-line diagram.

D. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings Verify all equipment, main breakers, ATS, and protective devices are applied within their ratings.

2. Adequacy of switchgear, switchboards, motor control centers, unit substations and panelboard bus bar bracing to withstand short-circuit stresses

3. Adequacy of transformer windings to withstand short-circuit stresses
4. Cable and busway sizes for ability to withstand short-circuit heating besides normal load currents.

5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

E. Through the General Contractor, furnish expected fault currents for industrial control panels, constructed and installed under other divisions and specifications of this contract, to the panel builder for his coordination with meeting the requirements of UL 508A and NEC article 409.

2.03 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves for distribution system, graphically displayed on log-log scale paper. Time Current Curve plots from SKM CAPTOR™ program are acceptable.

B. Each curve sheet to have title and one-line diagram with legend identifying the specific portion of system associated with time-current curves on that sheet.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Perform device coordination on time-current curves for low voltage distribution system(s).

F. Provide Individual protective device time-current characteristics on log-log paper or software generated graphs.

G. Plot Characteristics on Curve Sheets:

1. Electric utility's relays or protective device (if applicable).

2. Electric utility's fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands (if applicable).

3. Medium voltage equipment relays.

4. Medium and low voltage fuses including manufacturer's minimum melt, tolerance, and damage bands.

5. Low voltage equipment circuit breaker trip devices, including manufacturer’s tolerance bands.

6. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters.

7. Transformer damage curves.

8. Conductor damage curves.

9. ANSI transformer with stand parameters.

10. Significant symmetrical and asymmetrical fault currents.

11. Ground fault protective devices and settings (if applicable).

12. Pertinent motor starting characteristics and motor damage points.

13. Pertinent generator short circuit decrement curve and generator damage point.

14. Circuit breaker panelboard main breakers, where appropriate.

15. Motor circuit protectors for major motors

H. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

I. Primary Protective Device Settings for Delta-Wye Connected Transformer:

1. Secondary Line-to-Ground Fault Protection: Primary protective device operating band within the transformer's characteristics curve, including a point equal to 58 percent of ANSI C57.12.00 withstand point.

2. Secondary Line-To-Line Faults: 16 percent current margin between primary protective device and associated secondary device characteristic curves.

J. Separate medium voltage relay characteristics curves from curves for other devices by at least 0.4-second time margin.

2.04 ARC FLASH ANALYSIS

A. Perform incident energy calculations in accordance with IEEE 1584-2002 Guide for Performing Arc Flash Hazard Calculations for all equipment analyzed in the short circuit study. Tabular results and recommended labels from SKM ARC FLASH™ are acceptable.

B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, bussway and unit substations, variable frequency drives, industrial control panels) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all medium voltage, low voltage and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA. Arc-Flash Hazard Analysis on low voltage systems 120V and below is not required.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

I. Furnish recommendations for Personal Protective Equipment, in accordance with OSHA standards, and proper labels to be located on the electrical equipment in accordance with NEC Article 110.16.

J. Use manufacturer data for: enclosure type; gap between exposed conductors or buss way; grounding type; number of phases and connection; and working distance.

2.05 TABULATIONS

A. Input Data:

1. Utility three-phase and line-to-ground available contribution with associated X/R ratios.

2. Short circuit reactances of rotating machines and associated X/R ratios.

3. Cable type, construction, size, quantity per phase, length, impedance and conduit type.

4. Bus data, including impedance.

5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio.

B. Short Circuit Data:

1. Source fault impedance and generator contributions.

2. X to R ratios.

3. Asymmetry factors.

4. Motor contributions.

5. Short circuit kVA.

6. Symmetrical and asymmetrical fault currents.

C. Recommended Protective Device Settings:

1. Phase and ground relays:

    a. Relay name.

    b. Device number.

    c. Description.

    d. TCC catalog number.

    e. Short circuit ratings.

    f. Current transformer ratio.

    g. Current tap.

    h. Time dial setting (as applicable).

    i. Instantaneous pickup setting (as applicable).

    j. Ground fault setting (as applicable).

    k. Specialty, non-overcurrent device settings.

    l. Recommendations on improved relaying systems, if applicable

2. Circuit Breakers:

    a. Breaker name.

    b. Breaker Description.

    c. Model number.

    d. TCC catalog number.

    e. Short circuit rating.

    f. Frame/Sensor rating.

    g. Adjustable pickups and time delays (long time, short time, ground).

    h. Adjustable time-current characteristic.

i. Adjustable instantaneous pickup.

j. Recommendations on improved trip systems, if applicable

3. Motor Circuit Protectors (MCP):

a. MCP name.

b. MCP Description.

c. Model number.

d. TCC catalog number.

e. Short circuit rating.

f. Frame/Sensor rating.

g. Instantaneous settings.

4. Fuses:

a. Fuse name.

b. Fuse Description.

c. Model number.

d. TCC catalog number.

e. Short circuit rating.

f. Fuse rating.

D. Incident energy and flash protection boundary calculations.

1. Arcing fault magnitude

2. Device clearing time

3. Duration of arc

4. Arc flash boundary

5. Working distance

6. Incident energy

7. Hazard Risk Category

8. Recommendations for arc flash energy reduction

2.06 STUDY ANALYSES

A. Written Summary:

1. Scope of studies performed.

2. Explanation of bus and branch numbering system.

3. Prevailing conditions.

4. Selected equipment deficiencies.

5. Results of short circuit and coordination studies.

6. Comments or suggestions.

B. Suggest changes and additions to equipment rating and/or characteristics.

C. Notify Engineer in writing of existing circuit protective devices improperly rated for new fault conditions.

PART 3 - EXECUTION

3.01 GENERAL

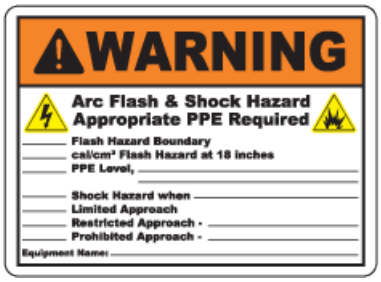
A. Adjust relay and protective device settings according to values established by coordination study.

B. Make minor modifications to equipment as required to accomplish conformance with the short circuit and protective device coordination studies.

C. Notify Engineer in writing of any required major equipment modifications.

3.02 SAMPLE ARC FLASH LABEL

A. Provide and attach all electrical equipment with appropriate Arc Flash label. Arc Flash label shall be weather resistant material and shall match existing Orange County's Standard Arc Flash label, as shown below.



END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI):

a. C55, 1, Standard for Shunt Power Capacitors.
b. C62.11, Standard for Metal-Oxide Surge Arrestors for AC Circuits.
c. Z55.1, Gray Finishes for Industrial Apparatus and Equipment.

2. American Society for Testing and Materials (ASTM):

a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
b. A240, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
c. A570, Standard Specification for Steel, Sheet, and Strip, Carbon, Hot-Rolled, Structural Quality.

3. Federal Specifications (FS):

a. W-C-596, Connector, Receptacle, Electrical.
b. W-S-896E, Switches - Toggle, Flush Mounted.

4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.

5. National Electrical Manufacturers Association (NEMA):

a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
b. AB 1 Molded Case Circuit Breakers and Molded Case Switches.
c. CP I, Shunt Capacitors.
d. ICS 2, Industrial Control Devices, Controllers, and Assemblies.
e. KS 1, Enclosed Switches.
f. LA I, Surge Arrestors.
g. PB 1, Panelboards.
h. ST 20, Dry-Type Transformers for General Applications.
i. WD I, General Requirements for Wiring Devices.

6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

7. Underwriters Laboratories, Inc. (UL):

   a. 67, Standard for Panelboards.
   b. 98, Standard for Enclosed and Dead-Front Switches.
   c. 198C, Standard for Safety High-Intermpting-Capacity Fuses, Current-Limiting Types.
   d. 198E, Standard for Class Q Fuses.
   e. 486E, Standard for Equipment Wiring Terminals.
   f. 489, Standard for Molded Case Circuit Breakers and Circuit Breaker Enclosures.
   g. 508, Standard for Industrial Control Equipment.
   h. 810, Standard for Capacitors.
   i. 943, Standard for Ground-Fault Circuit Interrupters.
   j. 1059, Standard for Terminal Blocks.
   k. 1561, Standard for Dry-Type General-Purpose and Power Transformers.

1.02 SUBMITTALS

A. Shop Drawings:

1. Device boxes for use in hazardous areas.
2. Junction and pull boxes used at, or below, grade.
3. Hardware.
4. Terminal junction boxes.
5. Panelboards and circuit breaker data.
6. Fuses.
7. Contactors.
8. Transformers.
9. All other miscellaneous material part of this project.
10. Wire pulling compound.

B. Quality Control Submittals:

1. Test Report: Sound test certification for dry type power transformers (0 to 600-volt, primary).

1.03 QUALITY ASSURANCE

A. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. Hazardous Areas: Materials and devices shall be specifically approved for hazardous areas of the class, division, and group shown and of a construction that will ensure safe performance when properly used and maintained.

1.04 SPARE PARTS

A. Furnish, tag, and box for shipment and storage the following spare parts:

1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

PART 2 - PRODUCTS

2.01 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

B. Cast Metal:

1. Box: Cast ferrous metal.
2. Cover: Gasketed, weatherproof, cast ferrous metal, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs (Cast Mounting) Manufacturer:
   a. Crouse-Hinds; Type FS or FD.
   b. Appleton; Type FS or FD.
   c. Or equal.

C. Cast Aluminum:

1. Material:
   a. Box: Cast, copper-free aluminum.
   b. Cover: Gasketed, weatherproof, cast copper-free aluminum with stainless steel screws.
2. Hubs: Threaded.
3. Lugs: Cast mounting.
4. Manufacturers:
   a. Crouse-Hinds; Type FS-SA or FD-SA
   b. Appleton; Type FS or FD.
   c. Or equal.

D. PVC-Coated Sheet Steel:

1. Type: One-piece.
2. Material: Zinc- or cadmium-plated.
3. Coating: All surfaces; 40-mil PVC.
4. Manufacturer: Appleton, or equal.

E. Nonmetallic: (use only if shown in drawings)

1. Box: PVC.
2. Cover: PVC, weatherproof, with stainless steel screws.
3. Manufacturer: Carlon; Type FS or FD, with Type E98 or E96 covers, or equal.

2.02 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under 3.02 OUTLET AND DEVICE BOXES.

B. Large Stainless Steel Box: NEMA 250, Type 1.

1. Box: 316 stainless steel.
2. Cover: Full access, screw type.
3. Machine Screws: Corrosion-resistant.

C. Large Stainless Steel Box: NEMA 250, Type 4X.

1. Box: 14-gauge, ASTM A240, Type 316 stainless steel.
2. Cover: Hinged with screws.
3. Hardware and Machine Screws: ASTM A167, Type 304 stainless steel.
4. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.
   c. Or equal.

D. Large Steel Box: NEMA 250, Type 4.

1. Box: 12-gauge steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces, with final ANSI Z55.1, No. 61 gray enamel on exterior surfaces.
2. Cover: Hinged with screws.
3. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
4. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.
   c. Or equal.

E. Large Nonmetallic Box: (Use only if shown on drawings or in corrosive areas)

1. NEMA 250, Type 4X.

2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat.
3. Cover: Hinged with screws.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Conduit hubs and mounting lugs.
6. Manufacturers:
    a. Crouse-Hinds; Type NJB.
    b. Carlon; Series N, C, or H.
    c. Robroy Industries.

F. Concrete Box:

1. Box: Reinforced, cast concrete.
2. Cover: Cast iron.
3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Manufacturers:
    a. Brooks Products Inc.; No. 36/36T.
    b. Qwikset; W 17.
    c. Or equal.

2.03 WIRING DEVICES

A. Switches:

1. NEMA WD I and FS W-S-896E.
2. Specification grade, totally-enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
4. Rating: 20 amps, 120/277 volts.
5. Color:
    a. Office Areas: Ivory.
    b. Other Areas: Brown.
6. Switches with Pilot Light: 125-volt, neon light with red jewel, or lighted toggle when switch is ON.
7. Manufacturers:
    a. Square D.
    b. Hubbell.
    c. Or equal.

B. Receptacle, Single and Duplex:

1. NEMA WD 1 and FS W-C-596.

2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
3. High strength, thermoplastic base color.
4. Color:
    a. Office Areas: Ivory.
    b. Other Areas: Brown.
    c. UPS power: Red Color Outlet, no exception.
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
7. Manufacturers:
    a. Square D.
    b. Hubbell.
    c. Or equal.

C. Receptacle, Ground Fault Circuit Interrupter: Duplex, specification grade, tripping at 5 mA.

1. Color: Ivory.
2. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, capable of interrupting 5,000 amps without damage.
3. Size: For 2-inch by 4-inch outlet boxes.
4. Standard Model: NEMA WD 1 with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.
5. Feed-Through Model: NEMA WD 1, with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.
6. Manufacturers:
    a. Square D GFSR.
    b. Hubbell GF.
    c. Or equal.

D. Receptacle, Special-Purpose:

1. Rating and number of poles as indicated or required for anticipated purpose.
2. Matching plug with cord-grip features for each special-purpose receptacle.

2.04 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Plastic:

1. Material: Specification grade, 0.10-inch minimum thickness, noncombustible, thermosetting.
2. Color: To match associated wiring device.
3. Mounting Screw: Oval-head metal, color matched to plate.

C. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

D. Cast Metal:

1. Material: Malleable ferrous metal, with gaskets.
2. Screw: Oval-head stainless steel.

E. Engraved:

1. Character Height: 3/16 inch.
2. Filler: Black.

F. Weatherproof:

1. For Receptacles: Gasketed, cast metal or stainless steel, with individual cap over each receptacle opening.
2. Mounting Screw: Stainless steel.
    a. Cap Spring: Stainless steel.
    b. Manufacturers:
        1) General Electric.
        2) Bryant.
        3) Hubbell.
        4) Sierra.
        5) Pass and Seymour.
        6) Crouse-Hinds; Type WLRD or WLRS.
        7) Bell.
        8) Arrow Hart.
3. For Switches: Gasketed, cast metal incorporating external operator for internal switch.
    a. Mounting Screw: Stainless steel.
    b. Manufacturers:
        1) Crouse-Hinds; DS-181 or DS-185.

2) Appleton; FSK-LVTS or FSK-IVS.
3) Or equal.

G. Raised Sheet Metal: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel boxes.

2.05 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. NEMA PB I, NFPA 70, and UL 67, including panelboards installed in motor control equipment.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

D. Interrupting ratings: as shown on the drawings.

E. Rating: As indicated on drawings and verified by short circuit and device coordination study required by specification section 16015. Final ratings shall be adjusted by recommendations of short circuit and device coordination study.

F. Where ground fault interrupter circuit breakers are indicated or required by code: 5 mA trip, 10,000 amps interrupting capacity circuit breakers.

G. Cabinet: As shown on plans.

H. Bus Bar:

1. Material: Copper, full sized throughout length.
2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
3. Neutral: Insulated, rated 150 percent of phase bus bars with at least one terminal screw for each branch circuit.
4. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
5. Lugs and Connection Points:

    a. Suitable for either copper or aluminum conductors.
    b. Solderless main lugs for main, neutral, and ground bus bars.
    c. Sub feed or through-feed lugs as shown.

6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

I. Circuit Breakers:

1. NEMA AB 1 and UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of the indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Non-interchangeable, in accordance with NFPA 70.
4. Locking: Provisions for handle padlocking, unless otherwise shown.
5. Type: Bolt-on circuit breakers in all panelboards.
6. Multi-pole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
7. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
8. Do not use tandem or dual circuit breakers in normal single-pole spaces.
9. Ground Fault Interrupter:
   a. Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-milliampere ground fault (UL 943, Class A sensitivity).
   b. Sensor with same rating as circuit breaker and a push-to-test button.

J. Manufacturers:

1. Cutler-Hammer;
2. Square D;
3. GE;

2.06 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA AB I, UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: As shown or as required.

C. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of the operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

F. Multi-pole breakers to automatically open all poles when an overload occurs on one-pole.

G. Enclosure: NEMA 250, Type 12, Industrial Use, 4X - outdoors, wet locations and corrosive areas, unless otherwise shown.

H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

I. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

J. Manufacturers:

1. Cutler-Hammer;
2. Square D;
3. GE;

2.07 FUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. UL 98 listed for use and location of installation.

B. NEMA KS 1 and UL 98 Listed for application to system with available short circuit current of 22,000 amps rms symmetrical.

C. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Fuse mountings shall reject Class H fuses and accept only current-limiting fuses specified.

F. Enclosure: NEMA 250, Type 12, Industrial Use, 4X - outdoors, wet locations and corrosive areas, unless otherwise shown.

G. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

H. Manufacturers:

1. Cutler-Hammer;
2. Square D;
3. GE;

2.08 NONFUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Enclosure: NEMA 250, Type 12, industrial use, 4X- outdoors, wet locations and corrosive areas, unless otherwise shown.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

F. Manufacturers:

1. Cutler-Hammer;
2. Square D;
3. GE;

2.09 FUSE, 0 TO 600 VOLTS

A. Current-limiting, with 200,000-ampere rms interrupting rating.

B. Provide to fit mountings specified with switches and features to reject Class H fuses.

C. Motor and Transformer Circuits, 0- to 600-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-1, dual element, with time delay. Time delay relays shall have LED indicators for On and Off.
3. Manufacturers:
   a. Bussmann; Type LPS-RK.
   b. Gould-Shawmut; Type LLS-RK.
   c. Or approved equal.

D. Motor and Transformer Circuits, 0- to 250-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-1, dual element, with time delay. Time delay relays shall have LED indicators for On and Off.

3. Manufacturers:

a. Bussmann; Type LPN-RK.
b. Gould-Shawmut; Type LLN-RK.
c. Or approved equal.

E. Feeder and Service Circuits, 0- to 600-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-I, dual element, with time delay. Time delay relays shall have LED indicators for On and Off.
3. Manufacturers:
   a. Bussmann; Type LPS-RK.
   b. Gould-Shawmut; Type LLS-RK.
   c. Or approved equal.

F. Feeder and Service Circuits, O- to 250-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-I, dual element, with time delay. Time delay relays shall have LED indicators for On and Off.
3. Manufacturers:
   a. Bussmann; Type LPN-RK.
   b. Gould-Shawmut; Type LLN-RK.
   c. Or approved equal.

G. Feeder and Service Circuits, 0- to 600-Volt:

1. Amperage: 601 to 6,000.
2. UL 198C, Class L, double O-rings and silver links.
3. Manufacturers:
   a. Bussmann; Type KRP-C.
   b. Gould-Shawmut; Type KLPC.
   c. Or approved equal.

2.10 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCHES

A. Contact Rating: NEMA ICS 2, Type A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Lights: Push-to-test.

D. Pushbutton Color:

1. ON or START: Black.
2. OFF or STOP: Red.

E. Pushbuttons and selector switches lockable in the OFF position where indicated.

F. Legend Plate:

1. Material: Aluminum.
2. Engraving: 11 character/spaces on one line, 14 character/spaces on each of two lines, as required, and indicating specific function.
3. Letter Height: 7/64 inch.

G. Manufacturers:

1. Heavy-Duty, Oil tight Type:
   a. Square D; Type T.
   b. Cutler-Hammer; Type CH10250T.
   c. Or equal.
2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
   a. Square D; Type SK.
   b. Cutler-Hammer; Type E34.
   c. Or equal.

2.11 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown.

B. Terminal Blocks: Provide separate connection point for each conductor entering or leaving box.

1. Spare Terminal Points: 25 percent.

C. Interior Finish: Paint with white enamel or lacquer.

2.12 TERMINAL BLOCK (0 TO 600 VOLTS)

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of all control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between the compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.
2. Capable of jumper installation with no loss of terminal or rail space.
3. Individual, rail mounted.

I. Marking system: allowed use of preprinted or field-marked tags.

J. Manufacturers:

1. Marathon, series 200.
2. Square D 9070GR6.
3. Or equal.

2.13 MAGNETIC CONTROL RELAY

A. NEMA ICS 2, Class A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control with field convertible contacts.

B. Time Delay Relay Attachment:

1. Pneumatic type, timer adjustable from 0.2 to 60 seconds (minimum).
2. Field convertible from ON delay to OFF delay and vice versa.

C. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.

D. Manufacturers:

1. Cutler-Hammer; Type M-600.
2. Square D.
3. Potter Brumfield.
4. Eagle Signal.

2.14 RESET TIMER

A. Drive: Synchronous motor, solenoid-operated clutch.

B. Mounting: Semi-flush, panel.

C. Contacts: 10-amp, 120-volt.

D. Manufacturers:

1. Eagle Signal; Bulletin 125.
2. Automatic Timing and Controls; Bulletin 305.
3. Or approved equal.

2.15 ELAPSED TIME METER

A. Drive: Synchronous motor.

B. Range: 0 to 99,999.9 hours, non-reset type.

C. Mounting: Semi-flush, panel.

D. Manufacturers:

1. Engler: AC-200-10NG7.
2. Hecon: TO621134.
3. Or approved equal.

2.16 MAGNETIC CONTACTOR

A. NEMA ICS 2, UL 508.

B. Electrically operated, electrically held.

C. Main Contacts:

1. Power driven in one direction with gravity dropout.
2. Silver alloy with wiping action and arc quenchers.
3. Continuous-duty, rated 30 amperes, 600-volt.
4. Three-pole.

D. Control: Two-wire.

E. One normally open and one normally closed auxiliary contacts rated 10 amperes at 480-volt.

F. Enclosure: NEMA 250, Type 12, unless otherwise shown.

G. Manufacturers:

1. Cutler-Hammer; ECL Series.
2. General Electric; CR 353.
3. Allen-Bradley; Bulletin 500 Line.

2.17 THERMOSTAT

A. Rating: 7.4 amps continuous, 44 amps locked rotor current at 120 volts and 3.7 amps continuous, 22 amps locked rotor current at 240 volts.

B. Line voltage, single-stage, treated to resist corrosion, dust, dirt, and humidity with sealed SPDT contacts.

C. Heating Adjustment Range: 35 to 100 degrees F.

D. Cooling or Ventilating Adjustment Range: 70 to 140 degrees F.

E. Manufacturer: Honeywell; Type T631F1084.

2.18 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. UL 1561, NEMA ST 20, unless otherwise indicated.

B. Self-cooled, two winding, UL K-4 rated for nonlinear loads.

C. Insulation Class and Temperature Rise: Manufacturer's standard.

D. Core and Coil:

1. Encapsulated for single-phase units 1/2 to 25 kVA and for three-phase units 3 to 15 kVA.
2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.

E. Enclosure:

1. Single-Phase, 3 to 25 kVA: NEMA 250, Type 3R, non-ventilated.
2. Single-Phase, 37-1/2 kVA and above: NEMA 250, Type 2, ventilated.

3. Three-Phase, 3 to 15 kVA: NEMA 250, Type 3R, non-ventilated.
4. Three-Phase, 30 kVA and above: NEMA 250, Type 2, ventilated.
5. Outdoor Transformers: NEMA 250, Type 3R.
6. Wall Bracket: For single-phase units, 15 to 37-1/2 kVA, and for three-phase units, 15 to 30 kVA.

F. Voltage Taps:

1. Single-Phase, 3 to 10 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
2. Single-Phase, 15 kVA and above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
3. Three-Phase, 3 to 15 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
4. Three-Phase, 30 kVA and above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

G. Impedance: 4.5 percent minimum on units 75 kVA and larger.

H. Maximum Sound Level: NEMA ST 20:

1. 40 decibels for 0 to 9 kVA.
2. 45 decibels for 10 to 50 kVA.
3. 50 decibels for 51 to 150 kVA.
4. 55 decibels for 151 to 300 kVA.
5. 60 decibels for 301 to 500 kVA.

I. Vibration Isolators:

1. Rated for transformer's weight.
2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.
4. 30 kVA and above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

J. Manufacturers:

1. Square D;
2. Or Orange County approved equal.

2.19 SUPPORT AND FRAMING CHANNELS

A. Material:

1. Dry indoors - galvanized.
2. All Other Areas: ASTM A167, Type 316 stainless steel or fiber-reinforced epoxy, as required.

B. Finish:

1. Dry indoors - galvanized.
2. All Other Areas: ASTM A167, Type 316 stainless steel or fiber-reinforced epoxy, as required.

C. Inserts: Continuous.

D. Beam Clamps: Gray cast iron.

E. Manufacturers:

1. B-Line.
2. Unistrut.

2.20 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: White, engraved to a black core.

D. Engraving:

1. Pushbuttons/Selector Switches: Name of drive controlled on one, two, or three lines, as required.
2. Panelboards: Panelboard designation, service voltage, and phases.

E. Letter Height:

1. Pushbuttons/Selector Switches: 1/8 inch.
2. Panelboards: 1/4 inch.

2.21 TRANSIENT VOLTAGE SURGE SUPPRESSION

A. This section describes the material and installation requirements for transient voltage surge suppression devices (TVSS) in service entrance equipment, panelboards, and control panels for the protection of all AC electrical circuits.

B. TVSS shall be listed and component recognized in accordance with UL 1449, UL 1283 and ANSI/IEEE 62.41 testing.

C. TVSS shall be installed and warranted by and shipped from the electrical distribution equipment manufacturer's factory.

D. TVSS shall provide surge current diversion paths for all modes of protection; L-L, L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.

E. TVSS shall be modular in design. Each module shall be fused with a surge rated fuse.

F. A UL approved disconnect switch shall be provided as a means of disconnect in the switchboard device or any TVSS that is not connected thru a breaker.

G. TVSS shall meet or exceed the following criteria:

1. Maximum surge current capability (single pulse rated) shall be:
   a. Service entrance equipment: 150kA per mode or 300kA per phase
   b. Branch panelboards: 80kA per mode or 160kA per phase
   c. Control panels: 40kA per mode or 80kA per phase

2. UL 1449 Listed and Recognized Component Suppression Voltage Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G
208Y/120	400V	400V	400V
480Y/277	800V	800V	800V

H. TVSS shall have a minimum EMI/RFI filtering of -44dB at 100kHz with an insertion ratio of 50:1 using MIL STD. 220A methodology.

I. TVSS shall have a minimum warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period. Warranty will be the responsibility of the electrical distribution equipment manufacturer.

J. For any external TVSS, provide and install conduits/cables, indicated or not on drawings, as recommended by the TVSS supplier and place TVSS unit as close as possible to the equipment/panel to be protected.

K. Approved manufactures are:

1. Surge Suppression Incorporated
2. Current Technologies
3. Joslyn/Total Protection Solutions

2.22 LIMIT SWITCH (INTRUSION SWITCH)

A. Limit switch shall be of the heavy-duty industrial type oiltight, watertight, and corrosion resistant NEMA 4 enclosure with at least one SPDT 24V DC / 120VAC 5A rated sealed contact switches of the FORM C type. The level arm shall be suitable for the application and shall be heavy duty corrosion resistant.

B. The switch shall be UL listed as manufactured by Allen-Bradley Type 802R lever type, spring return, or approved equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Install equipment in accordance with NECA 5055.

3.02 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in the wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
   a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by ENGINEER.
3. Light Switch: Install on lock side of doors.
4. Light Fixture: Install in symmetrical pattern according to room layout unless otherwise shown.

D. Mounting Height:

1. General:
    a. Measured to centerline of box.
    b. Where specified heights do not suit building construction or finish, mount as directed by ENGINEER.
2. Light Switch: 48 inches above floor.
3. Thermostat: 54 inches above floor.
4. Telephone Outlet: 6 inches above counter tops or 15 inches above floor.
5. Wall Mounted Telephone Outlet: 52 inches above floor.
6. Convenience Receptacle:
    a. General Interior Areas: 15 inches above floor.
    b. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of splashback, or 6 inches above countertops without splashback.
    c. Industrial Areas, Workshops: 48 inches above floor.
    d. Outdoor, All Areas: 24 inches above finished grade.
7. Special-Purpose Receptacle: 54 inches above floor or as shown.

E. Install plumb and level.

F. Flush Mounted:

1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
3. Holes in surrounding surface shall be no larger than required to receive box.

G. Support boxes independently of conduit by attachment to building structure or structural member.

H. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws threaded into steelwork.

I. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

J. Provide plaster rings where necessary.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. Install stainless steel mounting hardware in industrial areas.

M. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

N. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.

O. Box Type (Steel Raceway System):

1. Exterior Locations:

    a. Exposed Raceways: Cast metal.
    b. Concealed Raceways: Cast metal.
    c. Concrete Encased Raceways: Cast metal.
    d. Class I, II, or III Hazardous Areas: Cast metal.

2. Interior Dry Locations:

    a. Exposed Rigid Conduit: Cast metal.
    b. Exposed EMT: Sheet steel.
    c. Concealed Raceways: Sheet steel.
    d. Concrete Encased Raceways: Cast metal.
    e. Lighting Circuits, Ceiling: Sheet steel.
    f. Class I, II, or III Hazardous Areas: Cast metal.

3. Interior Wet Locations:

    a. Exposed Raceways: Cast metal.
    b. Concealed Raceways: Cast metal.
    c. Concrete Encased Raceways: Cast metal.
    d. Lighting Circuits, Ceiling: Sheet steel.
    e. Class I, II, or III Hazardous Areas: Cast metal.

4. Cast-In-Place Concrete Slabs: Sheet steel.

P. Box Type (Rigid Aluminum Raceway System): Cast aluminum.

Q. Box Type (Nonmetallic Raceway System):

1. Corrosive Locations: Nonmetallic.
2. Exposed Raceways: Nonmetallic.
3. Concealed Raceways: Nonmetallic.
4. Concrete Encased Raceways: Nonmetallic.

R. Box Type, Corrosive Locations (PVC-Schedule 80 Raceway System): PVC Schedule 80.

3.03 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Installed boxes shall be accessible.

F. Do not install on finished surfaces.

G. Install plumb and level.

H. Support boxes independently of conduit by attachment to building structure or structural member.

I. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork.

J. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. At or Below Grade:

1. Install boxes for below grade conduits flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Obtain ENGINEER's written acceptance prior to installation in paved areas, roadways, or walkways.
4. Use boxes and covers suitable to support anticipated weights.

M. Flush Mounted:

1. Install with concealed conduit.
2. Holes in surrounding surface shall be no larger than required to receive box.
3. Make edges of boxes flush with final surface.

N. Mounting Hardware:

1. Non-corrosive Interior Areas: Galvanized.
2. All Other Areas: Stainless steel.

O. Location/Type:

1. Finished, Indoor, Dry: NEMA 250, Type 1.
2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X Stainless Steel painted white.
4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.
5. Unfinished, Indoor and Outdoor, Hazardous: NEMA 250, Type 7 and Type 9, where indicated.
6. Underground Conduit: Concrete Encased.
7. Corrosive Locations: Nonmetallic.

3.04 WIRING DEVICES

A. Switches:

1. Mounting Height: See 3.02 OUTLET AND DEVICE BOXES.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:

1. Install with grounding slot down except where horizontal mounting is shown, in which case install with neutral slot up.
2. Ground receptacles to boxes with grounding wire only.
3. Weatherproof Receptacles:
    a. Install in cast metal box.
    b. Install such that hinge for protective cover is above receptacle opening.
4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for "downstream" conventional receptacles.
5. Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

3.05 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to the box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Engrave with designated titles.

F. Types (Unless Otherwise Shown):

1. Office: Stainless Steel.
2. Exterior: Weatherproof.
3. Interior:
    a. Flush Mounted Boxes: Stainless Steel.
    b. Surface Mounted, Cast Metal Boxes: Cast metal.
    c. Surface Mounted, Sheet Steel Boxes: Stainless Steel.
    d. Surface Mounted, Nonmetallic Boxes: Plastic.

3.06 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Heavy-Duty, Oil tight Type: Locations (Unless Otherwise Shown): Non-hazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Heavy-Duty, Watertight, and Corrosion-Resistant Type:

1. Locations (Unless Otherwise Shown): Non-hazardous, outdoor, or normally wet areas.
2. Mounting: NEMA 250, Type 4X enclosure.

3.07 TERMINAL JUNCTION BOX

A. Install in accordance with Paragraph JUNCTION AND PULL BOXES.

B. Label each block and terminal with permanently attached, non-destructible tag.

C. Do not install on finished outdoor surfaces.

D. Location:

1. Finished, Indoor, Dry: NEMA 250, Type 1.
2. Unfinished, Indoor, Dry: NEMA 250, Type 12 Gasketed.
3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.

3.08 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 6 feet above floor unless otherwise shown.

C. Provide typewritten circuit directory for each panelboard.

3.09 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

B. Provide moisture proof, flexible conduit for electrical connections.

C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

D. Provide wall brackets for single-phase units, 15 to 167-1/2 kVA, and three-phase units, 15 to 112 kVA.

3.10 SUPPORT AND FRAMING CHANNEL

A. Furnish zinc-rich primer; paint cut ends prior to installation, where applicable.

B. Install where required for mounting and supporting electrical equipment and raceway systems.

3.11 MOTOR SURGE PROTECTION

A. Ground in accordance with NFPA 70.

B. Low Voltage: Ground terminals to equipment bus.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including, but not limited to, the following:

1. Buried electrical line warnings.
2. Identification labeling for cables and conductors.
3. Operational instruction signs.
4. Warning and caution signs.
5. Equipment labels and signs.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01340, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product Data for each type of product specified.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION PRODUCTS

A. Colored Adhesive Marking Tape for Wires and Cables: Self-adhesive, vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.

B. Pre-tensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: Flexible acrylic bands sized to suit raceway diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.

C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letter.

D. Aluminum, Wraparound Cable Marker Bands: Bands cut from 0.014-inch-thick aluminum sheet, fitted with slots or ears for securing permanently around wire or cable jacket or around groups of conductors. Provide for legend application with stamped letters or numbers.

E. Engraved, Plastic Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners.

F. Baked Enamel Warning and Caution Signs for Interior Use: Pre-printed aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.

G. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, pre-printed cellulose acetate butyrate signs with 20-gauge galvanized steel backing, with colors, legend, and size appropriate to location. Provide 1/4-inch grommets in corners for mounting.

H. Fasteners for Plastic Laminated and Metal Signs: Self-tapping stainless steel screws or Number 10/32 stainless steel machine screws with nuts and flat and lock washers.

I. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18 inch minimum width, 50-pound minimum tensile strength, and suitable for a temperature range from minus 50 to 350 degrees F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification Work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by Code.

B. Underground Electrical Line Identification: During trench backfilling for exterior nonconcrete encased underground power, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench, do not exceed an overall width of 16 inches; install a single line marker.

C. Install line marker for underground wiring, both direct buried and in raceway.

D. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the Project secondary electrical system as follows:

Phase	480/277 Volts
A	Yellow
B	Brown
C	Orange
Neutral	White
Ground	Green

E. Wiring Standards:
   1. 480/277 Volt, 3-Phase Power:
      a. Brown.
      b. Orange.
      c. Yellow.
      d. White Neutral.
   2. 208 Volt, 3-Phase Power:
      a. Black.
      b. Red.
      c. Blue.
   3. 240/120 Volt, 1-Phase Power:
      a. Black.
      b. Red.
      c. White Neutral.
   4. Motor Leads, Control Cabinet/MCC:
      a. Black, numbered L1-T1, etc.
   5. Control Wiring:
      a. Red Control circuit wiring that is de-energized when the main disconnect is opened.
      b. Yellow Control circuit wiring that remains energized when the main disconnect is opened.
      c. Blue DC.
      d. Green Ground.

F. Use conductors with color factory applied entire length of conductors except as follows:
   1. The following field applied color coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
      a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last 2 laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
      b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply 3 ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

G. Power Circuit Identification: Securely fasten identifying metal tags of aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-pound test monofilament line or one-piece self-locking nylon cable ties.

H. Install wire/cable designation tape markers at termination points, splices, or junctions in each circuit. Circuit designations shall be as indicated on Drawings.

END OF SECTION

SECTION 16110

RACEWAYS

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): Division I, Standard Specifications for Highway Bridges, Fourteenth Edition.

2. American National Standards Institute (ANSI):

a. C80.1, Rigid Steel Conduit-Zinc Coated.
b. C80.3, Electrical Metallic Tubing-Zinc Coated.
c. CS0.5, Rigid Aluminum Conduit.
d. C80.6, Intermediate Metal Conduit (IMC)-Zinc Coated.

3. American Society for Testing and Materials (ASTM):

a. A123 El, Standard Specification for Zinc-Coated (Galvanized) Coatings on Iron and Steel Products.
b. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.

3. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.

4. National Electrical Manufacturers Association (NEMA):

a. RN 1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
b. TC 2, Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
c. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
d. TC 6, PVC and ABS Plastic Utilities Duct for Underground Installation.
e. VE 1, Metallic Cable Tray Systems.

6. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)
7. Underwriters Laboratories, Inc. (UL):

    a. 1, Standard for Safety Flexible Metal Conduit.
    b. 6, Standard for Safety Rigid Metal Conduit.
    c. 360, Standard for Safety Liquid-Tight Flexible Steel Conduit.
    d. 514B, Standard for Safety Fittings for Conduit and Outlet Boxes.
    e. 514C, Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
    f. 651, Standard for Safety Schedule 40 and 80 PVC Conduit.
    g. 651A, Standard for Safety Type EB and Rigid PVC Conduit and HDPF Conduit.
    h. 797, Standard for Safety Electrical Metallic Tubing.
    i. 870, Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings.
    j. 1242, Standard for Safety Intermediate Metal Conduit.
    k. 1660, Standard for Safety Liquid-Tight Flexible Nonmetallic Conduit.

1.02 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's Literature:

    a. Rigid galvanized steel conduit.
    b. Electric metallic tubing.
    c. Rigid aluminum conduit.
    d. PVC Schedule 40 conduits.
    e. PVC-coated rigid galvanized steel conduit.
    f. Flexible metal, liquid-tight conduit.
    g. Flexible, nonmetallic, liquid-tight conduit.
    h. Conduit fittings.
    i. Wireways.

2. Precast Manholes and Handholes:

    a. Dimensional drawings and descriptive literature.
    b. Traffic loading calculations.
    c. Accessory information.

3. Cable Tray Systems:

    a. Dimensional drawings, calculations, and descriptive information.

b. NEMA load/span designation and how it was selected.
c. Support span length and pounds-per-foot actual and future cable loading at locations, with safety factor used.
d. Location and magnitude of maximum simple beam deflection of tray for loading specified.
e. Layout drawings and list of accessories being provided.

4. Conduit Layout:

a. Plan and section type, showing arrangement and location of conduit and duct bank required for:

1) Low and medium voltage feeder and branch circuits.
2) Instrumentation and control systems.
3) Communications systems.
4) Empty conduit for future use.

b. Reproducible drawings showing all conduits in AutoCAD with scale not greater than 1 inch equal 20 feet.

5. Equipment and machinery proposed for bending metal conduit.

6. Method for bending PVC conduit less than 30 degrees.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 - PRODUCTS

2.01 CONDUIT AND TUBING

A. Electric Metallic Tubing (EMT):

1. Meet requirements of ANSI C80.3 and UL 797.
2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.
3. 3/4” minimum.

B. Rigid Aluminum Conduit:

1. Meet requirements of ANSI C80.5 and UL 6.
2. Material: Type 6063, copper-free aluminum alloy.

3. 3/4” minimum.

C. PVC Schedule 40 or 80 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.
3. 3/4” minimum.

D. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.
3. 3/4” minimum.

E. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Material: PVC core with fused flexible PVC jacket.
2. UL 1660 listed for:

    a. Dry Conditions: 80 degrees C insulated conductors.
    b. Wet Conditions: 60 degrees C insulated conductors.

3. 3/4” minimum.

5. Manufacturers:

    a. Carlon; Carflex or X-Flex.
    b. T & B; Xtraflex LTC or EFC.
    c. Or equal.

2.02 FITTINGS

A. Electric Metallic Tubing:

1. Meet requirements of UL 514B.
2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Set screw and drive-on fittings not permitted.
3. Compression Ring: Stainless steel.
4. Coupling Manufacturers:

    a. Appleton; Type 95T.
    b. Crouse-Hinds; Type CPR.
    c. Or equal.

6. Connector Manufacturers:

    a. Appleton; Type 86T.
    b. Crouse-Hinds; Type CPR.
    c. Or equal.

B. Rigid Aluminum Conduit:

1. General:

    a. Meet requirements of UL 514B.
    b. Type: Threaded, copper-free. Set screw fittings not permitted.

2. Insulated Bushing:

    a. Material: Cast aluminum, with integral insulated throat, rated for 150 degrees C.
    b. Manufacturer: O.Z. Gedney; Type AB, or equal.

3. Grounding Bushing:

    a. Material: Cast aluminum with integral insulated throat, rated for 150 degrees, with solderless lugs.
    b. Manufacturer: O.Z. Gedney; Type ABLG, or equal.

4. Conduit Hub:

    a. Material: Cast aluminum, with insulated throat.
    b. Manufacturers:

        1) O.Z. Gedney; Type CHA.
        2) T & B; Series 370AL.
        3) Or equal.

5. Conduit Bodies:

    a. Manufacturers (For Normal Conditions):

        1) Appleton; Form 85 threaded Unilets.
        2) Crouse-Hinds; Mark 9 or Form 7-SA threaded condulets.
        3) Killark; Series O Electrolets.

b. Manufacturers (For Hazardous Locations):
   1) Appleton.
   2) Crouse-Hinds.
   3) Killark.

6. Couplings: As supplied by conduit manufacturer.

7. Conduit Sealing Fitting Manufacturers:

   a. Appleton; Type EYF-AL or EYM-AL.
   b. Crouse-Hinds; Type EYS-SA or EZS-SA.
   c. Killark; Type EY or EYS.

8. Drain Seal Manufacturers:

   a. Appleton; Type EYDM-A.
   b. Crouse-Hinds; Type EYD-SA or EZD-SA.
   c. Or equal.

9. Drain/Breather Fitting Manufacturers:

   a. Appleton; Type ECDB.
   b. Crouse-Hinds; ECD.
   c. Or equal.

10. Expansion Fitting Manufacturers:

    a. Deflection/Expansion Movement: Steel City; Type DF-A, or equal.
    b. Expansion Movement Only: Steel City; Type AF-A, or equal.

11. Cable Sealing Fittings: To form watertight nonslip cord or cable connection to conduit.

    a. Bushing: Neoprene at connector entry.
    b. Manufacturer: Appleton CG-S, or equal.

C. PVC Conduit and Tubing:

1. Meet requirements of NEMA TC-3.
2. Type: PVC, slip-on.

D. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of UL 514B.
2. Type: Rigid galvanized steel, PVC coated by conduit manufacturer.
3. Overlapping pressure sealing sleeves.
4. Conduit Hangers, Attachments, and Accessories: PVC-coated.

E. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Long design type extending outside of box or other device at least 2 inches.
4. Manufacturer: T & B; Series 5300, or equal.

F. Flexible, Nonmetallic, and Liquid-Tight Conduit: Meet requirements of UL 514B.

1. Type: One-piece fitting body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.

2. Manufacturers:

a. Carlon; Type LT.
b. Kellems; Polytuff.
c. T & B; LT Series.

G. Watertight Entrance Seal Device:

1. New Construction:

a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
b. Manufacturer: O.Z./Gedney; Type FSK or WSK, or equal as required.

2. Gored-Hole Application:

a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
b. Manufacturer: O.Z./Gedney; Series CSM, or equal.

H. Hazardous Locations: Approved for use in the atmosphere involved.

1. Manufacturer: Crouse-Hinds; Type ECGJH, or equal.

I. Corrosive Locations:

1. Material: 40-mil PVC-coated rigid steel.
2. Manufacturers:

a. Robroy Industries.
b. Carlon.
c. Crouse-Hinds.

2.03 WIREWAYS

A. Meet requirements of UL 870.

B. Type: Steel-enclosed, with removable, hinged cover.

C. Rating: Outdoor raintight if outdoor, and indoor if indoor.

D. Finish: Gray, baked enamel.

E. Manufacturers:

1. Square D.
2. B-Line Systems, Inc.
3. Or equal.

2.04 CABLE TRAYS

A. Meet requirements of NEMA VE 1.

B. Type: Ladder of welded construction.

C. Material: Copper-free aluminum alloys 6063-T6 finishes.

D. Cover: Louvered, minimum 0.40-inch thick aluminum.

E. Barrier Strip: Vertical, solid type, with horizontal fittings and strip clamps.

F. Fittings of same cross-sectional tray area, and hardware of same material as cable tray.

G. Tray Grounding: Conform to NFPA 70 and NEMA VE 1.

H. Provide next higher NEMA VE 1 class designation than required for support of designed span length.

I. Design Loads: Use working load adequate for actual cable installed plus 50 percent additional weight allowance for future cables plus 200-pound concentrated static load applied between side rails at midspan, with safety factor of 2 in accordance with NEMA VE 1, Table 3-1.

J. Expansion Joints: NEMA VE 1 for 50 degrees F maximum temperature variation.

K. Furnish Cable Tray with no sharp edges, burrs, or weld projections.

L. Manufacturers:

1. B-Line Systems, Inc.
2. Square-D.
3. P. W. Industries.

2.05 PRECAST MANHOLES AND HANDHOLES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO Division 1, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6- or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.

D. Drainage:

1. Slope floors toward drain points, leaving no pockets or other non-draining areas.
2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

E. Raceway Entrances:

1. Provide on all four sides.
2. For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.

3. At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:

1. Material: 3/4-inch diameter stock, fastened to overall steel reinforcement before concrete is placed.
2. Location:

    a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
    b. Floor: Centered below manhole or handhole cover.

G. Cable Racks:

1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.

2. Wall Attachment:

    a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
    b. Insert Spacing: Maximum 3-foot on center entire inside perimeter of manhole.
    c. Arrange so that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:

1. Material: Machined cast iron.
2. Cover Type: Indented, solid top design, with two drop handles each.
3. Cover Loading: AASHTO Division I, H-20.
4. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:

    a. Above 600 Volts: ELECTRIC HV.
    b. 600 Volts and Below: ELECTRIC LV.
    c. TELEPHONE.

I. Handhole Frames and Covers:

1. Material: Steel, hot-dipped galvanized.
2. Cover Type: Solid, bolt on, of checkered design.
3. Cover Loading: H-20.

4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:

    a. 600 Volts and Below: ELECTRIC LV.
    b. TELEPHONE.

5. Manufacturers:

    a. US Foundry.
    b. Vulcan.
    c. Or equal.

J. Hardware: 316 Stainless Steel

K. Furnish knockout for ground rod in each handhole and manhole.

L. Manufacturers:

1. Allied Precast.
2. Atlantic Precast, Inc.
3. Dura Stress, Inc.
4. Mack Precast.
5. Standard Precast, Inc.
6. Hanson Pipe & Products.
7. Oldcastle Precast.
8. Delzotto Precast.

2.06 ACCESSORIES

A. Duct Bank Spacers:

1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturer: Underground Device, Inc.; Type WUNPEECE, or equal.

B. Identification Devices:

1. Raceway Tags:

    a. Material: Permanent, nylon.
    b. Shape: Round.
    c. Raceway Designation: Pressure stamped, embossed, or engraved.
    d. Tags relying on adhesives or taped-on markers not permitted.

2. Warning Tape:

    a. Material: Polyethylene, 4-mil gauge.
    b. Color: Red.
    c. Width: Minimum 6-inch.
    d. Designation: Warning on tape that electric circuit is located below tape.
    e. Manufacturers:

        1) Blackburn, Type RT.
        2) Griffolyn Co.
        3) Or equal.

3. Buried Raceway Marker:

    a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where routing changes direction.
    b. Designation: Incise to depth of 3/32 inch, ELECTRIC CABLES in letters 1/4-inch high.
    c. Minimum Dimension: 1/4-inch thick, 10 inches long and 3/4-inch wide.

4. Electronic Marker Systems:

    a. Manufacturer: 3M, or equal

        1) Scotchmark EMS11 Electronic Marker Locator #125.
        2) Scotchmark electronic marker.
        3) Greenball marker #1404

C. Raceway Coating:

1. Material: Bitumastic or plastic tape coating.
2. Manufacturers:

    a. Koppers bitumastic; No. 505.
    b. Scotchwrap; No. 51, plastic tape.
    c. Or approved equal.

D. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
2. Manufacturer: Raychem; Type TWDB, or equal.

E. All hardware shall be 316 Stainless Steel.

PART 3 - EXECUTION

3.01 GENERAL

A. Conduit and Tubing sizes shown are based on the use of copper conductors. Reference Section 16120, CONDUCTORS, concerning conduit sizing for aluminum conductors.

B. All installed Work shall comply with NECA 5055.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Aluminum Conduit: Do not install in direct contact with concrete.

G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

I. Group raceways installed in same area.

J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

M. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

N. Install watertight fittings in outdoor, underground, or wet locations.

O. Paint threads, before assembly of fittings, of galvanized conduit or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

P. All metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

Q. Do not install raceways in concrete equipment pads, foundations, or beams.

R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

3.02 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch; Underground: 1 inch.

B. Exterior, Exposed:

1. Rigid aluminum.

C. Interior, Exposed:

1. Rigid aluminum.
2. Electric metallic tubing for ceiling portion of lighting circuits in a conditioned environment.

D. Interior, Concealed (Not Embedded in Concrete):

1. Rigid aluminum.
2. PVC Schedule 40.

E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors: PVC Schedule 40.

F. Concrete Encased: PVC Schedule 40.

G. Under Slabs-On-Grade: PVC Schedule 80.

H. Corrosive Areas, Exterior: PVC Schedule 80.

I. Corrosive Areas, Interior: PVC Schedule 80.

J. Conduits between VFD’s and motors rigid aluminum (inside and outside).

K. Classified areas: rigid aluminum.

3.04 CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible metal, liquid-tight conduit.
2. Conduit Size Over 4 Inches: Nonflexible.
3. Corrosive Areas: Flexible, nonmetallic, liquid or PVC-coated metallic, liquid-tight.
4. Length: 18-inch minimum, 60-inch maximum, of sufficient length to allow movement or adjustment of equipment.

B. Lighting Fixtures in Dry Areas: Flexible steel, non-liquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas required to be Oil-tight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Transition From Underground to Exposed: PVC Coated Rigid aluminum conduit unless restricted by code.

E. Under Equipment Mounting Pads: Rigid aluminum conduit.

F. Exterior Light Pole Foundations: Rigid aluminum conduit.

3.05 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Fire-stop openings around penetrations to maintain fire-resistance rating.

D. Apply single layer of wraparound duct band to all metallic conduit in contact with concrete floor slabs to a point 2 inches above concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide non-shrink grout dry-pack, or use watertight seal device.

F. Entering Structures:

1. General: Seal raceway at the first box or outlet with minimum 2 inches thick expandable plastic compound to prevent the entrance of gases or liquids from one area to another.

2. Concrete Roof or Membrane Waterproofed Wall or Floor:

a. Provide a watertight seal.
b. Without Concrete Encasement: Install watertight entrance seal device on each side.
c. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
d. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.

3. Heating, Ventilating, and Air Conditioning Equipment:

a. Penetrate equipment in area established by manufacturer.
b. Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
c. Seal penetration with silicone type sealant as specified in Section 07270, FIRE STOPPING.

4. Corrosive-Sensitive Areas:

a. Seal all conduits passing through chlorine and ammonia room walls.
b. Seal all conduit entering equipment panel boards and field panels containing electronic equipment.
c. Seal penetration with silicone type sealant as specified in Section 07270, FIRE STOPPING.

5. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.

6. Non-waterproofed Wall or Floor (Underground, without Concrete Encasement):

a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.

b. Fill space between raceway and sleeve with an expandable plastic compound on each side.

7. Manholes and Handholes:

a. Metallic Raceways: Provide insulated grounding bushings.
b. Nonmetallic Raceways: Provide bell ends flush with wall.
c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.06 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.

B. All supporting hardware shall be 316 stainless steel.

C. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 40 percent extra space for future conduit.

D. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

1. Wood: Wood screws.
2. Hollow Masonry Units: Toggle bolts.
3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
4. Steelwork: Machine screws.

E. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.07 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:

1. Bends 30-Degree and Larger: Aluminum conduit.
2. 90-Degree Bends: Provide aluminum conduit elbows.
3. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.08 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, and in long tangential runs.

B. Provide expansion/deflection joints for 50 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.09 PVC CONDUIT

A. Solvent Welding:

1. Provide manufacturer recommended solvent; apply to all joints.
2. Install such that joint is watertight.

B. Adapters:

1. PVC to Metallic Fittings: PVC terminal type.
2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belied-End Conduit: Bevel the un-belled end of the joint prior to joining.

3.10 PVC-COATED RIGID STEEL CONDUIT

A. Install in accordance with manufacturer's instructions.

B. Provide PVC boot to cover all exposed threading.

3.11 WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

3.12 CABLE TRAYS

A. Install in accordance with Application Information Section of NEMA VE 1.

B. Provide accessories as necessary for a complete system.

C. Install such that joints are not made at support brackets.

D. Install horizontal section support brackets between support point and quarter point of tray span.

E. Provide ceiling trapeze for all horizontal cable trays.

F. Install support within 2 feet on each side of expansion joints and within 2 feet of fitting extremity.

G. Provide expansion joints in accordance with NEMA VE 1 for 50 degrees F maximum temperature variation.

H. Install horizontal tray level, plumb, straight, and true to line or grade within a tolerance of 1/8 inch in 10 feet and within a cumulative maximum of 1/2 inch.

I. Install vertical tray plumb within a tolerance of 1/8 inch in 10 feet.

J. Install without exposed raw edges.

K. Maintain 9-inch vertical separation between multi-tiered trays having a common support, and at all crossover locations.

L. Provide bonding jumper at each expansion joint and adjustable connection.

M. Ground Conductor: Provide properly sized clamps for each section, elbow, tee, cross, and reducer.

3.13 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Provide manufacturer's pre-molded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Sheet Metal Boxes, Cabinets, and Enclosures:

1. Rigid Galvanized Conduit:
   a. Provide one lock nut each on inside and outside of enclosure.
   b. Install grounding bushing.
   c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
   d. Install insulated bushing on ends of conduit where grounding is not required.
   e. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.

2. Electric Metallic Tubing: Provide gland compression, insulated connectors.

3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.

4. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.

5. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.

6. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut.

C. Motor Control Center, Switchboard, Switchgear, and Free-Standing Enclosures: Terminate conduit-entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

3.14 UNDERGROUND RACEWAYS

A. Below grade conduit shall be concrete encased with red dye.

B. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

C. Cover: Maintain minimum 2-foot cover above conduit, unless otherwise shown.

D. Make routing changes as necessary to avoid obstructions or conflicts.

E. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.

F. Union type fittings not permitted.

G. Spacers:

1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench.
2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

H. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

I. Installation with Other Piping Systems:

1. Crossings: Maintain minimum 12-inch vertical separation.
2. Parallel Runs: Maintain minimum 12-inch separation.
3. Installation over valves or couplings not permitted.

J. Metallic Raceway Coating: At couplings and joints and along entire length, apply wraparound duct band with one-half tape width overlap to obtain two complete layers.

K. Backfill:

1. As specified in Section 02220, EXCAVATION, BACKFILLING, AND COMPACTION.
2. Do not backfill until inspected by ENGINEER.

3.15 MANHOLES AND HANDHOLES

A. Excavate, shore, brace, backfill, and final grade in accordance with Section 02220, EXCAVATION, BACKFILLING, AND COMPACTION.

B. Do not install until final raceway grading has been determined.

C. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

D. Grounding: As specified in Section 16450, GROUNDING.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers shall be 1-inch minimum height.

3.16 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull-tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Paragraph IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.17 IDENTIFICATION DEVICES

A. Raceway Tags:

1. Identify origin and destination.
2. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed Raceway, whether in ceiling space or surface mounted.
3. Provide nylon strap for attachment.

B. Warning Tape: Install approximately 12 inches above underground raceways. Align parallel to, and within 12 inches of, centerline of runs.

C. Buried Raceway Markers:

1. Install at grade to indicate direction of underground raceways.
2. Install at all bends and at intervals not exceeding 100 feet in straight runs.

3.18 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up damage to coating on PVC-coated conduit with patching compound approved by manufacturer.

3.19 EXISTING UTILITIES

A. Perform exploratory excavation to locate all existing utilities/irrigation etc. prior to the installation of new equipment/conduits.

END OF SECTION

SECTION 16120

CONDUCTORS

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI): 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.

2. American Society for Testing and Materials (ASTM):

a. A167, Standard Specification for Stainless and Heat Resisting Chromium-Nickel-P1ated Steel Plate, Sheet, and Strip.
b. B3, Standard Specification for Soft or Annealed Copper Wire.
c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
d. B263, Standard Test Method for Determination of Cross- Sectional Area of Stranded Conductors.

3. Association of Edison Illuminating Companies (AEIC):

a. CS 5, Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 Through 35 kV.
b. CS 6, Ethylene- Propylene-Rubber-Insulated Shielded Power Cables Rated 5 Through 69 kV.

4. Insulated Cable Engineer's Association, Inc. (ICEA): T-29-250, Procedure for Conducting Vertical Cable Tray Flame Test With a Theoretical Heat Input of 210,000 Btu/hour.

5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

a. 48, Standard Test Procedures and Requirements or High-Voltage Alternating Current Cable Terminations.
b. 404, Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V through 46,000V and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V through 500,000V.

6. National Electrical Contractors Association, Inc. (NECA): 5055, Standard of Installation.

7. National Electrical Manufacturers' Association (NEMA):

a. CC 1, Electric Power Connectors for Substations.

b. WC 3, Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
c. WC 5, Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
d. WC 7, Crosslinked-Thermosetting-Polyethylene-lnsulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
e. WC 8, Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
f. WC 55, Instrumentation Cables and Thermocouple Wire.

8. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

9. Underwriters Laboratories, Inc. (UL):

a. 13, Standard for Safety Power-Limited Circuit Cables.
b. 44, Standard for Safety Rubber-Insulated Wires and Cables.
c. 62, Standard for Safety Flexible Cord and Fixture Wire.
d. 486A, Standard for Safety Wire Connector and Soldering Lugs for Use with Copper Conductors.
e. 486B, Standard for Safety Wire Connectors and Soldering Lugs for Use with Aluminum Conductors.
f. 510, Standard for Safety Insulating Tape.
g. 854, Standard for Safety Service-Entrance Cables.
h. 910, Standard for Safety Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air Handling Spaces.
i. 1072, Standard for Safety Medium-Voltage Power Cables.
j. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
k. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Shop Drawings:

1. Wire and cable descriptive product information.
2. Wire and cable accessories descriptive product information.
3. Cable fault detection system descriptive product information.
4. Manufactured wiring systems descriptive product information.
5. Manufactured wire systems rating information.
6. Manufactured wire systems dimensional drawings.
7. Manufactured wire systems special fittings.
8. Busway descriptive product information.

9. Busway rating information.
10. Busway dimensional drawings.
11. Busway special fitting information.
12. Busway-equipment interface information for equipment to be connected to busways.

B. Quality Control Submittals:

1. Certified Factory Test Report for conductors 600 volts and below.
2. Certified Factory Test Report per AEIC CS6, including AEIC qualification report for conductors above 600 volts.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 - PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 3, WC 5, and WC 7.

B. Conductor Type:

1. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Solid copper.
2. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Solid copper.
3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW insulation.

D. Aerial Conductors and Cables:

1. Type USE/RHH/RHW insulation, UL 54 listed, Type RHW-2/USE-2.
2. Conform to physical and minimum thickness requirements of NEMA WC 3.

E. Flexible Cords and Cables:

1. Type SOW-A50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 8.

F. Cable Tray Conductors and Cables: Type TC.

2.02 600-VOLT RATED CABLE

A. General:

1. Type: TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu/hr, and NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. CABLE Type “A”, Wire and Connectors

1. Cable shall be rated for 600 volts and shall meet the requirements below:
2. Conductors shall be stranded
3. All wire shall be brought to the job in unbroken packages and shall bear the data of manufacturing; not older than 12 months.
4. Type of wire shall be XHHW, rated 75 degrees C suitable for wet locations except where required otherwise by the drawings.
5. No wire smaller than No. 12 gauge shall be used unless specifically indicated.
6. Conductor metal shall be copper.
7. All conductors shall be megger tested after installation and insulation must be in compliance with the Insulated Power Cable Engineers Association Minimum Values of Insulation Resistance.

C. Type l-Multiconductor Control Cable:

1. Conductors:

a. No. 14 AWG, seven-strand copper.
b. Insulation: 15-mil PVC with 4-mil nylon.
c. UL 1581 listed as Type THHN/THWN rated VW-I.
d. Conductor group bound with spiral wrap of barrier tape.
e. Color Code: In accordance with NEMA WC 5, Method 1, and Sequence K-2.

2. Cable: Passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.

3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (inches)	Jacket Thickness (mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	00.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
   a. Okonite Co.
   b. Rome Cable.
   c. Or equal.

D. Type 2-Multiconductor Power Cable:

1. Conductors:
   a. Class B stranded, coated copper.
   b. Insulation: Chemically crosslinked ethylene-propylene with Hypalon jacket.
   c. UL 1581 listed as Type EPR, rated VW-1.
   d. Color Code: Conductors, size No. 8 AWG and smaller, colored conductors, NEMA WC5 Method 1, color 5 per Article POWER CONDUCTOR COLOR CODING. Conductors, size No. 6 AWG and larger, NEMA WC5, Method 4.
2. Cable passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.
3. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. Of Conductors	Max.Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2 3 4	0.42 0.45 0.49	45 45 45
10	10	2	0.54	60

		3 4	0.58 0.63	60 60
8	10	3 4	0.66 0.72	60
6	8	3 4	0.74 0.81	60
4	6	3 4	0.88 0.97	60 80
2	6	3 4	1.01 1.11	80
1/0	6	3 4	1.22 1.35	80
2/0	4	3 4	1.32 1.46	80
4/0	4	3 4	1.56 1.78	80

4. Manufacturers:
   a. Okonite Co.
   b. Rome Cable.
   c. Or equal.

E. Type B-No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

1. Outer Jacket: 45-mil nominal thickness.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
3. Dimension: 0.31-inch nominal OD.
4. Conductors:

   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8
   b. 20 AWG, seven-strand tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nominal nylon.
   e. Color Code: Pair conductors black and red.

5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Rome Cable.

6. The following test shall be performed on instrumentation and control system cables. All tests shall be end-to-end test of installed cables with the ends supported in free air, not adjacent to any ground object. All test data shall be recorded on forms acceptable to the Engineer. Complete records of all tests shall be made and delivered to the Engineer.

    a. Continuity tests shall be performed by measuring wire/shield loop resistances of signal cable as the wires, taken one at a time, are shorted to the channel shield. No loop resistance measurement shall carry by more than $\pm$2 ohms from the calculated average loop resistance valve.
    b. Insulation resistance tests shall be performed by using a 500 volt megohmeter to measure the insulation resistance between each channel wire and channel shield, between individual channel shields in a multi-channel cable, between each individual channel and the overall cable shield in multi-channel cable, between each wire and ground, and between each shield and ground. Values of resistance less than 10 megohms shall be unacceptable.

F. Type B1-No. 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

1. Outer Jacket: 45-mil nominal.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
3. Dimension: 0.32-inch nominal OD.
4. Conductors:

    a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
    b. 20 AWG, seven-strand, tinned copper drain wire.
    c. Insulation: 15-mil nominal PVC.
    d. Jacket: 4-mil nylon.
    e. Color Code: Triad conductors black, red, and blue.
5. Manufacturers:
    a. Okonite Co.
    b. Alpha Wire Corp.
    c. Rome Cable.

G. Type B2-No. 18 AWG, Multi-Twisted, Shielded Pairs with a Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 55 requirements.

1. Conductors:

   a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8
   b. Tinned copper drain wires.
   c. Pair drain wire size AWG 20, group drain wire size AWG 18.
   d. Insulation: 15-mil PVC.
   e. Jacket: 4-mil nylon.
   f. Color Code: Pair conductors black and red with red conductor numerically printed for group identification.
   g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.

2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.

3. Cable Sizes:

Number Of Pairs	**Maximum Outside Diameter (Inches)**	**Nominal Jacket Thickness (Mils)**
4	0.50	45
8	0.68	60
12	0.82	60
16	0.95	80
24	1.16	80
36	1.33	80
50	1.56	80

4. Manufacturers:

   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Rome Cable.

H. Type B3-No. 18 AWG, Multi-twisted Pairs with a Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 55.

1. Conductors:

   a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
   b. Tinned copper drain wire size 18 AWG

c. Insulation: 15-mil nominal PVC.
d. Jacket: 4-mil nylon.
e. Color Code: Pair conductors black and red, with red conductor numerically printed for group identification.

2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.

3. Cable Sizes:

Number Of Pairs	**Maximum Outside Diameter (Inches)**	**Nominal Jacket Thickness (Mils)**
4	0.46	45
8	0.63	60
12	0.75	60
16	0.83	60
24	1.06	80
36	1.21	80
50	1.42	80

4. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Rome Cable.

I. RTD Type Cable:
1. Coordinate with pump supplier for the actual RTD type (2-wire or 3-wire type) supplied with the motor and supplier recommended RTD type cable and provide accordingly.

2. Manufacturers:
   a. Belden, or equal.

2.03 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.04 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arcs and Fireproofing:
   a. 30-mil, elastomer
   b. Manufacturers and Products:

      1) Scotch; Brand 77, with Scotch Brand 69 glass cloth tape binder.

      2) Plytnount; Plyarc 30, with Plymount Plyglas glass cloth tape binder.

B. Identification Devices:

1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.
2. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
3. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO.

2. Nylon Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO.

D. Cable Lugs:

1. In accordance with NEMA CC I.
2. Rated 600 volts of same material as conductor metal.
3. Insulated, Locking-Fork, Compression Lugs:
   a. Manufacturers and Products:

      1) Thomas & Betts; Sta-Kon.
      2) ILSCO; ILSCONS.
      3) Or equal.

4. Un-insulated Crimp Connectors and Terminators:
   a. Manufacturers and Products:

      1) Square D; Versitide.
      2) Thomas & Betts; Color-Keyed.
      3) ILSCO.

5. Un-insulated, Bolted, Two-Way Connectors and Terminators:
   a. Manufacturers and Products:

      1) Thomas & Betts; Locktite.
      2) Burndy; Quiklug.
      3) ILSCO.

E. Cable Ties: Nylon, adjustable, self-locking, and reusable.

1. Manufacturers and Product: Thomas & Betts; TY-RAP, or equal.

F. Heat Shrinkable Insulation: Thermally stabilized, crosslinked polyofin.

1. Manufacturers and Product: Thomas & Betts; SHRINK-KON, or equal.

2.05 PULLING COMPOUND

A. Nontoxic, non-corrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

D. Manufacturers and Products:

1. Ideal Co.; Yellow 77.
2. Polywater, Inc.
3. Cable Grip Co.

2.06 BUSWAY

A. Low impedance, copper bus bar, outdoor copper-free 1/8-inch extruded aluminum housing with full neutral (where specified) and internal ground bus, totally enclosed non-ventilated and joint insulation of polyester film.

B. UL listed for support and spacing provided, meeting NFPA 70 requirements, NEMA BU-1, UL B57, ANSI C37.23, and totally enclosed throughout its length.

C. Suitable for mounting in vertical (edgewise) or horizontal position without derating, and capable of withstanding short-circuit of 100,000 amperes symmetrical.

D. Provide expansion fitting when the bus crosses a building expansion joint.

E. Provide integral weather seal on all outdoor entrance points.

F. Provide flanged ends or end cable tap box on all indoor end points.

G. Manufactured by Square D, Model I-Line II, or approved equal.

2.07 WARNING TAPE

A. As specified in Section 16110, RACEWAYS.

2.08 SOURCE QUALITY CONTROL

A. Conductors 600-Volts and Below: Test in accordance with UL 44 and 854 Standards.

B. Conductors Above 600 Volts: Test in accordance with NEMA W8 and AEIC CS 6 partial discharge level test for EPR insulated cable.

PART 3 - EXECUTION

3.01 GENERAL

A. Conductor installation to be in accordance with NECA 5055.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.

E. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

F. Bundling: Where single conductors and cables in manholes, hand holes, vaults, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

H. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.

I. Cable Tray Installation:

1. Install wire and cable parallel and straight in tray.
2. Bundle, in groups, all wire and cable of same voltage having a common routing and destination; use cable ties, at maximum intervals of 8 feet.
3. Clamp cable bundles prior to making end termination connections.
4. Separate cables of different voltage rating in same cable tray with barriers.
5. Fasten wires, cables, and bundles to tray with nylon cable straps at the following maximum intervals:
   a. Horizontal Runs: 20 feet.
   b. Vertical Runs: 5 feet.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.
2. No. 8 AWG and Smaller: Provide colored conductors.
3. Colors:

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

4. Tracer: Outer covering of white with an identifiable colored strip other than green in accordance with NFPA 70.

3.03 CIRCUIT IDENTIFICATION

A. Circuits Appearing in Circuit Schedules: identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, hand holes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:

1. Assign circuit name based on device or equipment at load end of circuit.
2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:

1. Conductors No. 3 AWG and Smaller: Identify with sleeves.
2. Cables, and Conductors No. 2 AWG and Larger:
   a. Identify with marker plates.
   b. Attach marker plates with nylon tie cord.
3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by ENGINEER.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 6 AWG and smaller.
3. Install un-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
4. Install un-insulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.
5. Install un-insulated bolted two-way connectors for motor circuit conductors No. 12 and larger.
6. Tape insulates all un-insulated connections.
7. Place no more than one conductor in any single-barrel pressure connection.
8. Install crimp connectors with tools approved by connector manufacturer.
9. Install terminals and connectors acceptable for type of material used.
10. Compression Lugs
    a. Attach with a tool specifically designed for purpose.

b. Tool shall provide complete controlled crimp and shall not release until crimp is complete.
c. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:

1. Splices shall not be allowed unless approved on a case by case bases. All approved splices shall be witnessed by R.P.R. with electrician. Schedule splices 7 days advanced notice.

a. Indoors: Use general purpose, flame retardant tape.
b. Outdoors: Use flame retardant, cold- and weather-resistant tape.

F. Cap spare conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wire, bridle and secure.
2. Where conductors pass through openings or over edges in sheet metal, remove bums, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
4. Where connections of cables installed under this section are to be made under Division 13, leave pigtails of adequate length for bundled connections.
5. Cable Protection:

a. Under Infinite Access Floors: May be installed without bundling.
b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least 1/2-inch in diameter.
c. Maintain integrity of shielding of instrumentation cables.

d. Ensure grounds do not occur because of damage to jacket over the shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies. Coil and label conductors for easy identification.

J. Variable Frequency Drive (VFD) Output Power Cable:

1. Install cables in raceway.
2. Terminate the three ground conductors together at the motor and at the ground bus of the VFD.
3. Terminate aluminum armor at motor and at VFD. At motor, terminate shield with cable manufacturer recommended termination kit. Termination shall be to the motor junction box. At the VFD, terminate armor to the invertor drive frame. The termination kit must provide a 360-degree connection of the armor to frame and motor junction box.

3.05 CONDUCTOR ARC AND FIREPROOFING

A. Install arc and fireproofing, tape on 600-volt single conductors and cables except those rated Type TC in manholes, hand holes, vaults, cable trays, and other indicated locations.

B. Install arc and fireproofing tape on 5 kV cables or 8 kV cables throughout their entire exposed length in manholes, hand holes, vaults, cable trays, and other indicated locations.

C. Wrap conductors of same circuit entering from separate conduit together as a single cable.

D. Follow tape manufacturer's installation instructions.

E. Secure tape at intervals of 5 feet with bands of tape binder. Each tape band shall consist of a minimum of two wraps directly over each other.

3.06 BUSWAY

A. Install in strict accordance with manufacturer's recommendations and NFPA 70.

B. Maximum Support Spacing: 10 feet.

3.07 FIELD QUALTTY CONTROL

A. In accordance Section 16950, ELECTRICAL TESTING.

END OF SECTION

SECTION 16139

VAULTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Extent of underground concrete encased conduit (ductbank) vault, manhole, and handhole work as indicated by Drawings, and is hereby defined to include those units which are utilized exclusively for installation of instrumentation, communication, and control media and equipment; and electrical power cables, wires, and equipment.

B. Types of vaults, manholes, and handholes in this Section include, but are not limited to:
   1. Utility vaults.
   2. Communication manholes.
   3. Communication handholes.
   4. Electrical manholes.
   5. Electrical handholes.
   6. Concrete encased conduit (ductbank).

C. Related Work in Other Sections:
   1. Section 02310 for excavation and backfill required in connection with vaults, manholes, and handholes.
   2. Division 3 Sections for concrete Work required in connection with vaults, manholes, and handholes.
   3. Division 7 Sections for waterproofing and dampproofing of vaults, manholes, and handholes.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01340, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Prefabricator's Data: Submit prefabricator's data on factory-fabricated vaults, manholes, and handholes.
   2. Manufacturer's Data: Submit manufacturer's data on concrete encased conduit vault, manhole, and handhole components and associated specialty products.
   3. Submit Shop Drawings for vault system, showing raceway types and sizes, locations, and elevations for horizontal runs. Include details of underground structures, accessories, fittings, and connections.

1.03 QUALITY ASSURANCE

A. Prefabricators: Firms regularly engaged in manufacture of factory fabricated vaults, manholes, and handholes, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Codes and Standards:
   1. ANSI Compliance: Comply with requirements of ANSI C2, "National Electrical Safety Code," pertaining to construction and installation of concrete encased conduit vaults, manholes, and handholes.

   2. ASTM Compliance: Comply with applicable requirements of American Society for Testing and Materials (ASTM) standards pertaining to construction and materials for vaults, manholes, and handholes.

   3. UL Compliance: Comply with applicable requirements of Standard 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors." Provide vault, manhole, and handhole accessories which are UL listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

B. Prefabricated Units:
   1. Advance Concrete.
   2. Hanson Pipe and Precast.
   3. Or equal.

2.02 FACTORY FABRICATED VAULTS, MANHOLES, AND HANDHOLES

A. Concrete Vaults and Manholes: Provide watertight, precast concrete vaults and manholes in types and sizes indicated, with access knockout entrance holes for raceways and cable, cast-iron manhole access cover and frame with machined bearing surfaces, with pulling/lift irons, sump/drainage box and vertical embedded continuous slot inserts.

B. Manhole Frames and Covers: Grey cast iron, ASTM A 48, Class 30B:
   1. Dip coat frames and covers in black asphalt paint. Provide 30-inch-diameter openings for vaults and manholes carrying low-voltage circuits. Provide 36-inch diameter openings for vaults and manholes carrying medium-voltage circuits.

2. Furnish covers with cast-in legend "ELECTRIC" or "COMMUNICATION" on roadway face.

3. Provide reinforced concrete for vaults and manholes with slabs designed for H-20 highway loading and walls designed for a lateral earth pressure of 80 pounds per square foot per foot of depth.

C. Handholes and Boxes: Provide handholes and boxes for pulling, splicing, and terminating conductors, in types and sizes indicated, with watertight cover and penta-head bolts and knockout access holes; equip base with sump/drainage box.
   1. Provide concrete body with cast iron cover and ring.

D. Accessories: Provide vault, manhole, and handhole accessories, including pulling-in irons, embedded cable support accessories, cable rack arms, porcelain saddles, sump pump pits, ladders, mastics, and sealants as indicated or required.

PART 3 - EXECUTION

3.01 INSPECTION

A. Installer must examine areas and conditions under which concrete encased conduit vaults, manholes, and handholes are to be installed, and notify CONTRACTOR in writing of those conditions detrimental to proper completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 UNDERGROUND CONCRETE ENCASED CONDUIT

A. Support conduit to be encased on approved spacers at the dimensions shown on Drawings.

B. Reinforce concrete encasement as indicated.

C. Slope duct runs a minimum of 0.5 percent in the direction indicated.

D. Maintain a 12-inch minimum clearance between concrete encasement and yard piping.

E. Provide 24-inch minimum clearance from top of concrete encasement to finished grade unless otherwise noted.

F. Mandrel and clean all underground conduits prior to cable installation.

3.03 INSTALLATION OF VAULTS, MANHOLES, AND HANDHOLES

A. Install vaults, manholes, and handholes as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that vaults, manholes, and handholes comply with requirements.

B. Set manhole frames and covers flush with sidewalk, pavement, or ground surface. In gravel driveways set covers 4 inches below surface.

C. Coordinate with other Work, including electrical raceway and wiring Work, as necessary to interface installation of vaults, manholes, and handholes with other Work.

3.04 INSTALLATION OF FACTORY FABRICATED UNITS

A. Install vaults, manholes, and handholes as indicated, in accordance with manufacturer's written instructions and recognized industry practices to ensure that vaults, manholes, and handholes comply with requirements and serve intended purposes.

B. Precast Concrete Units: Place precast concrete sections as indicated. Where units occur in pavements, set tops of frames and covers flush with finish surface, unless otherwise indicated. Use epoxy bonding compound where steps are mortared into unit walls.
   1. Apply bituminous mastic coating at joints between sections.
   2. Coordinate dampproofing and waterproofing Work with installation of precast concrete units as necessary for proper interface.
   3. Install dampproofing and waterproofing materials as indicated.

3.05 BACKFILLING

A. Delay backfilling of excavations surrounding vaults, manholes, and handholes until after initial inspection has been completed.

3.06 GROUNDING AND BONDING

A. Provide equipment grounding and bonding connections for exposed metal parts in vaults, manholes, and handholes as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

END OF SECTION

SECTION 16405

AC INDUCTION MOTORS

PART 1 - GENERAL

1.01 RELATED SECTIONS

A. This section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and any deviations from this section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. Anti-Friction Bearing Manufacturers' Association (AFBMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Rating and Fatigue Life for Roller Bearings.
2. American National Standards Institute (ANSI): C50.41, Polyphase Induction Motors for Power Generating Stations.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 85, Test Procedure for Airborne Sound Measurements on Rotating Machines.
   b. 112, Standard Test Procedures for Polyphase Induction Motors and Generators.
   c. 114, Standard Test Procedures for Single-Phase Induction Motors.
   d. 620, Guide for Construction and Interpretation of Thermal Limit Curves for Squirrel-Cage Motors Over 500 Horsepower.
   e. 841, Recommended Practice for Chemical Industry Severe-Duty Squirrel-Cage Induction Motors, 600V and Below.
4. National Electrical Manufacturers Association (NEMA):
   a. MG 1, Motors and Generators.
   b. MG 13, Frame Assignments for Alternating Current Integral Horsepower Induction Motors.
   c. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
5. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)
6. Underwriters Laboratories (UL):
   a. 547, Thermal Protectors for Electric Motors.

b. 674, Electric Motors and Generators Used in Hazardous (Classified) Locations.

1.03 DEFINITIONS

A. CISD-TEFC: Chemical industry, severe-duty enclosure.

B. DIP: Dust-ignition-proof enclosure.

C. EXP: Explosion-proof enclosure.

D. ODP: Open drip-proof enclosure.

E. TEFC: Totally enclosed, fan cooled enclosure.

F. TENV: Totally enclosed, non-ventilated enclosure.

G. WPI: Open weather protected enclosure, Type I.

H. WPII: Open weather protected enclosure, Type II.

I. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

1.04 SUBMITTALS

A. Shop Drawings:

1. Descriptive information.
2. Nameplate data in accordance with NEMA MG 1.
3. Additional Rating Information:
   a. Service factor.
   b. Locked rotor current.
   c. No load current.
   d. Safe stall time for motors 200 horsepower and larger.
   e. Multispeed load classification (e.g., variable torque).
   f. Adjustable frequency drive motor load classification (e.g., variable torque) and minimum allowable motor speed for that load classification.
4. Enclosure type and mounting (e.g. horizontal, vertical).
5. Dimensions and total weight.

6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
7. Bearing type.
8. Bearing lubrication.
9. Bearing life.
10. Space heater voltage and watts.
11. Description and rating of motor thermal protection.
12. Motor sound power level in accordance with NEMA MG 1.
13. Maximum brake horsepower required by the equipment driven by the motor.
14. Description and rating of submersible motor moisture sensing system.

B. Quality Control Submittals:

1. Factory test reports, certified.
2. Manufacturer's Certificate of Proper Installation, 100 horsepower and larger.
3. Operation and Maintenance Manual.

PART2 - PRODUCTS

2.01 MANUFACTURERS

A. General Electric.

B. U.S. Motors.

C. Baldor.

2.02 GENERAL

A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

B. In order to obtain single source responsibility, the contractor shall utilize a single supplier to provide a drive motor, its driven equipment, and specified motor accessories.

C. Meet requirements of NEMA MG 1.

D. Frame assignments in accordance with NEMA MG 13.

E. Provide motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

F. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

G. Lifting lugs on all motors weighing 100 pounds or more.

H. Operating Conditions:

1. Maximum ambient temperature not greater than 50 degrees C.
2. Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise.
3. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING

A. As designated in motor-driven equipment specifications.

B. Constant Speed Applications: Brake horsepower of the driven equipment at any head capacity point on the pump curve not to exceed motor nameplate horsepower rating, excluding any service factor.

C. Adjustable Frequency, Adjustable Speed Applications: Driven equipment brake horsepower at any head capacity point on the pump curve not to exceed motor nameplate horsepower rating, excluding any service factor.

2.04 SERVICE FACTOR

A. 1.15 minimum at rated ambient temperature, unless otherwise indicated.

2.05 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60-Hz.

B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specifications:

Size	Voltage	Phases
1/2 hp and smaller	115	1
3/4 hp through 400 hp	460	3
450 hp and larger	4,000	3

C. Suitable for full voltage starting.

D. One hundred horsepower and larger also suitable for reduced voltage starting with 65 or 80 percent voltage tap settings on reduced inrush motor starters.

E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.06 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 1 horsepower, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:

1. Efficiency:
   a. Tested in accordance with NEMA MG 1, paragraph 12.54.1.
   b. Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.
2. Power Factor: Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.

2.07 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code F or lower if motor horsepower not covered by NEMA MG 1 tables.

B. Safe stall time 15 seconds or greater.

2.08 INSULATION SYSTEMS

A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

B. Motors Rated Over 600 Volts: Sealed windings in accordance with NEMA MG 1.

C. Three-Phase and Integral Horsepower Motors, Unless Otherwise Indicated in Motor-Driven Equipment Specifications: Class F with Class B rise at nameplate horsepower and designated operating conditions, except EXP and DIP motors which must be Class B with Class B rise.

2.09 ENCLOSURES

A. All enclosures to conform to NEMA MG 1.

B. TEFC and TENV: Furnish with a drain hole with porous drain/weather plug.

2.10 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for all motors.

B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

C. Except ODP, furnish gaskets between box halves and between box and motor frame.

D. Minimum usable volume in percentage of that specified in NEMA MG 1-11.06 and 20.62 and NFPA 70, Article 430:

Voltage	Horsepower	Percentage
Below 600	15 thru 125	500
Below 600	150 thru 300	275
Below 600	350 thru 600	225
Above 600	All Sizes	200

E. Terminal for connection of equipment grounding wire in each terminal box.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:

1. 3/4 horsepower and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
2. 1 Through 400 horsepower: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
3. Above 400 horsepower: Regreasable antifriction bearings in labyrinth sealed end bells with removable grease relief plugs.
4. Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in AFBMA 9 and 11.

B. Vertical Motors:

1. Thrust Bearings:
   a. Antifriction bearing.
   b. Manufacturer's standard lubrication 100 horsepower and smaller.
   c. Oil lubricated 125 horsepower and smaller.
   d. Minimum 50,000 hours L-10 bearing life.

2. Guide Bearings:
    a. Manufacturer's standard bearing type.
    b. Manufacturer's standard lubrication 200 horsepower and smaller.
    c. Oil lubricated 250 horsepower and smaller.
    d. Minimum 100,000 hours L-1O bearing life.

C. Regreasable Antifriction Bearings:

1. Readily accessible, grease injection fittings.
2. Readily accessible, removable grease relief plugs.

D. Oil Lubrication Systems:

1. Oil reservoirs with sight level gauge.
2. Oil fill and drain openings with opening plugs.
3. Provisions for necessary oil circulation and cooling.

2.12 NOISE

A. Measured in accordance with IEEE 85 and NEMA MG 1.

B. Motors controlled by adjustable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1-12.06.

2.14 EQUIPMENT FINISH

A. External Finish: Prime and finish coat manufacturer's standard. Field painting in accordance with Sections 09900 PAINTING.

B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

A. Screen Over Air Openings: Stainless steel on motors with ODP, WPI, and WPII enclosures meeting requirements for Guarded Machine in NEMA MG 1.

B. Winding Thermal Protection:

1. Thermostats, unless otherwise noted in the pump specification:

a. Motors for constant speed and adjustable speed application 30 through 75 horsepower.
b. Bi-metal disk or rod type thermostats embedded in stator windings (normally closed contact).
c. Automatic reset contacts rated 120 volts ac, 5 amps minimum, and opening on excessive temperature. (Manual reset will be provided at motor controller.)

2. RTD (Resistance Temperature Detectors), unless otherwise noted in the pump specification:
a. Motors for constant speed and adjustable speed application above 75 horsepower.
b. six (6) RTD's per motor with 2 per phase.
c. Provide RTD transducers to be installed in the starter enclosure or PLC panel, unless otherwise noted in the drawings.

3. Motor Space Heaters: All motors 30 horsepower and larger except if otherwise noted, shall be furnished with 120V ac space heaters. The rating of the space heaters shall be determined in accordance with the motor manufacturer's standard for particular frame size and type. Coordinate the power requirements of the space heater with the manufacturer of motor starters or adjustable frequency drive for sizing of the control transformer. Space heater wire leads shall be brought out in the conduit box on the motor and clearly identified.

C. Nameplates:

1. Raised or stamped letters on stainless steel or aluminum.
2. Display all motor data required by NEMA MG 1-10.37 and NEMA MG 1-10.38 in addition to bearing numbers for both bearings.
3. Premium efficiency motor nameplates to also display NEMA nominal efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

2.16 FACTORY TESTING

A. Tests:

1. In accordance with IEEE 112 for polyphase motors and IEEE 114 for single-phase motors.
2. Routine (production) tests on all motors in accordance with NEMA MG 1, plus no load power at rated voltage and polyphase, rated voltage measurement of locked rotor current. Test multispeed motors at all speeds.

3. For energy efficient motors, test efficiency at 50, 75, and 100 percent of rated horsepower:
    a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, paragraphs 12.54 and 12.57.
    b. For motors 500 horsepower and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
4. Power factor:
    a. Speed.
    b. Current at rated horsepower.
    c. kW input at rated horsepower.
    d. On motors of 100 horsepower and smaller, furnish a certified copy of a motor efficiency test report on an identical motor.

B. Test Report Forms:

1. Routine Tests: IEEE 112, Form A-1.

PART 3 - EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts. Provide anchor bolts meeting manufacturer's recommendations and of sufficient size and number for the specified seismic conditions.

3.02 FIELD QUALITY CONTROL

A. Refer to Section 16950, ELECTRICAL TESTING.

3.03 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative at site in accordance with Section 01650, START-UP AND DEMONSTRATION, for installation assistance, inspection, equipment testing, and startup assistance for motors larger than 75 horsepower.

B. Manufacturer's Certificate of Proper Installation.

3.04 SUPPLEMENTS

A. Table supplements, following "END OF SECTION," are a part of this Specification.

END OF SECTION

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
1	1800	80.0	81.5			Mfr.'s Std.	Mfr.'s Std.		
	1200	78.5	79.3			Mfr.'s Std.	Mfr.'s Std.		
1.5	3600	79.3	81.5			Mfr.'s Std.	Mfr.'s Std.		
	1800	79.3	82.0			Mfr.'s Std.	Mfr.'s Std.		
	1200	82.5	84.0		82.0	Mfr.'s Std.	Mfr.'s Std.		Mfr.'s Std.
2	3600	82.0	84.0			Mfr.'s Std.	Mfr.'s Std.		
	1800	81.5	83.7			Mfr.'s Std.	Mfr.'s Std.		
	1200	85.5	85.5	83.7	83.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	82.9	82.5	82.9	81.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
3	3600	82.0	84.0	82.0	82.0	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	84.8	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	87.5	88.1	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	84.1	82.9	84.1	82.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
5	3600	84.8	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	86.5	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	87.5	88.1	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	87.5	86.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
7.5	3600	86.5	88.1	84.8	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	88.5	88.5	88.4	87.5	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	87.5	86.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
10	3600	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	89.5	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	89.3	88.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
15	3600	88.5	89.8	88.4	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	91.0	91.0	90.9	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	90.2	90.2	90.2	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	89.3	88.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
20	3600	91.0	90.6	90.9	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	91.7	91.7	91.7	90.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	91.0	90.6	90.2	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
25	3600	91.7	91.0	91.7	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	92.4	92.4	92.4	91.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	91.7	91.0	90.9	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
30	3600	91.7	91.4	89.5	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	92.4	92.4	92.4	91.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	91.7	91.0	91.7	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	91.7	91.7	90.9	90.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
40	3600	91.7	91.7	90.2	89.3	86.6	86.1	87.0	89.0
	1800	93.6	93.0	92.8	91.7	78.2	78.2	83.0	84.5
	1200	92.4	92.4	91.7	90.9	81.5	81.5	81.5	81.5
	900	91.7	91.0	90.9	90.2	70.0	70.5	70.0	70.5
50	3600	92.0	92.0	90.2	89.3	85.1	86.7	89.0	89.0

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
	1800	93.6	93.0	92.8	91.7	79.5	79.4	82.5	82.5
	1200	92.4	92.4	91.7	90.9	81.5	81.5	81.5	81.5
	900	91.7	91.7	90.9	90.9	78.5	72.9	78.5	80.0
60	3600	92.7	93.0	91.7	90.9	85.8	88.3	87.5	89.0
	1800	93.6	94.1	93.5	92.8	80.5	79.9	80.5	80.5
	1200	93.0	93.0	92.8	91.7	81.5	81.5	81.5	81.5
	900	92.4	91.7	91.7	90.9	79.5	73.2	79.5	79.5
70	3600	93.6	93.6	91.7	91.7	87.1	88.5	88.5	88.5
	1800	94.5	94.5	93.5	93.5	81.0	81.5	81.0	81.5
	1200	93.6	93.5	93.5	92.8	82.0	82.0	82.0	82.0
	900	92.8	92.4	92.8	91.7	80.5	74.5	80.5	81.0
100	3600	93.6	93.3	91.7	90.7	87.0	88.2	87.0	88.5
	1800	95.1	94.5	94.0	93.5	81.0	81.0	81.0	81.0
	1200	93.6	93.6	92.8	92.8	82.1	81.7	85.5	85.5
	900	93.5	92.4	92.8	91.7	77.0	77.3	77.0	80.0
125	3600	93.6	93.7	91.7	91.7	86.4	89.1	87.0	90.5
	1800	94.5	94.7	93.5	92.8	85.4	85.5	87.5	86.0
	1200	93.6	94.1	93.5	92.8	82.7	82.3	85.5	85.5
	900	93.5	93.0	92.8	92.4	78.5	78.5	78.5	78.5
150	3600	93.6	93.7	92.4	91.7	86.5	90.0	86.5	90.5
	1800	95.0	95.2	94.5	94.0	82.5	85.0	84.5	85.0
	1200	94.5	94.5	93.5	94.0	81.5	81.5	81.5	81.5
	900	93.5	93.0	92.8	92.4	78.0	78.5	78.0	78.5
200	3600	94.3	94.3	92.4	93.0	87.8	89.4	91.0	91.0
	1800	95.0	95.2	94.0	94.0	85.2	86.5	87.0	87.0

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	**Nom.Speed rpm**	**Drip-proof ODP**	**TEFC**	**Drip-proof ODP**	**TEFC**	**Drip-proof ODP**	**TEFC**	**Drip-proof ODP**	**TEFC**
	1200	94.5	94.5	93.5	93.5	79.0	82.5	79.0	82.5
250	3600	94.3	94.7	91.7	92.4	85.0	86.5	85.0	96.5
	1800	85.4	95.4	94.5	94.5	79.0	79.0	79.0	79.0
	1200	95.0	94.5	94.5	93.5	82.0	82.0	82.0	82.0
300	3600	93.7	94.3			89.8	89.9		
	1800	95.4	95.2	94.5	94.0	80.0	80.0	800	80.0
	1200	93.7	93.7			84.5	90.1		
350	3600	94.3	94.7			89.4	85.9		
	1800	94.7	94.7			85.9	85.9		
400	3600	94.3				88.4			
	1800	9437				86.8			
450	3600	94.7				89.1			
500	3600	94.7				88.3			

SECTION 16410

CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01340, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Product data for each type of product specified.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Sections 01730 and 13410, operation and maintenance manuals for items included under this Section, including circuits and motor disconnects.

1.02 QUALITY ASSURANCE

A. Codes and Standards:

1. Electrical Component Standards: Provide components which are listed and labeled by UL. Comply with UL Standard 98 and NEMA Standard KS 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Square D Company.

2.02 CIRCUIT AND MOTOR DISCONNECT SWITCHES

A. Provide NEMA 4, 4X, 7, 9, or 12 enclosure to match the rating of the area in which switch is installed. For motor and motor starter disconnects through 100 horsepower, provide units with horsepower ratings suitable to loads. For motor and motor starter disconnects above 100 horsepower, clearly label switch, "DO NOT OPEN UNDER LOAD."

B. Circuit Breaker Switches: Where individual circuit breakers are required, provide factory-assembled, molded-case circuit breakers with permanent instantaneous magnetic and thermal

trips in each pole, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees C. Provide with AL/CU-rated mechanical screw type removable connector lugs.

C. Non-fusible Disconnects: (Heavy-duty) switches of classes and current ratings as indicated.

D. Double-Throw Switches: (Heavy-duty) switches of classes and current ratings as indicated.

E. Switches for Classified (Hazardous) Locations: Heavy-duty switches with UL labels and listings for hazardous location classifications in which installed.

2.03 ACCESSORIES

A. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:

1. 316 Stainless Steel for NEMA 4 and NEMA 4X switches.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 16421

MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01340, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Product Data: Submit manufacturer's technical product data on NEMA Class 2, Type B motor control centers (MCCs).

2. Submit layout Drawings of MCCs showing accurately scaled basic equipment sections including, but not limited to, motor starters, controllers, device panels, and circuit breakers. Show spatial relationships of MCC components to proximate electrical equipment. Clearly differentiate on wiring diagrams those conductors which are factory installed and those which are field installed.

3. Fuse and Overload Sizes: Submit a compiled list of motors, fuse sizes, overload sizes, and types for motors actually installed.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01730, operation and maintenance manuals for items included under this Section. Include data and parts list for each MCC and troubleshooting maintenance guide.

1.02 QUALITY ASSURANCE

A. Codes and Standards:

1. NEMA Compliance: Comply with NEMA Standards Pub/No. ICS-2, pertaining to construction, testing, and installation of MCCs, and with applicable NEMA standards for circuit breakers and fuses.

2. UL Compliance: Comply with applicable requirements of UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," and UL Standard 845, "Electric Motor Control Centers." Provide MCCs and ancillary equipment which are UL listed and labeled.

3. IEEE Compliance: Comply with applicable requirements of IEEE Standard 241 pertaining to construction and installation of MCCs.

4. ANSI Compliance: Comply with applicable requirements of ANSI as applicable to MCCs.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. General Electric Co.
2. Square D Company.

2.02 MOTOR CONTROL CENTERS AND COMPONENTS

A. Provide MCCs and ancillary components of sizes, ratings, classes, types, and characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information and as required for complete installation and as specified herein.

B. MCCs: For operation on power source rating indicated, consisting of one or more vertical sections, each with groupings of control units containing motor starters, thermal overload units, disconnects, and including such other electrical equipment as controls, control transformers, metering panels, current transformers, and auxiliary devices as indicated. Provide MCC with NEMA Class 2, Type B wiring, wire units using 90°C SIS or MTW stranded copper wire; No. 14 AWG minimum. Tag all wires at each termination.

C. MCC Supporting Structures: Factory assembled, dead-front, MCC standard supporting structures with enclosed vertical sections, fastened together to form rigid freestanding assembly. Construct each section 90 inches high with 9-inch horizontal wireways at top and bottom, 20 inches wide, and with 20-inch section depth for front-of-board unit arrangement. Provide NEMA Type 1A enclosure. Provide gasketing on all enclosing sheet steel, wireways, and unit doors. Construct units with 4-5/8-inch wide, 8-inch deep, 90-inch high vertical wireway in each vertical structure on right side of unit, accessible through hinged doors, and with supports at proper intervals within for fastening wires/cables. Form supporting members of not less than 13 gauge hot-rolled steel. Construct structure doors with removable pin hinges and secure with quarter-turn indicating type fasteners. Provide front-accessible main lug compartment for connection of incoming cables in top or bottom as indicated. Provide removable lifting angle full length of MCC. Design lifting angle to support entire weight of MCC section. Design bottom channels to be removable; provide holes for bolting MCC units to floor.

1. Provide shipping splits in MCC lineup to allow for shipment of maximum 60-inch-long units. Design MCCs so matching vertical sections of same current rating and

manufacturer can be added later at either end of lineup without use of transition sections. Provide removable end and top plates to close off openings.

D. Bus System: Tin-plated aluminum or copper, braced to withstand faults of 65,000 rms symmetrical amperes minimum unless indicated otherwise. Provide main horizontal bus with rating shown and vertical bus rating of 300 amperes minimum; and construct vertical bus bars with protective barriers to prevent accidental contact of personnel with bus. Vertical bus shall be full length.

1. Provide 0.25-inch by 1-inch minimum copper ground bus running full width of MCC at bottom of lineup. Drill ground bus and furnish 1 lug per starter unit, minimum.

E. Starter Units: Draw-out type, magnetic motor starters with fusible switch or motor circuit protector type disconnects, auxiliary control devices, and NEMA size as indicated. Construct each starter unit with doors, unit support pans, saddles, and disconnect operators; enclose and isolate each unit from adjacent units. Design units so that faults will be contained within compartments. Equip with thermal and magnetic overload protection device for each motor circuit, unit-mounted pilot devices, timers, selector switches, indicating lights, and control relays. Provide 1 spare normally open auxiliary contact. Provide draw-out units with de-energized position where unit is still supported by structure, but no electrical connection is made. Provide method of locking unit in de-energized position. Design plug-in units of same NEMA size and branch feeder units of same trip rating, to be interchangeable with each other. All motors 60HP and above shall use reduced voltage starters unless powered by a VFD.

1. Three-phase starter may be following types:

a. Full Voltage Nonreversing (FVNR): One 3-pole magnetic contactor with a set of 3 overload devices.
b. Full Voltage Reversing (FVR): Two 3-pole magnetic contactors with a common set of 3 overload devices.
c. Reduced Voltage (for wye connected part winding motors): Two 3-pole magnetic contactors, each with its own set of 3 overload devices and a timer for closing of the running contactor. Running contactor shall be sized for motor full load current and starting (half winding) contactor shall be sized for at least 75 percent of full load current and shall be capable of interrupting at least 10 times full load current.
d. Reduced Voltage (closed transition autotransformer type): Three magnetic contactors, two 2-pole and one 3-pole with a common set of 3 overloads, a timing relay, and an auto-transformer with taps at 50, 65, 80, and 100 percent and an integral temperature switch or timing relay to protect transformer windings.

F. Unit Plug-On: Provide plug-on connections for each electrical power phase. Design contact fingers to be floating and self-aligning; silver plate contacts for obtaining low-resistance connections.

G. Disconnect Operators: Provide external operator handles for switches and circuit breakers. Design handle with up-down motion and with down position indicating OFF. Construct handles which permit locking handle in OFF position with 3 padlocks.

H. Unit Doors: Securely mounted with rugged concealed-type hinges which allow doors to swing open minimum of 115 degrees for ease of unit maintenance and withdrawal. Fasten doors to structure so that they remain in place when unit is withdrawn.

1. Closed door must cover unit space when unit has been temporarily removed. Provide interlock for each unit door with associated disconnect mechanism to prevent door from opening when unit is energized.

I. Control and Pilot Devices: Provide an individually fused control power transformer in each starter unit. Provide 2 fuses in transformer primary circuit and 1 in transformer secondary circuit. Size transformers such that they can supply 100VA in excess of unit requirements or provide 150VA rated transformer, whichever is greater.

1. Provide synchronous type timers unless otherwise noted.
2. Provide 300 volt-rated, oil-tight type pilot lights, push buttons, and selector switches. Equip Start push button with extended guard and black color insert. Equip Stop push buttons with half guard and red color insert.
3. Provide 120/6 volt transformer type push button to test pilot lights with lens color indicated.
4. Provide machine tool type relays, each with 1 spare N.O. contact.
5. Provide 6-digit elapsed time indicators with 1/10 hour increments.

J. Fusible Switch: Quick-make quick-break, gang-operated switches with positive pressure fuse clips suitable for use with class of fuses required. Provide switches with continuous current rating indicated and with a 100,000 ampere interrupting capability at rated voltage.

K. Motor Circuit Protector: Adjustable trip magnetic-only instantaneous molded-case circuit breakers for use in starter units. Provide a continuous current rating of at least 125 percent of the motor full load current and an interrupting capacity of 65,000 amps symmetrical. Provide a field adjustable instantaneous trip unit capable of being adjusted from 7 to 13 times motor full load current.

L. Circuit Breakers: Factory assembled, molded-case circuit breakers with permanent instantaneous magnetic and thermal trips in each pole and with fault-current limiting protection; ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle indication. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees. Provide with AL/CU rated mechanical screw type removable connector lugs.

M. Power Monitor: Ethernet capable, microprocessor-based device shall be capable of measuring each phase current, line-to-line voltage, line-to-neutral voltage, watts, VARS, power factor, demand watts, and frequency. Unit shall contain kilowatt hour totalizer. 3-CT's and 3 (fused)-PT's shall be provided and factory installed as required. Unit shall have two Form C, 2-amp rated output contacts, one to alarm upon abnormal voltage level and one to alarm on power failure.

N. Finishes: Thoroughly clean interior and exterior prior to coating of MCC, including bolted joints, with rust-inhibiting prime coat. Provide 2 finish coats of manufacturer's standard color baked-on enamel finish.

O. Spare Units: In each motor control center, provide a spare Size 2 full voltage, nonreversing combination starter. Provide a Hand-Off Auto switch and red "running" pilot light in this unit.
   1. In each motor control center, provide a spare 60 amp fusible switch.
   2. In each motor control center, provide spaces for addition of a Size 2 motor starter and a 60 amp fused feeder switch.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 16435

MEDIUM VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):

a. C37.04, Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
b. C37.06, Switchgear–AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
c. C37.09, Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
d. C37.2, Standard Electric Power Systems Device Function Numbers.
e. C37.20.2, Metal-Clad and Station Type Cubicle Switchgear.
f. C37.90.1, Standard Surge Withstand Capacity (SWC) Tests for Protective Relays and Relay Systems.
g. C39.1, Electrical Analog Indicating Instruments, Requirements for.
h. C39.5, Electrical and Electronic Measuring and Controlling Instrumentation, Safety Requirements.
i. C57.13, Standard Requirements for Instrument Transformers.
j. C62.11, Standard for Metal-Oxide Surge Arrestors for AC Power Circuits.
k. Z55.1, Gray Finishes for Industrial Apparatus and Equipment.

2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 460, Standard for Electrical Measuring Transducer for Converting AC Electrical Quantities into DC Electrical Quantities.
3. National Electrical Manufacturers Association (NEMA):
   a. LA 1, Surge Arrestors.
   b. SG 4, Alternating-Current High-Voltage Circuit Breakers.
   c. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Uniform Building Code (UBC): Section 2312, Earthquake Requirements.

1.02 SUBMITTALS

A. Shop Drawings:

1. Descriptive product information.
2. Dimensional drawings.
3. Itemized bill of material.
4. Protective device time-current characteristics on transparencies.
5. Operational description.
6. Installation instructions.
7. Bus data.
8. One-line, three-line, and control schematic drawings.
9. Connection and interconnection drawings.
10. Conduit entrance locations.

B. Quality Control Submittals:

1. Operation and maintenance manual.

1.03 UL COMPLIANCE

A. Products manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. UL listing mark for Category ”A” enclosure requirements of ANSI C37.20.2, Appendix A.

1.04 PACKING AND SHIPPING

A. Shipping Splits: As shown to facilitate ingress of equipment to final installation location within the building.

1.05 SPARE PARTS

A. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and materials:

1. 2 Each-Spare fuse, both power and control, of every size and type used.
2. 5 Each-Switchgear indicating lamps.
3. 2 Each-Indicating lamp pullers.
4. 2 Each-Color caps of each color for indicating lamps.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. GE.

B. No “or-equal” or substitute products will be considered.

2.02 GENERAL

A. Furnish switchgear that is the product of a single manufacturer. Assembled units with component parts of several manufacturers will not be acceptable with the exception that such minor items as terminal blocks, test switches, fuses, wiring, etc., may be manufactured by others.

B. Design, test, and assemble in accordance with ANSI C37.04, C37.06, and C37.20.2, and NEMA SG4.

C. Suitable for 4800 volts (4.8kV), three-phase, three-wire electrical service having an available short-circuit current shall be the same as existing sections.

D. All indicator lights shall be LED type.

2.03 STATIONARY STRUCTURE

A. Type:Indoor switchgear consisting of fuse, transition, and auxiliary sections assembled to form a rigid, self-supporting, metal enclosed structure.

B. Material: 11-gauge minimum cold-rolled steel, formed with reinforced steel members.

2.04 ENCLOSURE

A. Finish: Baked enamel applied over a rust-inhibiting, phosphated base coating.

1. Color: Match existing color.

B. Indoor Enclosure:

1. NEMA 250, Type 1, with formed edges on hinged and nonhinged panels.
2. Rear, full height, bolt-on panels for each enclosure section.
3. Cable Termination Access: Padlock provision.
4. All lights shall be LED type.

2.05 BUS BARS AND INTERCONNECTIONS

A. Continuous Current Rating: 600 amperes with sufficient cross-section to limit temperature rise at rated current to 55 degrees C.

B. Main Bus:

1. Totally enclosed by metal plates.

C. Ground Bus:

1. Material: Same as main bus.

2.06 CONTROL TRANSFORMER

A. Type: Insulated dry indoor.

B. Rating:

1. 4,800/240/120-volt, single-phase, three-wire with two 2-1/2 percent taps above, and two 2-1/2 percent taps below, normal voltage.

2.07 TERMINAL BLOCKS

A. Rating: 600 volts, 30-ampere minimum.

B. Type:

1. One-piece barrier with strap screws.
2. Shorting type for current transformer leads.
3. Pull-apart control wiring terminal boards on drawout units.

2.08 CONTROL WIRING

A. NFPA 70, Type SIS, single-conductor, Class B, stranded copper, rated 600 volts for control, instrumentation, and power circuits.

B. Individual seven-strand, copper conductors, twisted and covered with a 100 percent aluminum, polyester shield with tinned copper drain wire and overall outer jacket, rated 600 volts, 90 degrees C minimum for transducer output and analog circuits.

C. Conductor Lugs: Preinsulated, self-locking, spade type with reinforced sleeves.

D. Wire Markers: Each wire individually identified with permanent markers at each end.

E. Internal circuit wiring crossing shipping splits to have plug connectors.

F. Splices: Not permitted.

2.09 METERS AND INSTRUMENTS

A. As shown on drawings and match existing sections.

2.10 EQUIPMENT IDENTIFICATION

B. Master Nameplate:

1. Deep etched aluminum with manufacturer's name and model number.
2. Riveted to main vertical section.

C. Section Identification:

1. Match existing section.

D. Nameplate:

1. Match existing section.

2.11 FACTORY TESTING

E. Switchgear assembly production tested in accordance with ANSI C37.20.2.

F. Circuit breakers production tested in accordance with ANSI C37.09.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions and recommendations.

B. Secure equipment to floor with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Install equipment plumb and in longitudinal alignment with wall.

D. Tighten current-carrying bolted bus connections and enclosure framing and panel bolts to manufacturer's recommendations.

E. Coordinate terminal connections with installation of secondary feeders.

3.02 FIELD QUALITY CONTROL

A. In accordance with Section 16950, ELECTRICAL TESTING.

3.03 MANUFACTURER'S SERVICES

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

1. 2 person-days for installation assistance
2. 1 person-days for prestartup classroom or site training.
3. 1 person-days for facility startup.

B. See specification 16950 for testing.

END OF SECTION

SECTION 16440

PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:

1. Power distribution panelboards.
2. Lighting panelboards.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01340, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Manufacturer's product data on panelboards and enclosures.

1.03 QUALITY ASSURANCE

A. Codes and Standards:

1. UL Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards," and UL's 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories, and enclosures. Provide panelboard units which are UL listed and labeled.

2. NEMA Compliance: Comply with NEMA Standards Pub/No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," Pub/No. PB 1, "Panelboards," and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."

3. Federal Specification Compliance: Comply with FS W-P-115, "Power Distribution Panel," pertaining to panelboards and accessories.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. General Electric Company.

2. Square D Company.

2.02 PANELBOARDS

A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; with design and construction in accordance with published product information. Equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.

B. Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, and types shown; with anti-turn solderless pressure type main lug connectors approved for use with copper conductors. Select unit with feeders connecting at top of panel. Equip with tin-plated aluminum, or silver- or tin-plated copper bus bars braced for 50,000 rms symmetrical amperes fault current, and with full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide as indicated, either molded-case bolt-on main and branch circuit breakers for each circuit with toggle handles that indicate when tripped, or bolt-on fusible switches for main and branch circuits. Where multiple pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards.

C. Lighting Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, and types shown; with anti-turn solderless pressure type lug connectors approved for use with copper conductors. Construct unit for connecting feeders at top of panel; equip with copper bus bars, full-sized neutral bar with bolt-in type heavy-duty, quick-make quick-break, single pole circuit breakers, and toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards. Panelboards and circuit breakers shall be braced for 22,000 rms symmetrical amperes fault current unless otherwise indicated.

D. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges and door swings as indicated. Equip with interior circuit directory frame and card with clear plastic covering. Provide baked gray enamel finish over a rust-inhibitor coating. Design enclosures for recessed or surface mounting as indicated. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.

E. Molded-Case Circuit Breakers: Provide factory assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings, including rms symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in an ambient temperature of 40 degrees C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.

F. Ground Fault Protected Breakers: Provide UL Class A protected GFI breakers with 6 mA for personnel protection, and for general-purpose receptacles. For breakers dedicated to equipment (sump pumps, heat trace, etc.), provide breaker with 30 mA equipment protection.

G. Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, ground-fault protection units or circuit breaker locking hardware as indicated.

H. Spares: In each panelboard provide eight (8) installed, single pole, 20A spare circuit breakers unless otherwise indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF PANELBOARDS

A. Type out panelboard's circuit directory card upon completion of installation Work.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI): C2, National Electrical Safety Code (NESC).
2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.02 SUBMITTALS

A. Shop Drawings:

1. Product Data:
   a. Exothermic weld connectors.
   b. Mechanical connectors.
   c. Compression connectors.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 - PRODUCTS

2.01 GROUND ROD

A. Material: Copper clad.

B. Diameter: Minimum 3/4 inch.

C. Length: 30 feet.

2.02 GROUND CONDUCTORS

A. As specified in Section 16120, CONDUCTORS.

2.03 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Utilize low-smoke, low-emission process.
3. Manufacturers:
   a. Erico Products, Inc.; Cadweld amd Cadweld Exolon.
   b. Thermoweld.
   c. Or equal.

B. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Manufacturers:
   a. Burndy Corp.
   b. Thomas and Betts Co.
   c. Or equal.

2.04 GROUNDING WELLS

A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

B. Manufacturers:

1. Christy Co.; No. G5.
2. Lightning and Grounding Systems, Inc.; I-R Series.
3. Or equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Grounding shall be in compliance with NFPA 70 and ANSI C2.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed non-current-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

E. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

F. Shielded Control Cables:

1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
3. Do not ground control cable shield at more than one point.

G. Mechanical type connections will be allowed in applications where exothermic type connections are not practical.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to non current-carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.03 MOTOR GROUNDING

A. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to non current-carrying grounding bus.
B. Connect all new frame grounds to currently installed building grounding grid system.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

3.05 GROUNDING WELLS

A. Install inside buildings, asphalt, and paved areas.

B. Install riser ring and cover flush with surface.

C. Place 9 inches crushed rock in bottom of each well.

3.06 CONNECTIONS

A. General:

1. Above grade Connections: Use either exothermic weld or mechanical-type connectors; or brazing.
2. Below grade Connections: Install exothermic weld connectors unless otherwise noted.
3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
4. Notify ENGINEER prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each.

B. Ground Rod Floor Protrusion: 4 to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all non current-carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 4/0 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.

B. Bond neutrals of substation transformers to substation grounding grid and system grounding network via neutral grounding resistor.

C. Bond neutrals of pad-mounted transformers to four locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.10 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

3.11 INSTRUMENT GROUND - SURGE SUPPRESSION

A. Connect all instrument surge protection with #6 insulated copper ground wire (in conduit where above grade) to closest plant ground system

3.12 BONDING

A. Bond to Main Conductor System:

1. All roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.
2. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.
3. Provide air terminals as required.

B. Bond steel columns or major framing members to grounding system per National Electrical Code.

C. Bond each main down conductor to grounding system.

3.13 GROUNDING SYSTEM

A. Grounding Conductor (Counterpoise):

1. Completely encircle building structure.
2. Bury minimum 30” below finished grade.
3. Minimum 2 feet distance from foundation walls.

B. Interconnect ground rods by direct-buried copper cables.

C. Connections:

1. Install ground cables continuous between connections.
2. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and non-accessible connections.
3. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
4. Use bolded offset parapet bases or through-roof concealed base assemblies for air terminal connections.
5. Provide interconnections with electrical and telephone systems.
6. Provide electric service arrestor ground wire to building water main.

3.14 FIELD QUALITY CONTROL

A. As specified in Section 16950, ELECTRICAL TESTING.
B. Ground test shall be witnessed by the County and shall be measured 5 ohms or less.

END OF SECTION

SECTION 16461

PADMOUNTED TRANSFORMERS (2500 kVA and below)

PART 1 - GENERAL

1.01 SCOPE

A. This specification shall cover mineral oil immersed three phase pad-mounted transformers of low silhouette design, 2500 kVA, or below with ratings noted below or as shown on the drawings.

B. The equipment to be furnished shall be designed, built and tested in accordance with the latest revision of all applicable standards of IEEE, NEMA, and ANSI. Transformer shall be designed for outdoor application at altitudes not to exceed 3,300 feet, in an ambient not exceeding 50 degrees C and average ambient for any 24—hour period not exceeding 40 degrees C.

1.02 RATINGS

A. The ratings of the transformer(s) shall be as follows or as shown on the drawings:

kVA:	As shown on drawings.
Frequency :	60 hertz
Impedance:	ANSI % *(+7.5%* tolerance)
Primary Voltage:	As shown on drawings Δ connected
Primary Taps:	*+2~2 @ 2.5%*
Primary BIL:	95 kV
Secondary Voltage:	480 volts Y connected
Secondary BIL:	30 kV

B. The transformer shall carry its continuous rating with average winding or temperature rise by resistance that shall not exceed 65 degrees C.

1.03 GENERAL CONSTRUCTION

A. The transformer tank and terminal compartment shall be bolted together to form an integral unit of the outdoor weather—resistant type. The terminal compartment shall be completely enclosed with one high voltage and one low voltage compartment door. There shall be no bolts, screws, or other fastening devices which are externally removable, with the exception of hexhead bolts for security, that provide access to the energized parts within the enclosure. The enclosure shall be tamper—resistant design meeting the requirements of ANSI C57.12.28 — 1988 “Pad-mounted Equipment — Enclosure Integrity for Switchgear and

Transformers”

B. Full height, air—filled incoming and outgoing terminal compartments with hinged doors shall be located side by side, separated by an isolating barrier. The doors shall be attached with stainless steel hinges and hinge pins and incorporate a three point latching mechanism operated by the low voltage door handle, with door stops on both doors to secure doors during servicing. To facilitate making connections and permit cable pulling, the doors and compartment hood shall be removable. A removable door sill shall be provided to permit rolling or skidding the unit into place over conduit stubs in foundation.

C. The high voltage compartment shall be on the left, and shall be accessible only after the door to the low voltage compartment has been opened. The high voltage compartment shall enclose the high voltage bushings or bushing wells and provide for incoming cable from below. The high voltage equipment shall be arranged for the type of feed as shown on the drawings.

D. The pad-mounted transformer shall be manufactured by ABB, Cutler_Hammer, Square-D, or GE.

PART 2 - PRODUCTS

2.01. STANDARD ACCESSORIES

A. The unit shall be equipped with the following standard accessories.

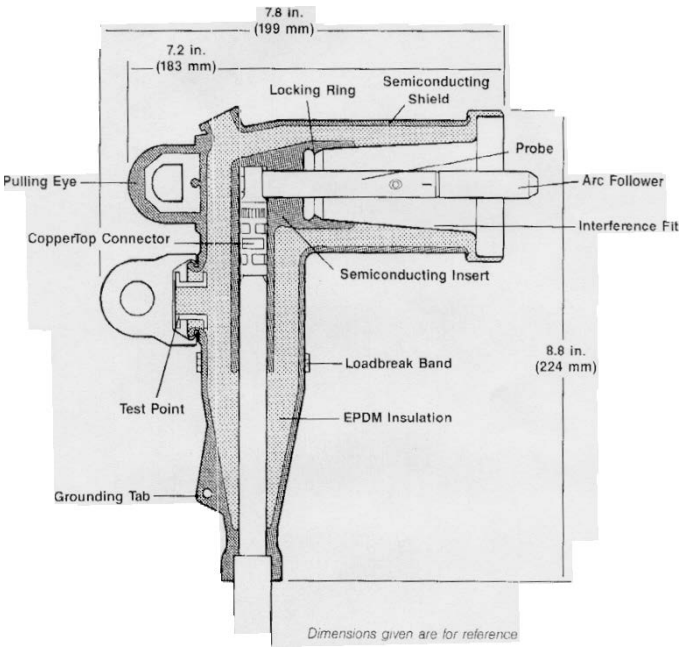
1. A weather cover over the cabinet is to be provided with additional hold down hardware to secure it more firmly to the cabinet.
2. Four lifting hooks.
3. Bolted—on terminal compartment 18 inches deep with removable front sill.
4. Hinged, lift—off cabinet doors.
5. Interlocked hex—head bolt/padlock handle to operate a cam assembly which is to be part of the three point door latching mechanism.
6. Tank ground pads (1 in HV - 1 in LV).
7. Steel high/low voltage compartment barrier.
8. Two 1/2 inch hex-head bolts which must be removed from the steel high/low barrier before the HV door can be opened.
9. Nameplate — A durable metal nameplate made of corrosion—resistant material and conforming to ANSI/IEEE C57.12.00 — 1980 affixed to each transformer.
10. Oil level/fill plug and oil drain plug.
11. Self—actuating pressure relief device to relieve slow pressure build—up shall be provided that will automatically vent when pressure reaches l0(±2) PSI and recloses when pressure falls to 6 PSI.

12. Removable neutral ground strap.
13. Five—legged core/coil assembly suitable for grounded WYE—grounded WYE connections, DELTA-ground WYE connections or DELTA—DELTA connections as required.
14. Handhole cover bolted onto tank top (protected by weather cover).

15. Tap changer handle for de—energized operation only.
16. Drain valve with sampling device.
17. Liquid level gauge.
18. Dial type thermometer.
19. Provision for pressure vacuum gauge.
20. Lightning arrester mounting pads (live front only).

2.02. HIGH VOLTAGE TERMINATIONS

A. DEAD FRONT construction, with externally clamped high voltage epoxy bushing wells with loadbreak 200 ampere inserts. Contractor to provide loadbreak elbows for the size and type cable shown on the drawings.



200A, 15 kV Class
Loadbreak Elbow
Connector

2.03 HIGH VOLTAGE SWITCHING

A. Oil immersed switching

1. Designed for pad-mounted transformers enabling an operating person to quickly isolate a line fault in a loop feed system, while maintaining full service continuity.
2. Available in 200 300 400 and 600 amp, hook stick operable. Available at the following ratings, as defined by ANSI Standard C37.72, 1987, American National Standard Requirements for Manually—operated, Dead Front Pad-mounted Switchgear with Load Interrupting Switches and Separable Connectors for Alternating—Current Systems.
3. The electrical characteristics of each rating:

Ratings	200A – 300A	400A	600A
Maximum Voltage:			
10(Line —Ground)	21.9 kV	15.5 kV	8.3 kV
Impulse Withstand Voltage	125-150 kV	150 kV	95 kV
Continuous and Interrupting Current	200-300 A	400 A	600 A
Momentary & Making Current:			
(Sym)	l0 kA	l6 kA	10 kA
(RMS)(Asym)	16 kA	25.6 kA	10 kA
60 Hz Withstand Voltage:			
Design	70 kV	60 kV	35 kV
Production	50 kV	40 kV	34 kV
Corona Extinction Voltage (RMS)	26 kV	19 kV	11 kV
Mechanical Operations	500 +	500 +	500 +

2.04. HIGH VOLTAGE FUSING

A. The high voltage shall include the following:

1. **Partial range current limiting fuses** consisting of internal, oil immersed, block mounted fuses mounted inside the tank. Either the protective expulsion fuse link (1) or the bayonet expulsion fuse link (2) must be connected in series with the partial range current limiting fusing for complete system protection.
2. Two (2) spare fuses per transformer shall be provided to the OWNER.

B. Fuses to have continuous current ratings sized per the manufacturer's recommendation for the indicated kVA, impedance and primary voltages.

2.05. HIGH VOLTAGE SURGE ARRESTERS

A. Dead front — The transformer shall be designed as loop—feed, but utilized as radial—feed with second set of wells used for dead front arresters. Provide dead front metal oxide varistor elbow arresters.

B. Dead front — Underoil surge arresters shall be of the metal oxide type of the Distribution Class, installed in the tank and block mounted underoil.

C. Live Front — Surge arresters shall be of the metal oxide type of the Distribution Class, installed in the high voltage compartment and appropriately grounded.

2.06. LOW VOLTAGE TERMINATIONS

A. The low voltage compartment shall be arranged for cabling from below. Three line bushings and one insulated neutral bushing with an externally removable ground strap shall be supplied. The bushings shall be supplied with spade type terminations and standard NEMA spacing and drilling.

B. Externally clamped low voltage epoxy or polyester bushings with threaded copper studs and NEMA four hole rotatable spades (45 to 500 kVA), NEMA eight hole rotatable spades (750 to 2500 kVA).

2.07. ENCLOSURE & FINISH INTEGRITY

A. The enclosure shall be designed to meet the requirements of ANSI C57.12.28 — 1988 "Pad-mounted Equipment — Enclosure Integrity for Switchgear and Transformers". To comply, all tank, cabinet, and fin steel shall be shot—blasted prior to application of the protective finish to comply. The finish process should include an epoxy primer and a final urethane coat. The total, film thickness applied shall be 3.0 MIL thickness as determined by testing per U.P.A. Technology MINIDERM S-100A standard.

B. The paint finish shall be capable of passing a 1500 hours Salt Spray test per ASTM B117 and Federal Specification TT—P—141 with NO blistering and passing method 6061 with less than 1/16 inch underfilm corrosion.

C. The paint finish shall be capable of passing a 1000 hours Humidity test with 98% relative humidity at 45 C, ±1 C with no blistering.

D. The paint finish shall be capable of passing a direct impact test per ASTM D—2794 for values greater than 160 in—lbs. and also capable of passing a crosshatch—tape adhesion test.

E.. The paint finish shall be capable of passing oil resistance tests of three days immersion at room temperature and three days immersion at 100^0C with no apparent effect. The paint color shall be GREEN 7GY/3.29/1.5MUNSELL.

PART 3 - EXECUTION

3.01 TESTING PROGRAM

A. The following tests shall be made on all transformers. The numbers shown do not necessarily indicate the sequence in which the tests shall be made. All tests shall be made in accordance with the latest revision of ANSI Standard Test Code C57.12.90, where applicable.

B. Transformers shall pass the following routine electrical tests:

12.2.1 Ratio Test
12.2.2 Demagnetization Test
12.2.3 Applied Voltage Test of High Voltage
12.2.4 Applied Voltage Test of Low Voltage
12.2.5 400 Hertz Induced Voltage Test
12.2.6 Iron loss and Exciting Current Test
12.2.7 Impedance and Load loss Test
12.2.8 Full Wave Impulse Test.

C. Transformers shall pass a Mechanical Leak and Pressure Test on tank and coolers

D. The following ANSI basic design tests are to be made on a sufficient number of transformers and ratings to demonstrate compliance with these standards. Design tests are not required to be repeated unless the design of the transformer is changed so as to modify the reliability of predicated results.

12.4.1 Short circuit
12.4.2 Audible sound level
12.4.3 Temperature rise
12.4.4 Power factor

E. Certified copies of actual loss data for the standard tests and test data on basic design shall be provided to the engineer.

3.02 QUALITY

A. Transformers addressed by this specification are subject to a quality program which establishes requirements to assure that the transformers provided by the vendor will comply with Industry Standards or this specification.

B. This specification covers three phase pad-mounted transformers, 2500 kVA, or below with ratings noted on page 1 or as shown on the drawings.

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END OF SECTION

SECTION 16485

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and incidentals required, and install, place in operation and field test variable frequency drive(s) (VFD's).

B. The variable frequency drive shall be a space vector Pulse-Width Modulated (PWM) design. Modulation methods which incorporate "gear-changing" techniques are not acceptable. The final responsibility of distributor or packager modifications to a third-party standard product will reside with the VFD manufacturer. The VFD manufacturer shall have overall responsibility for the drives. All drives shall be supplied by one manufacturer. The VFD shall be manufactured within the United States of America to alleviate concerns of future serviceability and parts availability.

C. VFDs shall be six-pulse drives with line and load reactors, except VFDs for Process Areas 30 and 50. VFDs for Process Areas 30 and 50 shall be 18-pulse drives. Refer to 2.02A.8 for the power unit rating requirements of the VFD.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Pumps, General

B. Section 16050 - Motors

C. Division 13 - Instrumentation

1.03 QUALITY ASSURANCE

A. The entire VFD system as described in section 2.01B shall be factory assembled and system tested by the VFD manufacturer to assure a properly coordinated system.

B. Codes: Provide equipment in full accordance with the latest applicable rules, regulations, and standards of:

1. Local Laws and Ordinances.
2. State and Federal Laws.
3. National Electric Code (NEC).
4. Underwriters Laboratories (UL).
5. American National Standards Institute (ANSI).

6. National Electrical Manufacturers Association (NEMA).
7. Institute of Electrical and Electronics Engineers (IEEE).

C. The complete drive system shall be UL listed.

D. Acceptable Manufacturers:

1. Square D.
2. Allen-Bradley.
3. Cutler-Hammer.

1.04 SUBMITTALS

A. Submittals shall conform in all respects to Section 01340 SHOP DRAWINGS, WORKING DRAWINGS, AND SAMPLES.

B. Submittals shall be custom prepared by the VFD manufacturer for this specific application.

C. Submittal information shall include, but not be limited to:

1. Equipment dimensions, including stub-up locations, shipping splits and shipping weights.
2. Catalog cuts of major components.
3. Spare parts list, per Paragraph 3.03.
4. Certifications, including:
   a. Warranty, per section 1.04.
   b. Efficiencies, per section 2.02.A.1.
5. Harmonic Distortion Analysis, per section 2.01D.

1.05 WARRANTY

A. All equipment furnished under this section shall be warranted for on site parts and labor by the contractor and the equipment manufacturers for a period of five (5) years after completion of startup.

PART 2 - PRODUCTS

2.01 Material and Equipment

A. Any modifications to a standard product required to meet this specification shall be performed by the VFD manufacturer only. Distributor or system integrator changes to the VFD manufacturer's product are specifically disallowed.

B. The VFD system shall consist of a power factor correction / harmonic filter unit, input rectifier-grade phase-shifting transformer, 18 pulse converter section, output

inverter and control logic section, harmonic filtering unit, 3% input line reactor, and 3% output filter. All components listed including power factor correction / harmonic filter shall be integral to the VFD lineup, factory wired and tested as a complete system. The entire VFD system shall meet the requirements of NEC article 409 and IEEE 508A for fault current withstand ratings as indicated on the project electrical drawings.

C. Input circuit breaker, interlocked with the enclosure door, with through-the-door handle to provide positive disconnect of incoming AC power and shall be capable of being locked in the open position.

D. VFD system shall maintain a 0.95 minimum true power factor throughout the entire speed range.

2.02 VARIABLE FREQUENCY DRIVES

A. Ratings

1. The drive system shall be 96% efficient at full load and full speed and 95.5% efficient at 51% load and 80% speed. Losses to be utilized in drive system efficiency calculation shall include input transformer, harmonic filter and power factor correction if applicable, VFD converter and output filter if applicable. Auxiliary controls, such as internal VFD control boards, cooling fans or pumps, shall be included in all loss calculations.
2. Rated Input Power: 460 Volts 60 Hz, +10%, -5% at rated load, 3-phase.
   a. Voltage Dip Ride-Through: VFD shall be capable of sustaining continued operation with a 40% dip in nominal line voltage. Output speed may decline only if current limit rating of VFD is exceeded.
   b. Power Loss Ride-through: VFD shall be capable of a minimum 3 cycle power loss ride-through without fault activation.
3. Output Power: As required by motors supplied.
4. Ambient Temperature Range: 0 to 40°C.
5. Elevation: Up to 3300 feet (1000 meters) above MSL without derating.
6. Atmosphere: Non-condensing relative humidity to 95%.
7. AC Line Frequency Variation: +/- 3 Hertz.
8. Power Unit Rating Basis: 110% rated current continuous, 150% rated current for one minute, at rated temperature. If the power unit rating of the VFD does not meet the above requirements, provide VFD with one standard size larger than the nameplate motor horsepower.

B. Construction

1. The controller shall produce an adjustable AC voltage/frequency output. It shall have an output voltage regulator to maintain correct output V/Hz ratio despite incoming voltage variations.

2. The controller shall have a continuous output current rating of 100% of motor nameplate current.
3. The converter section shall be 18 pulse minimum utilizing diodes.
4. The inverter output shall be generated by IGBTs. Pulse Width Modulation strategy will be of the space vector type implemented to generate a sine-coded output voltage. 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. The inverters shall be able to sustain 1600 volt surges.
5. The controller(s) shall be suitable for use with any standard NEMA-B squirrel-cage induction motor(s) having a 1.15 Service Factor or with existing standard NEMA-B squirrel-cage induction motor(s) with nameplate data as shown on the plans. Provide drives with dV/dT output filters manufactured by Trans-Coil type KLC. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage and RPM) in the field.
6. The control logic section shall be fully digital and not require analog adjustment pots or fixed selector resistors. A power failure will not necessitate a reload of any drive parameter or configuration.
7. Minimum Starting Speed: When called to operate, the VFD shall amp to a minimum speed. The minimum speed shall be adjustable but initially set at 60% of maximum speed. The 4-20 mA speed signal from the PLC and potentiometer on the front of the drive shall modulate the signal between the minimum speed setpoint and the maximum output speed of the drive; i.e., at the 4 mA signal, the VFD shall run at the minimum speed. At the 20 mA signal, the VFD shall run at full speed. The potentiometer shall also adjust speed between the minimum speed setpoint and the maximum running speed. Below the minimum speed setpoint, the potentiometer shall have no effect.
8. All 18 pulse VFD’s shall be provided with 3% line and load reactors.

C. Basic Features

1. The door of each power unit shall include: a keypad with a manual speed device, "HAND / OFF / REMOTE" mode selector switch, "POWER ON" light, “VFD FAIL” light, VFD "RUNNING" light, fault reset pushbutton, “MOTOR OVER TEMPERATURE” light, “MOTOR HEATER ON” light, “ENCLOSURE OVER TEMPERATURE” light, “DRIVE LOCKOUT” light, CONTROL POWER ON light, START and STOP pushbuttons and a TEST / NORMAL selector switch. All lights shall be LED type.
2. The VFD shall include a customer selectable automatic restart feature. When enabled, the VFD shall automatically attempt to restart after a trip condition resulting from instantaneous overcurrent, overvoltage, out of saturation or overload. For safety, the drive shall shut down and require manual reset and

restart if the automatic reset/restart function (programmable for up to 3 attempts) is not successful within a customer programmable time period. Auto-Restart shall be programmable to allow for individual fault selection.

3. A door-mounted membrane keypad with integral 2-line minimum, 24-character LCD display shall be furnished, capable of controlling the VFD and setting drive parameters. The keypad shall include the following features:
   a. The digital display must present all diagnostic message and parameter values in English engineering units when accessed, without the use of codes.
   b. The digital keypad shall allow the operator to enter exact numerical settings in English engineering units. A user menu written in plain English (rather than codes) shall be provided in software in nonvolatile memory as a guide to parameter setting and resettable in the field through the keypad. Multiple levels of password security shall be available to protect drive parameters from unauthorized personnel. The drive set up parameters must be able to be transferred to new boards to reprogram spare boards.
   c. The following digital door-mounted keypad indications may be selectively displayed:
      1) Speed demand in percent.
      2) Output current in amperes.
      3) Output Frequency in hertz.
      4) Input voltage.
      5) Output voltage.
      6) Total 3-phase KW.
      7) Kilowatt hour meter
      8) Elapsed time running meter.
      9) RPM.
      10) DC bus voltage.
   d. VFD shall have the capability of communicating all information via a RJ-45 Ethernet port with a Quantum PLC.
   e. VFD parameters, fault log and diagnostic log shall be downloadable via a RJ-45 Ethernet port.
4. Refer to the VFD wiring diagram in the drawings for remote signals and alarms.

D. Enclosure

1. All VFD components shall be factory mounted and wired on a dead front, grounded, NEMA-12 Gasketed enclosure. If a free-standing enclosure is provided, it shall be suitable for mounting on a concrete housekeeping pad. Maximum enclosure dimensions for various VFD sizes shall be as follows:
   a. 150 HP: 75”W x 25”D x 94” H

b. 600 HP: 140”W x 35”D x 94” H

E. Protective Features and Circuits: The controller shall include the following alarms and protective features:

1. Instantaneous overcurrent and overvoltage trip.
2. Undervoltage and power loss protection.
3. Power unit overtemperature alarm and protection. Upon sensing an overtemperature condition, the VFD is to automatically trip.
4. Electronic motor inverse time overload protection.
5. Responsive action to motor winding temperature detectors or thermostatic switches. A dry contact (NC) input to the VFD is required.
6. When power is restored after a complete power outage, the VFD shall be capable of catching the motor while it is still spinning and restoring it to proper operating speed without the use of an encoder.
7. The VFD shall be protected from damage due to the following, without requiring an output contactor:
   a. Three-phase short circuit on VFD output terminals.
   b. Loss of input power due to opening of VFD input disconnecting device or utility power failure during VFD operation.
   c. Loss of one (1) phase of input power.
8. The VFD shall continue to operate at a reduced capacity under a single-phase fault condition.
9. The VFD shall be able to withstand the following fault conditions without damage to the power circuit components:
   a. Failure to connect a motor to the VFD output.
   b. VFD output open circuit that may occur during operation.
   c. VFD output short circuit that may occur during operation.
10. Three phase lightning and surge protection across the line input at each VFD. Lea Dynatec TVSS #GB-100.
11. Provide 120V motor heater power that is active when the motor is off and is off when the motor is active.

F. Parameter Settings

1. The following system configuring settings shall be provided and field adjustable, without exception, through the keypad/display unit. Except for Motor Nameplate Data, all parameters must be adjustable while the processor is on-line and the drive is running.
   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 HP.
7) Current limit, max.

b. VFD Configuration Parameters.
1) Independent accelerate/decelerate rates.
2) Max/Min speed (frequency)
3) Catch-a spinning load selection.
4) No load boost.
5) Full load boost.
6) Volts/Hertz ratio.
7) Overspeed trip.
8) Overload trip curve selection.
9) Overload trip time selection.

c. Automatic VFD Control.
1) PID utilizing an internal or external setpoint.
2) Three selectable critical speed avoidance bands with programmable bandwidths.
3) Auto start functions: On/Off, Delay On/Off. Operable from a 4-20mA signal or from the PID output, command, or feedback signal.
4) Speed Profile: Programmable entry and exit points.
5) Programmable loss of signal control: Stop, maintain last speed, or default to preselected setpoint.

2. All drive setting adjustments and operation parameters shall be stored in a parameter log which lists allowable maximum and minimum points as well as the present set values. This parameter log shall be accessible via a RJ-45 Ethernet port capable of communicating with a Quantum PLC as well as on the keypad display.

G. Input/Output Features

1. Two programmable analog inputs: VFD speed in, spare.
2. Three programmable analog outputs: VFD speed output, Drive (output) current in Amps, spare.
3. Two programmable digital inputs: Run, spare.
4. Ten programmable digital outputs: VFD fault, VFD running, VFD in remote, 6 spare.
5. One Pot input (three wire control, +10 V, wiper and common).
6. System Program providing built-in drive control or application specific configuration capability.

H. Diagnostic Features and Fault Handling

1. The VFD shall include a comprehensive microprocessor based digital diagnostic system that monitors its own control functions and displays faults and operating conditions.

2. A “Fault Log” shall be accessible via a RJ-45 Ethernet link capable of communicating with a Quantum PLC as well as line-by-line on the keypad display. The "FAULT LOG" shall record, store, display and output to a serial port upon demand, the following for the 64 most recent events:
    a. Date and time of day.
    b. Type of fault.
    c. All faults and events shall be stored and displayed in English, not fault codes.
3. A "HISTORIC LOG" shall record, store, and output via a RJ-45 Ethernet link port capable of communicating with a Quantum PLC upon demand, the following selectable control variables at 1 msec. intervals for the 58 intervals immediately preceding and the 20 intervals immediately following a fault trip:
    a. Torque demand.
    b. Torque command.
    c. Torque feedback.
    d. Torque error.
    e. Torque maximum.
    f. Current demand.
    g. Peak current.
    h. Motor current.
    i. DC bus voltage.
    j. Line voltage.
    k. Velocity demand.
    l. Velocity reference.
    m. PI min/max limit.
    n. Boost.
    o. VFD mode (Auto/Manual).

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. The VFD manufacturer shall provide as a minimum, the following quality assurance steps within his factory:

1. Incoming inspection of components and raw materials based on strategic supplier base and experience. Sampling plans based on MIL STD 105E.
2. MIL STD 45662 calibration system.
3. All products subject to 100% testing and final inspection; no sampling plans permitted.

3.02 PRE-DELIVERY TESTING COORDINATION

A. One VFD unit of each specified type and application shall be shipped to the pump manufacturer's test facility for complete operational testing. The VFD Manufacturer shall provide a qualified representative at the pump Manufacturer's test facility during testing. All costs incurred by the VFD Manufacturer to meet this requirement shall be included in the bid.

B. Certified test reports shall be submitted to the ENGINEER before the equipment is shipped to the project site.

3.03 STARTUP AND TRAINING

A. VFD manufacturer shall provide the services of a factory technician for startup assistance and training. Verification of VFD input harmonic voltage and current distortion limits specified must be verified as part of final startup and acceptance. If harmonic distortion requirements are not met, it is the responsibility of the VFD supplier to meet the specification at the supplier's expense. A recording type Fluke 41 or equivalent harmonic analyzer displaying individual and total harmonic currents and voltages must be utilized.

B. A 10% payment retainage will be released upon field test verification of harmonic specification requirements and final acceptance.

3.04 SPARE PARTS

A. The following spare parts shall be furnished:

1. Three of each type of fuse rated 460V or less.
2. Two of each type of converter power semiconductor.
3. Two of each type of inverter power semiconductor.
4. One of each type of type control printed circuit board and gate firing boards.
5. One keypad assembly.

3.05 FIELD QUALITY CONTROL

A. Functional Test:

1. Conduct on each VFD.
2. Inspect controller for electrical supply termination connections, interconnections, proper installation, and quiet operation.
3. Vibration Test: Complete assembly, consisting of motor, load, and flexible shafting, connected and in normal operation, shall not develop amplitudes of vibration exceeding limits recommended by current edition of Hydraulic Institute Standards. Where pumps and motors are separated by intermediate flexible shafting, measure vibration both at top motor bearing and at two points on top pump bearing, 90 degrees apart.
4. Record test data for report.

B. Performance Test:

1. Conduct on each VFD.

2. Perform under actual or approved simulated operating conditions.
3. Test for continuous 48-hour period without malfunction.
4. Demonstrate performance by operating the continuous period while varying the application load, as the input conditions allow, in order to verify system performance.
5. Record test data for report.

END OF SECTION

SECTION 16490

SOLID STATE REDUCED VOLTAGE STARTER

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide the solid state reduced voltage starter (SSRVS) as shown on the drawings and/or as specified herein. The SSRVS shall be microprocessor controlled suitable for use with three phase induction motors rated 600 VAC or less. It shall provide a closed loop current ramp for smooth and stepless motor acceleration and deceleration.

1.02 SYSTEM DESCRIPTION AND QUALIFICATIONS

A. The SSRVS shall be the product of a manufacturer who has produced SSRVS for a minimum of 10 years (consecutive).

B. The SSRVS shall be manufactured by
1. Benshaw, Inc., Redi-Start Micro Series
2. Square D
3. or Engineer approved equal

C. The SSRVS shall be U.L. labeled where U.L. has such a listing.

D. The SSRVS shall be designed, manufactured and tested to conform, where applicable, with the following industry standards and specifications:

1. ANSI
2. CSA
3. IEEE
4. UL
5. NEC
6. EEMAC
7. NEMA
8. OSHA

E. SSRVS performance requirements

1. Nominal operating ambient temperatures: 0 - 40 deg C (32 deg F to 104 deg F) with relative humidity of up to 95% (noncondensing).
2. Power: Operate with three phase AC power at nominal voltages 200 through 600 VAC.
3. Frequency: operates on 25 through 70 Hz.

4. Meet Uniform Building Code on Non-building structures, section 2338 for zone 1, 2, 3, and 4 requirements.

F. Design Criteria:

DESCRIPTION	SPECIFICATION
Horsepower	HP: as shown on plans
Power Ratings	500% for 30 sec. and 125% cont.
PIV	2.5 x line voltage or 1200 PIV min.
Starting Torque	0 to 100%
Ramp Time	0 to 120 seconds
Decel Time	0 to 60 seconds
Nominal ratings	200 through 600 VAC. 25 through 70 Hz. With frequency tracking within this range
Standard Insulation Test	2500 VAC minimum
Overall Efficiency	Average 99.7%
SCR Firing Technique	Hard Drive with "picket fence"
Transient Voltage Protection	DV/DT=s or SIOV=s
Diagnostics and LEDs	Power On Gate Power Micro Computer Fault SCR Condition LCD display (16 char. X two lines.)
Control Input	120 VAC or dry contact, 2/3 wire.

1.03 SUBMITTALS

A. The following drawings/information shall be supplied by the SSRVS manufacturer in the shop drawings and with the shipment of each starter:

1. Elementary wiring diagrams.
2. Wiring and interconnect diagrams.
3. Enclosure frontal elevation and dimension drawings.
4. Internal component layout diagrams
5. Available conduit entry and exit locations.
6. Instruction manuals required for proper operation of the SSRVS.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualification: The manufacturer of the SSRVS shall be a firm experienced in manufacturing the equipment as specified herein for this project and who has a record of successful in-service performance.

1.05 DELIVERY, STORAGE AND HANDLING

A. Handling and shipment of the equipment shall be in such a manner to prevent internal component damage, breakage, and denting and scoring of the enclosure finish.

PART 2 - PRODUCTS

2.01 GENERAL.

A. Provide SSRVS where and as shown on the plans and as described by one-line diagrams and/or equipment schedules.

B. The SSRVS assembly shall include the necessary interface relays, timers, and those additional items necessary for interface to the pumps controls as identified on the plans.

C. The complete SSRVS shall be rated for an available fault current of 100,000 asymmetrical.

2.02 ENCLOSURE CONSTRUCTION

A. The SSRVS enclosure shall be constructed as NEMA 12.

B. The dimensions of the over-all enclosure shall be maximum as shown on the plans and include a door mounted operator interface panel.

C. The enclosure shall include a lockable circuit breaker disconnect handle mechanism used to remove power from the SSRVS. Enclosure door shall be interlocked with the disconnect handle mechanism such that entry to the enclosure is prevented until power to the SSRVS is removed.

2.03 DISCONNECTS

A. The SSRVS package shall be supplied complete with a circuit breaker used as a means of removing line power from the starter as well as for short circuit protection.

B. The circuit breaker shall be supplied as shown on the drawings and as indicated within this section. Where no circuit breaker ratings are specified on the drawings or within this section, the circuit breaker shall be supplied to meet the normal standards of the manufacturer of the SSRVS. As a minimum, the circuit breaker shall conform to the requirements of the National Electric Code (NEC).

C. The disconnect shall be interlocked via the disconnect handle mechanism such that entry to any part of the enclosure is prevented until power to the SSRVS is removed.

2.04 BYPASS CONTACTORS

A. A bypass contactor shall be supplied. This bypass contactor shall bypass the SCRs of the SSRVS once the motor is up to speed. The effect of the bypass contactor during run shall eliminate the heat buildup resulting from the voltage drop across the SCRs of the SSRVS.

B. For SSRVS to be installed at wells, it is not the intent to use the bypass contactor also as a means of starting the motor.

2.05 SSRVS LOGIC CONTROL CONFIGURATION

A. Description

1. The SSRVS shall be supplied standard with programming buttons and local start/stop buttons on one main keypad with LCD display.

2. Standard starter control logic shall be located on a microprocessor-based PC card, which provides the sequential logic for the starter and gate signals to the power card, which is used to drive the SCRs.

3. Design control logic to perform timing required for operation of the SSRVS and bypass contactor while continuously monitoring motor and starter for faults. If a fault is detected, the control logic of the SSRVS shall provide fault indication via an LCD display. In the event of a fault condition, the control logic shall safely shut down the starter to disable the motor.

4. The PC cards of the SSRVS shall be interchangeable with other control logic cards on starters of a similar design.

B. Electrical

1. The logic control of the SSRVS shall incorporate a micro computer which consists of all circuitry required to drive the power semiconductors and provide motor and starter monitoring functions.

2. The SSRVS logic shall provide the following standard features:

a. Adjustable Ramp Time (0-120 seconds)
b. Adjustable Initial Current (50-400% of motor FLA)
c. Adjustable Max Current (200-600% of motor FLA)
d. Adjustable Decel Profile for Pumps
e. Line Phase Loss Detection
f. Adjustable Line Current Imbalance Detection (10-40%)
g. Adjustable Over/Under Line Voltage Protection (10-30%)
h. Up To Speed Indication
i. Line Phase Sequence Sensitivity or Insensitivity
j. Selectable Solid State Overload Class (10, 20, 30, None)
k. Selectable Motor Service Factor (1.0, 1.15, or 1.25)
l. Adjustable Motor Full Load Amperes
m. Adjustable Current Transformer Ratio
n. Battery "Backup" of Set Starter Parameters
o. Selectable Passcode Protection of Set Starter Parameters
p. Line Voltage Independent Operation
q. Line Frequency Tracking (25Hz Through 70Hz)
r. Instantaneous Overcurrent Detection
s. Shorted SCR Detection
t. Software Selectable (Via LCD) Relay Outputs
u. ""Revolving" Event Recorder (99 most recent events)
v. LCD Status Display

3. Standard features shall operate concurrently.

4. The following optional features shall be included with each SSRVS:

a. Selectable Automatic Energy Savings Feature
b. Over/Under Current Fault Protection used in pumping applications for indicating pump jam
c. Starts Per Hour Limiter
d. Elapsed Time Meter (Via LCD Display)
e. Time Between Starts Limiter

C. Software Selectable Relay Outputs

1. Two selectable relay outputs shall be provided with each SSRVS.

2. Relay outputs shall be selectable via LCD display.

3. Selectable relay outputs shall be from the following menu:

   a. Run
   b. Up To Speed
   c. Shorted SCR Trip
   d. Motor Thermal Overload Trip
   e. Motor Thermal Overload Warning
   f. Motor Thermal Overload Lockout
   g. SHT Fault Relay

4. The selectable relay outputs shall be in addition to one fixed general fault relay output. This general fault relay shall indicate any of the following faults:

   a. Line Phase Loss
   b. Line Phase Imbalance
   c. Low Three Phase Line
   d. Line Phase Sequence Change
   e. Motor Thermal Overload Trip
   f. Battery Backup Failure (Computer PC Card)
   g. Instantaneous Overcurrent
   h. Shorted SCR Fault
   i. Three Phase Line Frequency Deviation
   j. Control Power Failure
   k. Computer Error
   l. Up To Speed Fault (Stall Time Has Expired)

5. Contact ratings for output relays shall be rated 5 Amps inductive and 10 Amps resistive.

D. LCD Status Display

1. Each SSRVS shall have a keyboard/LCD display assembly designed to:
   a. Set or examine operating parameters.
   b. Provide starter status information.
   c. Provide real-time information about line current, voltage and frequency.
   d. Provide a means to start and stop the SSRVS.

2. The LCD display for the SSRVS shall be mounted on the door of the starter enclosure for viewing from the outside of the enclosure.

E. LED Indicators

1. The following LED indicators shall be provided for advisory status and fault annunciation:

a. Power On
b. Micro Computer Fault
c. SCR Gate Drive Power
d. SCR Condition

PART 3 - EXECUTION

3.01 SHIPPING AND HANDLING

A. All equipment parts shall be properly protected in accordance with Manufacturer requirements 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. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

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

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

E. All scratched or otherwise marred painted surfaces shall be touched-up after installation to match original finishes.

3.02 INSTALLATION AND STARTUP

A. The Manufacturer, through the Contractor, shall examine all areas and conditions under which the variable frequency drives, motors, and isolation transformers are to be installed. The Manufacturer shall notify the Contractor, in writing of conditions detrimental to the proper completion of the work. No work shall proceed until all unsatisfactory conditions have been corrected in a manner acceptable to the Manufacturer.

B. If there are any difficulties in installation or operation of the equipment due to the Manufacturer's design or fabrication, additional services shall be provided at no cost or expense to the Owner.

C. The Contractor shall be responsible for furnishing a Manufacturer's engineer to assist in installation, to inspect and adjust the equipment before initial service, and during startup. Testing, checkout, and start-up of the SSRVS shall be performed under the technical direction of the manufacturer's service engineer. Under no circumstances, are any portions of the drive system to be energized without authorization from the manufacturer's representative.

D. Install SSRVS's and motors in accordance with the equipment Manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of NEC, U.L. and NEMA standards, to insure that products fulfill requirements.

E. Tighten connectors and terminals, including screws and bolts, in accordance with equipment Manufacturer's published torque tightening values for equipment connectors. Where Manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in U.L. Standards 486A and B, and the National Electrical Code. The SSRVS enclosure shall not be used as a raceway for wiring unless a dedicated wiring space is provided. Wiring shall not run through or between components not served.

F. Prior to energization of SSRVS equipment, check with ground resistance tester, phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled. Check circuitry for electrical continuity, and for short-circuits, and ensure that direction of rotation of each motor fulfills requirements.

G. Provide equipment grounding connections for SSRVS equipment as indicated. Tighten connections to comply with tightening torques specified in U.L. Standard 486A to assure permanent and effective grounding.

H. Upon completion of installation of SSRVS equipment and electrical circuitry, energize SSRVS circuitry and demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest to demonstrate compliance.

3.03 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified Manufacturer's technical representative who shall adequately supervise the installation and testing of and start up of all equipment furnished under this Contract and instruct the Contractor's personnel and the Owner's operating personnel in its maintenance and operation as outlined in the General Conditions. The services of the

Manufacturer's representative shall be provided for the periods stated in the following schedule:

	INSTALLATION TRIP (DAYS)	OPERATION TRIP* (DAYS)	GUARANTEE PERIOD TRIP (DAYS)
For each Type of SSRVS	2	2	2

* During the operation trip, the Manufacturer shall instruct Owner's personnel.

A total of six (6) service days (48 hours) shall be provided by the Manufacturer's representative.

B. The Manufacturer's representative shall direct all final adjustments necessary for the drive system to meet all operational and performance requirements outlined herein.

C. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The Manufacturer's representative shall sign in and out at the office of the resident representative on each day of arrival at the project.

3.04 WARRANTY

A. Equipment furnished under this Section shall be guaranteed for two (2) years from the date of final completion.

B. Work shall include labor, materials, and travel time for necessary repairs at the job site.

END OF SECTION

SECTION 16503

POLES AND STANDARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Exterior lighting fixtures (luminaires) and brackets, which are required in connection with electrical poles and standards, are specified in Section 16500.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01340, Shop Drawings covering items included under this Section. Shop Drawing submittals shall include:
   1. Shop Drawings of electrical poles and standards, including mast arms and wire/cable connections which are custom work.
   2. Product Data: Submit manufacturer’s data on electrical poles, standards, and hardware. Include certified dimension Drawings for fabricated poles, standards, and mast arms, if any.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. UL Compliance: Comply with UL Standards, including UL 486A and B pertaining to electrical poles and standards. Provide lighting components and fittings which are UL listed and labeled.
   2. AASHTO Compliance: Comply with applicable requirements of American Association of State Highway and Transportation Officials Standard LTS-1, "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals."
   3. NEMA Compliance: Comply with NEMA Standards Pub/No's. LE 2 and TT 1 pertaining to electrical pole and standard units, materials, and installation.
   4. IES Compliance: Comply with applicable requirements of IES RP-8, "Roadway Lighting," and RP-20, "Parking Facilities Lighting."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering electrical poles and standards which may be incorporated in Work include:
   1. Standards:
      a. Appleton Electric Co.
      b. General Electric Co.
      c. Kirlin Company.
      d. Koppers Company.
      e. Lexington Standard Corp.
      f. Lighting Division, Harvey Hubbell, Inc.
      g. Spring City Electrical Mfg. Co.
      h. Sternberg Lanterns, Inc.
      i. Union Metal Mfg. Co.
      j. Westinghouse Electric Corp.

2.02 ELECTRICAL POLES AND STANDARDS

A. Poles and standards shall be suitable for 140 mph sustained wind with appropriate gust factor per applicable zone of installation as defined in the Florida Building Code. The contractor shall include with the shop drawing submittal, a pole wind loading calculation signed and sealed by a structural engineer registered in Florida showing that the proposed installations will meet the given wind loading requirement.

B. Fiberglass Lighting Standards: Provide fiberglass, raceway-type, lighting poles and standards, of sizes and types indicated, comprised of shafts and tenon joints. Equip with grounding connections readily accessible from handhole or transformer base access doors; and construct of the following materials and additional construction features:
   1. Material:
      a. Fiberglass.
   2. Configuration:
      a. Embedded type base and reinforcing sleeve with hand and cable entrance holes where indicated.
      b. Anchor base type with handhole and cover where indicated.
      c. Transformer base type with access door and cover.
   3. Fiberglass Lighting Standard Accessories: Provide accessories for fiberglass lighting standards, including anchor bolts, as recommended by lighting standard manufacturer, of sizes and materials needed to meet erection and loading application requirements.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 16670

LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Lightning Protection Institute (LPI): 175, Installation Standard.
2. National Fire Protection Association (NFPA): 780, Lightning Protection Code.
3. Underwriters Laboratories, Inc. (UL):
   a. 96, Standard for Safety Lightning Protection Components.
   b. 96A, Standard for Safety Installation Requirements for Lightning Protection Systems.

1.02 DESIGN REQUIREMENTS

A. Provide lightning protection system design for all of the following facilities:

1. New Process 20 Area.
2. New Process 30 Area.
3. New Process 50 Building Addition.

B. The work includes, but is not limited to, furnishing and installing air terminals, grounding conductors, connectors, fasteners, ground rods, and other materials necessary for a complete protective system.

C. Lightning protection system design to comply with all applicable provisions of LPI 175 and 176, UL 96 and 96A, and NFPA 780.

1.03 SUBMITTALS

A. Shop Drawings:

1. CADD Drawings:

   a. Lightning protection system layout.
   b. Component locations.

2. Detailed plans.
3. Down conductor.

4. Connecting conductor.
5. Bond strap.
6. Air terminals.
7. Fittings.
8. Connectors.
9. Ground rods.

B. Quality Control Submittals:

a. Field test report.

C. Contract Closeout Submittals: Submit to OWNER:

1. Ground Witness Certification-Form LPI-175A.
2. Post-Installation System Certification
3. UL 96 Master Label "C" Certification.

1.04 QUALITY ASSURANCE

A. Designer: Lightning protection system design shall be prepared by an LPI-certified designer or recognized lightning protection manufacturer.

B. Manufacturer: All system components shall be the product of a single manufacturer regularly engaged in the manufacturing of lightning protection components in accordance with LPI 176 and UL 96.

C. Installer: Lightning protection system shall be installed under the direct supervision of an LPI 175 Certified Master Installer.

D. Inspector: Final installation and grounding connection inspection of the System shall be performed by the owner representative or agent in accordance with LPI 177.

E. UL Compliance: Materials manufactured within scope of Underwriters Laboratories, Inc. shall conform to UL Standards and have an applied UL listing mark.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Thompson Lightning.

B. IPC Protection.

C. Erico Eritech Lightning Protection Systems.

D. Lightning & Grounding Systems, Inc.

2.02 GENERAL

A. Complete system shall bear UL 96 Master Label C.

B. System Material: Copper or high copper content, heavy-duty bronze castings, unless otherwise specified.

C. All material shall comply in weight, size, and composition for the class of structure to be protected as established by UL 96 and 96A.

2.03 AIR TERMINAL

A. Material: Solid copper rods, with tapered points.

B. Length: Sufficient to extend minimum 10 inches above object being protected.

C. UL 96 Label B applied to each terminal.

2.04 CONDUCTORS

A. Copper Cable: Bare medium hard-drawn stranded copper or stranded aluminum as required for the application, having 97.5 percent minimum conductivity.

B. Main Down Conductor: Per UL and NFPA criteria and based on building height.

C. Connecting Conductor: Secondary size per UL and NFPA criteria

D. Bonding Conductor: Flexible strap, minimum 3/4-inch wide by 1/8-inch thick.

E. All main down and connecting conductors shall bear the UL 96 Label A, applied every 10 feet.

2.05 CABLE FASTENER AND ACCESSORIES

A. Capable of withstanding minimum pull of 100 pounds.

2.06 FITTINGS

A. Heavy-duty Class II bolt pressure type.

B. Bolts, Screws, and Related Hardware: Stainless steel.

2.07 GROUND RODS

A. Material: Copper clad steel – 3/4” x 30’ long UL 469 listed..

2.08 GROUNDING CONNECTIONS

A. Welds: Exothermic process.

B. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.

C. Hardware: Stainless Steel.

2.09 CABLE CONNECTIONS AND SPLICERS

A. Welds: Exothermic process (underground).

B. Fasteners: Bolted clamp type, corrosion-resistant copper alloy (above grade).

C. Through-Roof Connectors: Straight or right angle with lead flashing washer and other appurtenances to match existing roofing system.

2.10 CONDUIT

A. Schedule 40 PVC, as specified in Section 16110, RACEWAYS.

PART 3 - EXECUTION

3.01 GENERAL

A. Workmanship to comply with all applicable provisions of LPI 175, UL 96 and 96A, and NFPA 780.

B. Installation of bare copper materials on aluminum surfaces will not be permitted.

C. Provide waterproof seal of all roof penetrations.

D. Install system in inconspicuous manner so that components blend with building aesthetics.

3.02 EXAMINATION

A. Verify conditions prior to installation. Actual conditions may require adjustments in air terminal and ground rod locations.

3.03 AIR TERMINALS

A. Supports: Brackets or braces.

B. Parapet Bracket Attachment: Lag or expansion bolts.

C. Secure base to roof surface with adhesive or pitch compatible with roofing bond.

D. Provide terminal flashing at roof penetrations.

E. Perimeter Terminals:

1. Maximum Spacing: 20 feet.
2. Maximum Distance From Outside Edge of Building: 2 feet.

F. Roof Ridge Terminals: Maximum spacing 20 feet.

G. Mid-Roof Terminals: Maximum spacing 50 feet.

3.04 CONDUCTORS

A. Conceal whenever practical.

B. Provide 1-inch PVC conduit in building walls or columns for main downleads and roof risers.

C. Support: Maximum spacing for exposed conductors.

1. Vertical and Horizontal: 3 feet.

D. Maintain horizontal and vertical conductor courses free from dips or pockets.

E. Bends: Maximum 90 degrees, with minimum 8-inch radius.

F. Install air terminal conductors on the structural roof surface before roofing composition is applied.

3.05 BONDING

A. Bond to Main Conductor System:

1. All roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.

2. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.
3. Provide air terminals as required.

B. Bond steel columns or major framing members to grounding system per National Electrical Code.

C. Bond each main down conductor to grounding system.

3.06 GROUNDING SYSTEM

A. Grounding Conductor:

1. Completely encircle building structure.
2. Bury minimum 30” below finished grade.
3. Minimum 2 feet distance from foundation walls.

B. Interconnect ground rods by direct-buried copper cables.

C. Connections:

1. Install ground cables continuous between connections.
2. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and nonaccessible connections.
3. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
4. Use bolded offset parapet bases or through-roof concealed base assemblies for air terminal connections.
5. Provide interconnections with electrical and telephone systems and all underground water and metal pipes.
6. Provide electric service arrestor ground wire to building water main.

3.07 FIELD QUALITY CONTROL

A. Isolate lightning protection system from other ground conditions while performing tests.

B. Resistance: Test ground resistance of grounding system by the fall-of-potential method.

1. Test Resistance to Ground: Maximum 5 ohms per National Electric Code.
2. Install additional ground rods as required to obtain maximum allowable resistance. Demonstrate to the County that 5 ohms are obtained. County shall witness the test.

C. Test Report:

1. Description of equipment tested.
2. Description of test.
3. Test results.
4. Conclusions and recommendations.
5. Appendix, including appropriate test forms.
6. Identification of test equipment used.
7. Signature of responsible test organization authority.
8. County witnessed 5-ohm test results.

END OF SECTION

SECTION 16950

ELECTRICAL TESTING

PART1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):
   a. 450, Recommended Practice for Maintenance, Testing, and Replacement of Large lead Storage Batteries for Generator Stations and Substations.
   b. C2, National Electrical Safety Code.
   c. C37.20.1, Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
   d. C37.20.2, Metal-Clad and Station-Type Cubicle Switchgear.
   e. C37.20.3, Metal-Enclosed Interrupter Switchgear.
   f. C62.33, Standard Test Specifications for Varistor Surge- Protective Devices.
2. American Society for Testing and Materials (ASTM):
   a. D665, Standard Test Method for Rust Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.
   b. DS77, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   c. D923, Standard Test Method for Sampling Electrical Insulating Liquids.
   d. D924, Standard Test Methods for A-Class Characteristics and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   e. D971, Standard Test Method for Interfacial Tension of 0.1 Against Water by the Ring Method.
   f. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   g. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   h. D1500, Standard Test Method for ASTM Color of Petroleum Products.
   i. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
   j. D1533, Standard Test Methods for Water in Insulating Liquids.

k. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.
l. D2285, Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin Against Water by the Drop-Weight Method.

3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
   b. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminators.
   c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   d. 95, Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.
   e. 118, Standard Test Code for Resistance Measurement.
   f. 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.
4. National Electrical Manufacturers Association (NEMA):
   a. AB 4, Guideline for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
   b. PB 2, Deadfront Distribution Switchboards.
   c. WC 7, Cross-Linked-Thermosetting-Polyethylene- Wire and Cable for the Transmission and Distribution of Electrical Energy.
   d. WC 8, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
5. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.

1.02 SUBMITTALS

A. Administrative Submittals: Submit 30 days prior to performing inspections or tests:

1. Schedule for performing inspection and tests.
2. List of references to be used for each test.
3. Sample copy of equipment and materials inspection form(s).
4. Sample copy of individual device test form.
5. Sample copy of individual system test form.

B. Quality Control Submittals: Submit within 30 days after completion of test:

1. Test or inspection reports and certificates for each electrical item tested.

C. Contract Closeout Submittals:

1. Operation and Maintenance Data:
   a. In accordance with Section 01730, OPERATING AND MAINTENANCE DATA.
   b. After test or inspection reports and certificates have been reviewed by ENGINEER and returned, insert a copy of each in operation and maintenance manual.

1.03 QUALITY' ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers, of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologists (NICET), or International Electrical Testing Association and having a minimum of 5 years testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA Title 29, Part 1907 criteria for accreditation of testing laboratories or a full Member Company of International Electrical Testing Association.

B. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

C. Test instrument calibration shall be in accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment are to be:

1. Scheduled with ENGINEER prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify ENGINEER at least 3 days prior to performing tests on energized electrical equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Tests specified in this section are to be performed in accordance with the requirements of Section 01650, FACILITY STARTUP.

B. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Set, test, and calibrate protective relays, circuit breakers, fuses, and other applicable devices in accordance with values established by the short circuit and coordination study as specified in Section 16015, ELECTRICAL SYSTEMS ANALYSIS.

E. Adjust mechanisms and moving parts for free mechanical movement.

F. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents.

H. Realign equipment not properly aligned and correct unlevelness.

I. Properly anchor electrical equipment found to be inadequately anchored.

J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of applicable moving parts.

M. Inform ENGINEER of working clearances not in accordance with NFPA 70.

N. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

O. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by ENGINEER, door and panel sections having dented surfaces.
5. Repair or replace, as determined by ENGINEER, poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
    a. Provide matching paint and touch up scratches and mars.
    b. If required due to extensive damage, as determined by ENGINEER, refinish the entire assembly.

P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

Q. Replace transformer insulating oil not in compliance with ASTM D923.

3.02 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.
8. Cleanliness and improper blockage of ventilation passages.
9. Verify that tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:
      1) Winding-to-winding.
      2) Winding-to-ground,
   b. l0-minute test duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
   c. Results temperature corrected in accordance with NETA ATS, Table 7.2.4.
   d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.03 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Power Cable No. 6 and Larger For:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.

c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
d. Color coding conformance with specifications.
e. Proper circuit identification.

2. Mechanical Connections For:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 10. 1, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.
4. Control Cables For:
   a. Proper termination.
   b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:

1. Insulation Resistance Tests:
   a. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.
   b. Evaluate ohmic values by comparison with conductors of same length and type.
   c. Investigate values less than 50 megohms.
   d. Utilize 1,000V dc megohmmeter for 600V insulated conductors.
2. Continuity test by ohmmeter method to ensure proper cable connections.

3.04 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.
4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 10.1.
6. Proper phase barrier material and installation.
7. Verify that fuse sizes and types correspond to one-line diagram.
8. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
   b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
   c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.05 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 70 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.
6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480- and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 10.2.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.

b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.

3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   f. Trip times shall be within limits established by NEMA AB 4, Table 5-3.
   g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4.

3.06 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually Check Current, Potential, and Control Transformers For:
   a. Cracked insulation.
   b. Broken leads or defective wiring.
   c. Proper connections.
   d. Adequate clearances between primary and secondary circuit wiring.
2. Verify Mechanically That:
   a. Grounding and shorting connections have good contact.
   b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests:

1. Current Transformer Tests:
   a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.
   b. Polarity test.
2. Potential Transformer Tests:
   a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 7.1.1 for 1 minute on:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.

3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

3.07 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify that meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.08 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control centers, panelboards, switchboards, and switchgear assemblies for proper connection and tightness.
2. Ground bus connections in motor control centers, panelboards, switchboards, and switchgear assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-Of-Potential Test:
   a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
   b, Main ground electrode system resistance to ground to be no greater than 5 ohms.
2. Two-Point Direct Method Test:
   a. In accordance with IEEE 81, Section 8.2. 1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

3.09 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 5 horsepower and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate Motor and Check For:
    a. Excessive mechanical and electrical noise.
    b. Overheating.
    c. Correct rotation.
    d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
    e. Excessive vibration.
5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:
    a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
        1) Motors above 200 horsepower for l0-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
        2) Motors 200 horsepower and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
    b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
2. Calculate polarization index ratios for motors above 200 horsepower. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.
5. Overpotential Tests:
    a. Applied dc voltage in accordance with IEEE 95.
    b. Limited to 4,000-volt motors rated 1,000 horsepower and greater.
    c. Test results evaluated on pass/fail basis.

3.10 AUTOMATIC TRANSFER SWITCHES

A. Visual and Mechanical Inspection:

1. Check doors and panels for proper interlocking.
2. Check connections for high resistance by low resistance ohmmeter.
3. Check positive mechanical and electrical interlock between normal and alternate sources.
4. Check for Proper Operation:
   a. Manual transfer function switch.
   b. Generator under load and nonload conditions.
   c. Auto-exerciser of generator under load and no-load conditions.
5. Verify settings and operation of control devices.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2 for each phase with switch CLOSED in both source positions.
   b. Phase-to-phase and phase-to-ground for 1 minute.
   c. Test values in accordance with manufacturer's published data.
2. Contact Resistance Test:
   a. Contact resistance in microhms across each switch blade for both source positions.
   b. Investigate values exceeding 500 micro-ohms.
   c. Investigate values deviating from adjacent pole by more than 50 percent.
3. Set and Calibrate in Accordance with Specifications:
   a. Voltage and frequency sensing relays.
   b. Time delay relays.
   c. Engine start and shutdown relays.
4. Perform Automatic Transfer Tests By:
   a. Simulating loss of normal power.
   b. Return to normal power.
   c. Simulating loss of alternate power.
   d. Simulating single-phase conditions for normal and alternate sources.
5. Monitor and Verify Operation and Timing Of:
   a. Normal and alternate voltage sensing relays.
   b. Engine start sequence.
   c. Timing delay upon transfer and retransfer.
   d. Engine cool down and shutdown.
   e. Interlocks and limit switch functions.
   f. Engine cool down and shutdown feature.

3.11 BATTERY SYSTEM

A. Visual and Mechanical Inspection:

1. Physical damage and electrolyte leakage.
2. Evidence of corrosion.
3. Intercell bus link integrity.
4. Battery cable insulation damage and contaminated surfaces.
5. Operating conditions of ventilating equipment.
6. Visual check of electrolyte level.

B. Electrical Tests:

1. Measure:
   a. Bank charging voltage.
   b. Individual cell voltage.
   c. Electrolyte specific gravity in each cell.
   d. Measured test values to be in accordance with manufacturer's published data.
2. Verify During Recharge Mode:
   a. Charging rates from charger.
   b. Individual cell acceptance of charge.
3. Load tests for integrity and capacity; test values in accordance with ANSI 450.

3.12 LOW VOLTAGE SURGE ARRESTORS

A. Visual and Mechanical Inspection:

1. Adequate clearances between arrestors and enclosures.
2. Ground connections to ground bus or electrode.

B. Electrical Tests:

1. Varistor Type Arrestors:
   a. Clamping voltage test.
   b. Rated RMS voltage test.
   c. Rated dc voltage test.
   d. Variator arrester test values in accordance with ANSI C62.33, Sections 4.4 and 4.7.

3.13 STANDBY AND EMERGENCY GENERATOR SYSTEMS

A. Visual and Mechanical Inspection:

1. Proper grounding via neutral grounding resistor.
2. Blockage of ventilating passageways.
3. Proper operation of jack water heaters.
4. Integrity of engine cooling and fuel supply systems.
5. Excessive mechanical and electrical noise.
6. Overheating of engine or generator.
7. Proper installation of vibration isolators.
8. Proper cooling liquid type and level.
9. Operate Engine-Generator and Check For:
    a. Excessive mechanical and electrical noise.
    b. Overheating.
    c. Correct rotation.
    d. Check resistance temperature detectors or generator inherent thermal protectors for functionability and proper operation.
    e. Excessive vibration.
10. Verify that voltage regulator and governor operation will cause unit speed and output voltage to stabilize at proper values within reasonable length of time.
11. Proper operation of meters and instruments.
12. Compare generator nameplate rating and connection with one-line diagram.
13. Verify engine-generator operation with adjustable frequency drives energized and operating under normal load conditions.

B. Electrical and Mechanical Tests:

1. Cold start test by interrupting normal power source with test load consisting of connected building load to verify:
    a. Transfer switch operation.
    b. Automatic starting operation.
    c. Operating ability of engine-generator.
    d. Overcurrent devices capability to withstand inrush currents.
2. Phase rotation tests.
3. Test Engine Protective Shutdown Features For:
    a. Low oil pressure.
    b. Overtemperature.
    c. Overspeed.
4. Vibration base-line test on generator sets rated above 250 kW; levels in accordance with manufacturer's recommendations.

5. Load bank test with reactors and resistors adjusted to 80 percent power factor for each load step. Record voltage, frequency, load current, oil pressure, and engine coolant temperature at 15-minute intervals:
    a. 25 percent applied load for 30 minutes.
    b. 50 percent applied load for 30 minutes.
    c. 75 percent applied load for 30 minutes.
    d. 100 percent applied load for 3 hours.
    e. Load test results to demonstrate ability of unit to deliver rated load for test period.
6. One-Step Rated kW Load Pickup Test:
    a. Perform test immediately after performing load bank test.
    b. Apply rated load, minus largest rated horsepower motor, to generator.
    c. Start largest rated horsepower motor and record voltage drop for 20 cycles minimum with high-speed chart recorder or digital storage oscilloscope.
    d. Compare voltage drop with maximum allowable voltage dip for specified starting situation.

3.14 THERMOGRAPHIC SURVEY

A. Provide a thermographic survey of connections associated with incoming service conductors, bus work, and branch feeder conductors No. 2 and larger at each:

1. Medium voltage switchgear and transformer.
2. Switchboard.
3. Low voltage motor control center.
4. Panelboard.

B. Provide a thermographic survey of feeder conductors No. 2 and larger terminating at:

1. Motors rated 30 horsepower and larger.
2. Medium and low voltage disconnect switches.
3. Transfer switches.
4. Engine-generators.

C. Remove necessary enclosure metal panels and covers prior to performing survey.

D. Perform with equipment energized during periods of maximum possible loading.

E. Do not perform survey on equipment operating at less than 20 percent of rated connected operating load.

F. Utilize Thermographic Equipment Capable Of:

1. Detecting emitted radiation.
2. Converting detected radiation to visual signal.
3. Detecting 1 degree C temperature difference between subject area and reference point of 30 degrees C.

G. Temperature Gradients Of:

1. 3 degrees C to 7 degrees C indicates possible deficiency that warrants investigation.
2. 7 degrees C to 15 degrees C indicates deficiency that is to be corrected as time permits.
3. 16 degrees C and above indicates deficiency that is to be corrected immediately.

H. Provide Written Report Of:

1. Areas surveyed and the resultant temperature gradients.
2. Locations of areas having temperature gradients of 3 degrees C or greater.
3. Cause of heat rise and actions taken to correct the cause of heat rise.
4. Detected phase unbalance.

3.15 MEDIUM VOLTAGE TESTING

A. Engage the services of a recognized independent testing firm to inspect and test the installed equipment prior to energization. The testing firm shall provide all material, labor, equipment and technical supervision to perform the tests and inspection. Notify the ENGINEER at least two weeks prior to scheduling any testing.

B. Equipment testing and inspection shall be performed before energizing the switchgear in accordance with the latest NETA Standard ATS and shall include the following:

a. Visual and mechanical inspection.
b. Phasing check.
c. Ratio and polarity tests on current and voltage transformers.
d. Ground resistance test.
e. Current injection test on each circuit.
f. Insulation resistance tests (phase-to-phase and phase-to-ground).
g. Over potential test on each bus section (phase-to-ground).
h. Meter calibration.
i. Circuit breaker contact resistance test.
j. Insulation power factor and resistance test for surge arresters.

C. In the event of an equipment fault, notify the ENGINEER immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the CONTRACTOR, the ENGINEER, the OWNER and the equipment manufactures factory service technician. Repair of replace the equipment as directed by the ENGINEER and OWNER prior to placing the equipment back into service.

D. Adjustment:

a. The switchgear manufacturer shall provide the services of a factory trained service technician for 16 hours. The first trip shall be coordinated with the field testing. The second trip shall include any necessary follow-up or punch list work, and technical instruction for the OWNER'S designated personnel. The manufacturer's service technician shall demonstrate all operational features of the installed switchgear.
    i. As part of demonstration the operational features, utility power loss shall be done on an individual phase basis, in addition to all three phases.
b. The switchgear manufacturers factory service technician shall make the following test and adjustments:
    i. Calibrate and test all protective relays and controls.
    ii. Adjust and lubricate circuit breaker operating mechanisms and contacts.

END OF SECTION

APPENDIX A

LIST OF APPROVED PRODUCTS

ORANGE COUNTY UTILITIES
LIST OF APPROVED PRODUCTS
(February 11, 2011)

APPENDIX D **LIST OF APPROVED PRODUCTS - TRANSMISSION SYSTEMS** **FEBRUARY 11, 2011**

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	Comments
Air Release	ARV Enclosure	**All ARV above ground enclosures shall be vented with tamper proof locking device**						
		Water Plus Polyethylene Enclosure	131632 H30-B	Blue 44" Tall	131632 H30-P	Pantone 44"	131632 H30-G	Green 44" Tall
			171730 H40-B	Blue 30" Tall	171730 H40-P	Pantone 30"	171730 H40-G	Green 30" Tall
		Hot Box Vent Guard Fiberglass Enclosure	AVG2036 Encl GP3232 Base	Blue 36" Tall	AVG2036 Encl GP3232 Base	Pantone 36" Tall	AVG2036 Encl GP3232 Base	Green 36" Tall
			AVG2041 Encl GP3232 Base	Blue 41" Tall	AVG2041 Encl GP3232 Base	Pantone 41" Tall	AVG2041 Encl GP3232 Base	Green 41" Tall
		Safety-Guard/Hydro Guard	15100 Encl	Blue 34" Tall	15100 Encl	Pantone 34" Tall	15100 Encl	Green 34" Tall
	Air Release Valves	**Air Release Valves shall be Combination Type, 316 SS**						
		ARI	D-040SS	Combination	D-040SS	Combination	D-020 (SS)	Combination
		H-TEC	NA	NA	NA	NA	986 (316SS)	Combination
		Vent-O-Mat	Series RBX DN50	2"	Series RBX DN50	2"	RGX series	
	ARV Vault	**Air Release Valve Frame and Cover**						
		US Foundry	NA	NA	NA	NA	USF 7665-HH-HJ	
Blow Off	Auto Blow Off	**Automatic Blow Off Valve**						
		Hydro Guard	HG-1 Standard Unit	Automatic	NA	NA	NA	NA
	Blow Off Valve	**Blow Off Valve - Fits standard 5-1/4 inch Valve Box**						
		Kupferle Foundry Co	Truflo Series TF #550		Truflo Series TF #550		NA	NA
		Water Plus Corp	The Hydrant Plus Series VB 2000B		The Hydrant Plus Series VB 2000B		NA	NA
Casing Seals / Spacers	Casing End Seals	**Casing End Seals. Annular space between pipe and steel casing shall be brick and mortar with end seals to secure ends.**						
		Advance Products	Model AC and AW		Model AC and AW		Model AC and AW	
		BWM Company	Model WR and PO		Model WR and PO		Model WR and PO	
		Cascade Water Works	Model CCES		Model CCES		Model CCES	
		CCI Pipeline	Model ESW and ESC		Model ESW and ESC		Model ESW and ESC	
		Pipeline Seal & Insulator, Inc (PSI)	Model C and W		Model C and W		Model C and W	
		Power Seal	Model 4810ES		Model 4810ES		Model 4810ES	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Casing Seals / Spacers	Casing spacer	**Casing spacers shall be a min. 8-inches wide for pipe 12" Dia or less or min. 12-inches wide for pipe 16 or greater , shall have a minimum 14 gauge 304 stainless steel shell/band, minimum 10 gauge 304 reinforced risers; minimum thickness of 0.090 EPDM or PVC interior liners, glass reinforces polymer or ultra high molecular weight polyethylene and 304 stainless bolts, nuts and washers.**						
		Advance Products	SSI8 / SSI12		SSI8 / SSI12		SSI8 / SSI12	
		BWM Company	BWM-SS-8 / SS-12		BWM-SS-8 / SS-12		BWM-SS-8 / SS-12	
		Cascade Water Works	Series CCS 8" / 12"		Series CCS 8" / 12"		Series CCS 8" / 12"	
		CCI Pipeline	Model CCS8 / CSS12		Model CCS8 / CSS12		Model CCS8 / CSS12	
		Pipeline Seal & Insulator, Inc (PSI)	Series S8G-2 / S12G-2		Series S8G-2 / S12G-2		Series S8G-2 / S12G-2	
Coatings	Exterior Coatings for Exposed Metal Assets	**Coatings: Aerial pipe, hydrants, above ground piping, fittings, valves and Appurtenances - System 1 Zinc / Urethane / Fluoropolymer application and color code per Section 3119 Coatings & Linings. Coating shall not be in contact with Potable water unless NSF 61 approved.**						
		Carboline	Carbozinc 621	3.0 - 8.0 mils	Carbozinc 621	3.0 - 8.0 mils	Carbozinc 621	3.0 - 8.0 mils
			Carbothane 133 HB	3.0 -5.0 mils	Carbothane 133 HB	3.0 -5.0 mils	Carbothane 133 HB	3.0 -5.0 mils
			Carboxane 950	2.0 - 3.0 mils	Carboxane 950	2.0 - 3.0 mils	Carboxane 950	2.0 - 3.0 mils
		Tnemec	Zinc Series 90-97	2.5 - 3.5 mils	Zinc Series 90-97	2.5 - 3.5 mils	Zinc Series 90-97	2.5 - 3.5 mils
			Typoxy Series 27WB	4.0 -14.0 mils	Typoxy Series 27WB	4.0 -14.0 mils	Typoxy Series 27WB	4.0 -14.0 mils
			EnduraShield Series73	2.0 - 3.0 mils	EnduraShield Series73	2.0 - 3.0 mils	EnduraShield Series73	2.0 - 3.0 mils
			Hydroflon Series 700	2.0 - 3.0 mils	Hydroflon Series 700	2.0 - 3.0 mils	Hydroflon Series 700	2.0 - 3.0 mils
	Exterior Coatings for Exposed Metal Assets	**Coatings: Aerial pipe, hydrants, above ground piping, fittings, valves and Appurtenances - System 2 Zinc / Epoxy / Urethane application and color code per Section 3119 Coatings & Linings. Coating shall not be in contact with Potable water unless NSF 61 approved.**						
		Carboline	Carbozinc 621	3.0 - 8.0 mils	Carbozinc 621	3.0 - 8.0 mils	Carbozinc 621	3.0 - 8.0 mils
			Carboguard 60	4.0 -6.0 mils	Carboguard 60	4.0 -6.0 mils	Carboguard 60	4.0 -6.0 mils
			Carboxane 950	2.0 - 3.0 mils	Carboxane 950	2.0 - 3.0 mils	Carboxane 950	2.0 - 3.0 mils
		Tnemec	Zinc Series 90-97	2.5 - 3.5 mils	Zinc Series 90-97	2.5 - 3.5 mils	Zinc Series 90-97	2.5 - 3.5 mils
			Typoxy Series 27WB	4.0 -14.0 mils	Typoxy Series 27WB	4.0 -14.0 mils	Typoxy Series 27WB	4.0 -14.0 mils
			Hi-Build Epoxoline II Series N69	4.0 - 10.0 mils	Hi-Build Epoxoline II Series N69	4.0 - 10.0 mils	Hi-Build Epoxoline II Series N69	4.0 - 10.0 mils
			EnduraShield Series73	2.0 - 3.0 mils	EnduraShield Series73	2.0 - 3.0 mils	EnduraShield Series73	2.0 - 3.0 mils
		PPG / Ameron	Amercoat 68HS	Min 3.0 mils	Amercoat 68HS	Min 3.0 mils	Amercoat 68HS	Min 3.0 mils
			Amercoat 385	4.0 - 6.0 mils	Amercoat 385	4.0 - 6.0 mils	Amercoat 385	4.0 - 6.0 mils
			Amercoat 450H	2.0 - 3.0 mils	Amercoat 450H	2.0 - 3.0 mils	Amercoat 450H	2.0 - 3.0 mils

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Fittings	Fittings	**Ductile Iron Fittings C153 SSB / C110 FLG: (Water & Reclaimed Water fittings shall cement lined or holiday free fusion bonded epoxy lined) (Wastewater fittings interior shall be Protecto 401 and holiday free)**						
		American	30" & up	FBE / Cement	30" & up	FBE / Cement	30" & up	Protecto 401
		Sigma		FBE / Cement		FBE / Cement		Protecto 401
		Star		FBE / Cement		FBE / Cement		Protecto 401
		Tyler Union & Clow		FBE / Cement		FBE / Cement		Protecto 401
Flow	Flow Meter	**Flow Meters With Replaceable Sensors**						
		EMCO	NA	NA	NA	NA	Unimag 4411E	
Hydrants	Hydrants	**Hydrants Shall open left, 1-1/2 Pentagon operating nut, NST hose & pumper thread, rotate 360 degrees, closed drains, epoxy on shoe in & out and 304 SS nuts & bolts below ground.**						
		American Flow Control	B-84-B (6 inch)		NA	NA	NA	NA
		Clow	Medallion 2545		NA	NA	NA	NA
		Mueller	Super Centurion 250		NA	NA	NA	NA
Joint Restraints	Ductile iron pipe MJ Restraints	**Mechanical Joint Wedge-action Restraining Gland, Epoxy Coated Restrain ductile iron pipe to mechanical joint fittings, pipe and appurtenances.**						
		EBAA Iron Inc	Megalug Series 1100		Megalug Series 1100		Megalug Series 1100	
		Ford / Uni-Flange	UFR-1400		UFR-1400		UFR-1400	
		Sigma	OneLok Series SLD/SLDE		OneLok Series SLD/SLDE		OneLok Series SLD/SLDE	
		Smith Blair	Cam Lok Series 111		Cam Lok Series 111		Cam Lok Series 111	
		Star	Star Grip Series 3000		Star Grip Series 3000		Star Grip Series 3000	
		Tyler Union	TufGrip Series TLD		TufGrip Series TLD		TufGrip Series TLD	
	DIP Bell Joint Restraints (4"-12") (New & Existing)	**Bell Joint Restraints for Ductile Iron Pipe (4"-12") (New & Existing) - All restraints split serrated on bell and spigot ends. Pipe 16" and greater shall have restraint gaskets or locking bells. (Wastewater only for restraint of existing DIP FM)**						
		EBAA Iron Inc	Tru-Dual Series 1500TD		Tru-Dual Series 1500TD		Tru-Dual Series 1500TD	
		Ford / Uni-Flange	Uni-Flange Series 1390C		Uni-Flange Series 1390C		Uni-Flange Series 1390C	
		Sigma	PV-Lok Series PWP-C		PV-Lok Series PWP-C		PV-Lok Series PWP-C	
		Smith Blair	Bell-Lock Series 165		Bell-Lock Series 165		Bell-Lock Series 165	
		Star	StarGrip Series 3100S		StarGrip Series 3100S		StarGrip Series 3100S	
		Tyler Union	TufGrip-Series 300C		TufGrip-Series 300C		TufGrip-Series 300C	
	DIP Bell Joint Restraints (16" & Greater)	**Ductile Iron Pipe Bell Joint Restraints for Ductile Iron Pipe (16" & Greater) - All restraints shall have a split back-up ring for the bell and a serrated or wedge action gland for the spigot end. New installation for water & reclaimed water piping 16" and greater shall have restraint gaskets or locking bells.**						
		EBAA Iron Inc	Series 1100HD	Existing Only	Series 1100HD	Existing Only	Series 1100HD	Existing Only
		Sigma	Series SSLDH	Existing Only	Series SSLDH	Existing Only	Series SSLDH	Existing Only
		Star	Series 3100S	Existing Only	Series 3100S	Existing Only	Series 3100S	Existing Only

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Joint Restraints	Ductile iron pipe Bell Joint Restraint Gaskets and Locking Bell (4" & Above)	**Bell Joint Restraint Gaskets and Locking Bell (4" & Above) Stainless Steel locking wedges built into the gasket-rubber. ANSI/AWWA C111/A21.11 Standard for Rubber-Gasket Joints for Ductile Iron Pressure Pipe. Ductile Iron Bell Joint Restraint for Push-On Pipe- Locking bell joint system that prevents joint separation and allows for joint deflection. Bells shall be painted red to verify restrained gasket.**						
		American	Fast Grip Gasket	Gasket	Fast Grip Gasket	Gasket	NA	NA
			Flex-Ring Joint	Bell Lock	Flex-Ring Joint	Bell Lock	NA	NA
			Lok-Ring Joint	Bell Lock	Lok-Ring Joint	Bell Lock	NA	NA
		Griffin	Talon RJ Gasket	Gasket	Talon RJ Gasket	Gasket	NA	NA
			Snap-Lok	Bell Lock	Snap-Lok	Bell Lock	NA	NA
		McWane Inc. DI Pipe Group	Sure Stop 350 Gasket	Gasket	Sure Stop 350 Gasket	Gasket	NA	NA
			Thrust-Lock	Bell Lock	Thrust-Lock	Bell Lock	NA	NA
			TR-Flex	Bell Lock	TR-Flex	Bell Lock	NA	NA
			Super-Lock	Bell Lock	Super-Lock	Bell Lock	NA	NA
		US Pipe	Field Lok 350 Gasket	Gasket	Field Lok 350 Gasket	Gasket	NA	NA
			Field Lok Gasket	Gasket	Field Lok Gasket	Gasket	NA	NA
			TR-Flex	Bell Lock	TR-Flex	Bell Lock	NA	NA
			HP Lok Restraint Joint	Bell Lock	HP Lok Restraint Joint	Bell Lock	NA	NA
	SS to DIP Transition Restraint	**SS to DIP Transition Restraint -Flanged stainless steel pipe from Wetwell to Valve box restrained joint transition (epoxy coated, SS hardware) Flg x PE RJ.**						
		EBAA Iron Inc	NA	NA	NA	NA	Megaflange 2100	
		Sigma	NA	NA	NA	NA	SigmaFlange with One Lock SLDE	
		Smith Blair	NA	NA	NA	NA	911 Flange - Lock Restrained FCA	
	PVC Pipe MJ Restraints	**Mechanical Joint Wedge-action Restraining Gland, Epoxy Coated Restrain PVC pipe to mechanical joint fittings, and appurtenances.**						
		EBAA Iron Inc	Mega-lug Series 2000PV		Mega-lug Series 2000PV		Mega-lug Series 2000PV	
			NA	NA	NA	NA	Megalug Series 2200	(42"-48")
		Ford / Uni-Flange	UFR 1500 Series		UFR 1500 Series		UFR 1500 Series	
		Sigma	One Lok Series SLC/SLCE		One Lok Series SLC/SLCE		One Lok Series SLC/SLCE	
		Smith Blair	Cam Lok Series 120		Cam Lok Series 120		Cam Lok Series 120	
		Star	Star Grip Series 4000		Star Grip Series 4000		Star Grip Series 4000	
		Tyler Union	TufGrip Series TLP		TufGrip Series TLP		TufGrip Series TLP	
	PVC Bell Joint Restraints (4" - 12") (New & Existing)	**PVC Bell Joint Restraints: PVC pipe Split Serrated on Bell End and Spigot End. (4" - 12") (New & Existing)**						
		EBAA Iron Inc	Tru-Dual Series 1500TD		Tru-Dual Series 1500TD		Tru-Dual Series 1500TD	
		Ford / Uni-Flange	Uni-Flange Series 1390		Uni-Flange Series 1390		Uni-Flange Series 1390	
		Sigma	PV-Lok Series PWP		PV-Lok Series PWP		PV-Lok Series PWP	
		Smith Blair	Bell-Lock Series 165		Bell-Lock Series 165		Bell-Lock Series 165	
		Star	Series 1100C		Series 1100C		Series 1100C	
		Tyler Union	TufGrip 300C		TufGrip 300C		TufGrip 300C	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Joint Restraints	PVC Bell Joint Restraints (16" & Greater)	**PVC Bell Joint Restraints: (16" & Greater) PVC pipe Split Serrated on Bell End and Spigot End. Water & Reclaimed Water Existing pipe only. Wastewater shall be new and existing pipe.**						
		Ford / Uni-Flange	Series 1390	Existing Only	Series 1390	Existing Only	Series 1390	
		JCM	Sur-Grip Series 621	Existing Only	Sur-Grip Series 621	Existing Only	Sur-Grip Series 621	
		Sigma	PV-Lok PWP	Existing Only	PV-Lok PWP	Existing Only	PV-Lok PWP	
		Smith Blair	Bell-Lock Series 165	Existing Only	Bell-Lock Series 165	Existing Only	Bell-Lock Series 165	
		Star	Series 1100C	Existing Only	Series 1100C	Existing Only	Series 1100C	
Pipe	PVC C900 DR 18 Bell & Spigot (4" - 12")	**C900 Bell & Spigot PVC Pipe: 4 to 12-inch - AWWA C-900, Minimum DR18 for Water, Reclaimed and Wastewater. DR14 for Fire Lines. Manufacturers shall be members in good standing with Uni-Bell to maintain approval status.**						
		Certainteed 4" to 12"	Certa-Lok C900/RJ	Blue	Certa-Lok C900/RJ	Pantone Purple	Certa-Lok C900/RJ	Green
		Diamond Plastics Corp	C-900	Blue	C-900	Pantone Purple	Diamond C900	Green
		Ipex Inc	C-900 Blue Brute	Blue	C-900	Pantone Purple	C900 Blue Brute	Green
		JM Eagle	C-900	Blue	C-900	Pantone Purple	C-900	Green
		National Pipe & Plastics Inc	C-900 Dura- Blue	Blue	C-900	Pantone Purple	C-900 Pipe	Green
		North American Pipe Corp (NAPCO)	C-900	Blue	C-900	Pantone Purple	C-900	Green
		Sanderson Pipe Corp	C-900	Blue	C-900	Pantone Purple	C-900	Green
	PVC C905 DR 18 Bell & Spigot 16" and Larger	**C905 Bell & Spigot PVC Pipe 16" and Larger: AWWA C-905, Minimum DR18 for all Force Mains up to 24". Minimum DR21/DR25 for 30" and greater. Manufacturers shall be members in good standing with Uni-Bell to maintain approval status.**						
		Certainteed 16"	NA	NA	NA	NA	Certa-Lok C905/RJ	NA
		Diamond Plastics Corp	NA	NA	NA	NA	Trans-21 DR18	Green
		Ipex Inc	NA	NA	NA	NA	IPEX Centurion	Green
		JM Eagle	NA	NA	NA	NA	C905 Big Blue	Green
		National Pipe & Plastics Inc	NA	NA	NA	NA	C905	Green
		North American Pipe Corp (NAPCO)	NA	NA	NA	NA	C905 Big Blue	Green
	HDPE C906 DR11	**HDPE Pipe DR11 AWWA C906 shall be Ductile Iron Pipe Size, PE 3408/3608/4710 DIPS manufactured in accordance with ASTM F-714 and listed with NSF. Pipe shall be marked in accordance with either AWWA C901,AWWA C906. Compression type connections are not acceptable in new installations. Pipe joints shall be butt fusion or electro-fusion with flange or adapter. All HDPE shall be color coded to the Utility. Color identifications are in accordance with the APWA/ULCC Uniform Color Code. Manufacturers shall be members in good standing with PPI to maintain approval status.**						
		JM Eagle	HDPE	DR11 Blue	HDPE	DR11 Pantone	HDPE	DR11Green
		Performance Pipe(Chevron)	Driscoplex 4000	DR11 Blue	Driscoplex 4000	DR11 Pantone	Driscoplex 4300	DR11 Green
		PolyPipe, Inc.	EHMW Poly Pipe	DR11 Blue	EHMW	DR11 Pantone	EHMW	DR11Green

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pipe	Ductile Iron Pipe	**Ductile iron/Cast iron: (4" to 12" = Class 350, 16" to 24" - Class 250, 30" to 64" = Class 200). Water and Reclaimed water shall be cement lined. Wastewater Piping shall be Protecto 401 and Holiday Free. Exterior coatings as specified. Wastewater DIP piping shall be for pump station piping only. Manufacturers shall be members in good standing with DIPRA to maintain approval status.**						
		American	Cement Lined	Blue	Cement Lined	Pantone Purple	Protecto 401	Pump Station
		Griffin	Cement Lined	Blue	Cement Lined	Pantone Purple	Protecto 401	Pump Station
		McWane Inc. DI Pipe Group	Cement Lined	Blue	Cement Lined	Pantone Purple	Protecto 401	Pump Station
		US Pipe	Cement Lined	Blue	Cement Lined	Pantone Purple	Protecto 401	Pump Station
Sample	Sample Station	**Sample Stations - Bacteriological Sample Station with built in flush system, all internal piping to be 2", brass and includes lockable green enclosures.**						
		Safety-Guard	SG-BSS-05 pedestal #77	green enclosure	NA	NA	NA	NA
		Water Plus Corp	Model 5000	green	NA	NA	NA	NA
Services	Brass Service Saddles	**Brass Service Saddles for 1" & 2" water & reclaimed water services on 4" through 12" Mains - Service saddles can be hinge or bolt controlled OD saddles to be used on C-900 and existing IPS OD PVC pipe.**						
		Ford	Series S-70, S-90	4"-12"	Series S-70, S-90	4"-12"	NA	NA
		AY McDonald	Model 3891 / 3895,3801 / 3805	4"-12"	Model 3891 / 3895,3801 / 3805	4"-12"	NA	NA
		Mueller	Series S-13000/H-13000	4"-12"	Series S-13000/H-13000	4"-12"	NA	NA
	Service Saddles	**Service Saddles for 1" (CC) & 2" (Iron pipe threads) Water & Reclaimed Water services on mains greater than 12". Service saddles for 2" taps (iron pipe threads) on 4" mains and greater for Waste Water. : Epoxy or nylon coated stainless steel 18-8-type 304 double straps, controlled O.D. saddles to be used on C-900 / C905 or DI for all 1-in and -2in taps on pipes over 12in.**						
		Ford	Series FC202	16" & greater	Series FC202	16" & greater	Series FC202	4" & greater
		JCM	Series 406	16" & greater	Series 406	16" & greater	Series 406	4" & greater
		Mueller	DR2S	16" & greater	DR2S	16" & greater	DR2S	4" & greater
		Romac	Series 202NS	16" & greater	Series 202NS	16" & greater	Series 202NS	4" & greater
		Smith Blair	Series 317	16" & greater	Series 317	16" & greater	Series 317	4" & greater
	Service Saddles for HDPE	**Service Saddles for 1" (CC) & 2" (Iron Pipe threads) Water and Reclaimed Water Services: Epoxy or nylon coated stainless steel 18-8-type 304 double straps, controlled O.D. saddles to be used on HDPE for all 1-in and -2in taps. Taps to HDPE pipe shall be approved on a case by case basis.**						
		Ford	Series FCP202		Series FCP202		Series FCP202	
		Romac	Series 202N-H		Series 202N-H		Series 202N-H	
		Smith Blair	Series 317-1 for HDPE		Series 317-1 for HDPE		Series 317-1 for HDPE	
	Corporation Stops Ball Type	**Corporation Stops Ball Type (1-inch with AWWA taper C threads only/pack joint outlet for CTS) 2" Corporation Stop Ball Type shall be 2" MIP X FIP threads.**						
		Ford	FB1000, FB1700-7		FB1000, FB1700-7		FB1700-7	2" ARV
		AY McDonald	4701B-22, 3149B2		4701B-22, 3149B2		3149B2	2" ARV
		Mueller	P25008, B-20046		P25008, B-20046		B-20046	2" ARV

APPENDIX D **LIST OF APPROVED PRODUCTS - TRANSMISSION SYSTEMS** **FEBRUARY 11, 2011**

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Services	Curb Stops	**Curb Stops - Straight Valves: Ball type compression 2" cts O.D. tubing by 2" FIP**						
		Ford	B41-777W		B41-777W		NA	NA
		AY McDonald	6102W-22		6102W-22		NA	NA
		Mueller	P25172		P25172		NA	NA
	Curb Stops	**Curb Stops - Straight Valves: ball type compression x compression**						
		Ford	B44-444W		B44-444W		NA	NA
		AY McDonald	6100W-22		6100W-22		NA	NA
		Mueller	P25146		P25146		NA	NA
	PE tubing	**Polyethylene tubing: AWWA C901. UV protection (SDR-9) 1-inch and 2-inch only. PE 3408 / PE 4710**						
		Charter Plastics	Blue Ice		Lav Ice		NA	NA
		Endot	Endopure Blue		Endocore Lavender		NA	NA
		JM Eagle	Pure-Core		NA	NA	NA	NA
Tapping Sleeves and Valves	Line Stops	**Line Stops**						
		JCM						
		Romac						
		Smith Blair						
	Tapping Sleeves	**Tapping Sleeves: (Mechanical joint for taps on cast iron, ductile iron, PVC & AC pipe, including size on size) with stainless steel nuts and bolts.**						
		American Flow Control	Series 2800		Series 2800		Series 2800	
			Series 1004		Series 1004		Series 1004	
		Clow	Series F-5205	DIP/PVC	Series F-5205	DIP/PVC	Series F-5205	DIP/PVC
			Series F-5207	A/C Pipe	Series F-5207	A/C Pipe	Series F-5207	A/C Pipe
		JCM	Series 414	FBE	Series 414	FBE	Series 414	FBE
		Mueller	Series H-615	DIP/PVC	Series H-615	DIP/PVC	Series H-615	DIP/PVC
			Series H-619	A/C Pipe	Series H-619	A/C Pipe	Series H-619	A/C Pipe
		Smith Blair	Style 623	FBE	Style 623	FBE	Style 623	FBE
	Tapping Valves: 12" and smaller	**Tapping Valves: 12" and smaller - Tapping Valves shall be furnished with an alignment lip and installed in the vertical position for Water and Reclaim Water. Wastewater shall be installed horizontally and abandoned in the open position. Tapping valves shall be resilient seated only and meet the requirements of AWWA C509 or C515**						
		American Flow Control	Series 2500	Alignment Lip	Series 2500	Alignment Lip	Series 2500	Alignment Lip
		Clow	Series F-6114	Alignment Lip	Series F-6114	Alignment Lip	Series F-6114	Alignment Lip
		Mueller	Series T2360 (4"-12")	Alignment Lip	Series T2360 (4"-12")	Alignment Lip	Series T2360 (4"-12")	Alignment Lip

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Tapping Sleeves and Valves	Tapping Valves: 16" and Larger	**Tapping Valves: 16" and Larger - Tapping valves shall be furnished with an alignment lip and be installed in the vertical position for Water and Reclaimed Water. No tapping valve shall be installed horizontally for Water and Reclaim Water unless approved by the engineer. Tapping Valves 16" and larger AWWA C515 resilient seated only (16" and 24" no gearing required) above 24" shall be installed vertically with a spur gear actuator unless noted by the engineer. All tapping valves above 24" shall be furnished with NPT pipe plugs for flushing the tracks when valves are installed horizontally. Tapping valves for Wastewater shall be installed horizontally and abandoned in open position.**						
		American Flow Control	Series 2500	Alignment Lip & flushing port	Series 2500	Alignment Lip & flushing port	Series 2500	Alignment Lip & flushing port
		Clow	Series F-6114	Alignment Lip & flushing port	Series F-6114	Alignment Lip & flushing port	Series F-6114	Alignment Lip & flushing port
		Mueller	Series T2361 (14"&up)	Alignment Lip & flushing port	Series T2361 (14"&up)	Alignment Lip & flushing port	Series T2361 (14"&up)	Alignment Lip & flushing port
Valves	Butterfly Valve 42" and Above	**Butterfly Valves 42"and above. AWWA C504. Actuators input torques based on 150 psi valve pressure and 16 fps velocity with a maximum input of 80 ft-lb on 2" nuts and shall withstand 250 ft-lbs. Valve seats shall be leak-tight in both directions at 150 psi.**						
		Clow	Style #1450		Style #1450		NA	NA
		Dezurik	BAW		BAW		NA	NA
		Mueller / Pratt	LINSEAL III / Groundhog		LINSEAL III / Groundhog		NA	NA
	Check Valves	**Valves (Check) 4-inch and Larger (8 mil epoxy lined)**						
		American Flow Control	NA		NA		Series 600 or 50 line	
		Clow / M&H / Kennedy	NA		NA		106	
		Mueller	NA		NA		Series 2600	
	Gate Valves 4" - 12"	**Gate Valves 12" and smaller - resilient seated only AWWA C509 or C515. Valve seat shall be leak-tight in both directions at 150 psi.**						
		American Flow Control	Series 2500		Series 2500		NA	NA
		Clow	Series F-6100		Series F-6100		NA	NA
		Mueller	Series A-2360		Series A-2360		NA	NA
	Gate Valves (Vertical) 16" and Up	**Gate Valves 16" and larger (Vertical Installation) AWWA C515 resilient seated only (16" and 24" no gearing required) above 24" shall be installed vertically with a gear actuator unless noted by the engineer. Valve seat shall be leak-tight in both directions at 150 psi.**						
		American Flow Control	Series 2500		Series 2500		NA	NA
		Clow	Series F-6100		Series F-6100			
		Mueller	Series A-2361		Series A-2361		NA	NA

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Valves	Plug Valves	**Plug Valves - Bi-directional, MJ & Flanged (min. 8mil fusion bonded epoxy with stainless steel bolts), gear operator to be sized for rated pressure of the valve. Valves 4"-20" shall be 80% Full Port and valves 24" and greater shall be minimum of 70% full port. Valve shall be factory tested to minimium 100 PSI in both directions.**						
		Clow	NA	NA	NA	NA	F-5412 FLG	4" & up
			NA	NA	NA	NA	F-5413 MJ	4" & up
		Dezurik	NA	NA	NA	NA	Series PEF or PEC	4"& up
		Millikan / Pratt	NA	NA	NA	NA	Eccentric / Ballcentric	4"& up
		Val-Matic	NA	NA	NA	NA	5600 or 5800 (FLG)	4" & up
			NA	NA	NA	NA	5700 or 5900 (MJ)	4" & up
Valve Boxes	Valve Boxes with Locking Lids (Cast Iron)	**Two piece standard screw type Heavy Duty Valve Boxes with Locking Lids (Cast Iron) and type of service cast in heavy duty traffic lid (H20 loading) ASTM A48**						
		Bingham/Taylor	Series 4905	Box	NA	NA	Series 4905	Box
			4905-X	Extension	NA	NA	4905-X	Extension
			4904-L	Blue Water Locking Lid	NA	NA	4904-L	Green Sewer locking Lid
		Sigma	Series VB 261X-267X	Box	VB-25031LK-VB-2612	Box	Series VB 261X-267X	Box
			VB 6302	Extension	VB-6302	Extension	VB 6302	Extension
			VB 4650W	Blue Water Locking Lid	VB2503LK	Purple Square Locking Lid	VB 4650S	Green Sewer locking Lid
		Star	Series VB-0002	Box	NA	NA	Series VB-0002	Box
			VBEX 12-24S	Extension	NA	NA	VBEX 12-24S	Extension
			VBLIDLOCK	Blue Water Locking Lid	NA	NA	VBLIDLOCK	Green Sewer locking Lid
		Tyler Union	Series 6850	Box	NA	NA	Series 6850	Box
			58, 59, 60	Extension	NA	NA	58, 59, 60	Extension
			Locking Lid	Blue Water Locking Lid	NA	NA	Locking Lid	Green Sewer locking Lid
	Valve Box	**For mains equal to, or greater than, 16" diameter or equal to greater than 6' feet deep**						
		American Flow Control	# 2A - 9A Retrofit Valve Box Insert	Fit inside std valve boxes	NA		2A - 9A Retrofit Valve Box Insert	Green Sewer locking Lid
		Mueller Company	MVB050C thru MVB130C with Extension Stem MVB875 Guide Plate	Blue Water Locking Lid	MVB050CR thru MVB130CR with Extension Stem MVB875 Guide Plate	Purple Square Locking Reclaim Lid	MVB050C thru MVB130C with Extension Stem MVB875 Guide Plate	Green Sewer locking Lid

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Coatings	Anti-Graffiti Paint	**Block Walls-Anti-Graffiti Paint per Section 3119 Coatings & Linings**						
		American Building Restoration Products	NA	NA	NA	NA	Polyshield Graffiti Preventer for Unpainted Masonry Type B	Super Bio Strip or Strip it all
		Tnemec / Chemprobe	NA	NA	NA	NA	626 DUR A PEL	680 Mark A Way
		Professional Products of Kansas, Inc	NA	NA	NA	NA	Professional Water Seal & Anti-Graffitiant (PWS-15 Super Strength)	Professional Phase II Cleaner
	Coatings for Existing Manholes	**Rehabilitation corrosion protection system per Section 3119 Coatings & Linings. Interior coating for force main connections to existing concrete manholes only. New precast structures and existing pump stations shall be lined.**						
		CCI Spectrum, Inc	NA	NA	NA	NA	Spectrashield	min of 500 mils
		Kerneos Aluminate Technologies	NA	NA	NA	NA	Sewpercoat	1" (1000mil)
		Raven Lining System	NA	NA	NA	NA	Raven 155 Primer Raven 405	min 8 mils min 125 mils
		Sauereisen	NA	NA	NA	NA	210 Series Topcoat Glaze 210G	min 125 mils min 20 mils
		Tnemec	NA	NA	NA	NA	Series 434 Topcoat Glaze 435	min 125 mils 15-20 mils
PVC Pipe and fittings	Pipe SDR 35 Gravity Mains	**PVC Pipe for Gravity SDR26/SDR 35 (Green in color) ASTM-D034. Manufacturers shall be members in good standing with Uni-Bell to maintain approval status.**						
		Certainteed	NA	NA	NA	NA	Gravity Sewer Pipe	
		Diamond Plastics Corp	NA	NA	NA	NA	Sani-21 SDR-35	
		JM Eagle	NA	NA	NA	NA	Gravity Sewer	
		National Pipe & Plastics, Inc.	NA	NA	NA	NA	Ever-Green Sewer Pipe	
		North American Pipe Corp (NAPCO)	NA	NA	NA	NA	Gravity Sewer	
		Sanderson Pipe Corp	NA	NA	NA	NA	Gravity Sewer	
	Locate Balls	**Locating Marker Systems - Wastewater Locator balls placed at all sanitary sewer cleanouts**						
		3M	NA	NA	NA	NA	3M™ EMS 4" Extended Range 5' Ball Marker 1404-XR	
	Fittings SDR 35	**Fittings, Adapters and Plugs - Gravity PVC ASTM-D3034, Min SDR26/ SDR 35**						
		GPK Products, Inc.	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	
		Harrington Corporation (HARCO)	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	
		Multi Fittings Corp.	NA	NA	NA	NA	SDR26/SDR 35 Trench Tough Sewer Fittings	
		JM Eagle	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	
		Plastic Trends Inc	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	
		TIGRE USA, Inc.	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
PVC Pipe a	Flexible Pipe Connectors	**Flexible Pipe Connectors and Transitions**						
		Fernco	NA	NA	NA	NA	1002, 1051, 1056 Series	
		Indiana Seal	NA	NA	NA	NA	102, 151, 156 Series	
		Mission Rubber	NA	NA	NA	NA	MR02, MR51, MR 56 Series	
Precast Concrete Structures	MH Lids	**Frame and Cover**						
		USF Fabrication Inc.	NA	NA	NA	NA	USF 225-AS	
	Adj Ring	**Top Adjusting Rings - HDPE with heavy duty loading (H-20)**						
		Ladtech, Inc	NA	NA	NA	NA	24R, 24S with Rope Sealant CS2455	
	Hatches	**Wet Well and Valve Vault Access Frames and Covers (Include the term "Confined Space" etched or cast into the cover with recessed lock & hasp. Frames and covers per manufacturers specifications.**						
		Halliday Products	NA	NA	NA	NA	S1R or S2R Series	
		USF Fabrication Inc.	NA	NA	NA	NA	APS or APD Series	
	Precast Concrete Structures	**Precast Manhole and Wetwell Structures ASTM C478. Precast concrete shall be batched with concrete dyed crystalline waterproofing admixture with corrosion protection. Concrete without admixture or without color tint /tracer shall be rejected.**						
		Allied Precast	NA	NA	NA	NA		Dyed Admix
		Atlantic Concrete Products, Inc.	NA	NA	NA	NA		Dyed Admix
		Delzotto Products, Inc.	NA	NA	NA	NA		Dyed Admix
		Dura Stress Underground Inc.	NA	NA	NA	NA		Dyed Admix
		Hanson Pipe & Product	NA	NA	NA	NA		Dyed Admix
		Mack Concrete	NA	NA	NA	NA		Dyed Admix
		Oldcastle Precast	NA	NA	NA	NA		Dyed Admix
		Standard Precast Inc.	NA	NA	NA	NA		Dyed Admix
	Concrete Admix	**Crystalline Waterproofing Concrete Admix with color dye shall be added to all concrete structures (precast and cast-in-place) to provide waterproofing and corrosion resistance. Concrete without admixture or without color tint / tracer shall be rejected. % concentration of admix with colored dye added to the mix shall be based on weight of cement.**						
		Kryton International	NA	NA	NA	NA	KIM K-301R (with red dye)	2%
		Xypex Chemical Corp	NA	NA	NA	NA	Xypex Admix C-1000Red (with red dye)	3.0 - 3.5%
	Liners	**Interior Liner for New or existing Precast Manhole and Precast Wetwell Structures per Section 3119 Coatings & Linings**						
		AFE	NA	NA	NA	NA	Fiberglass Liner	
		AGRU Liner	NA	NA	NA	NA	HDPE Liner (Min 2 mm for Manhole / Min 5 mm for Pump Station)	
		Containment Solutions Inc. (Flowtite)	NA	NA	NA	NA	Fiberglass Liner	
		GSE Studliner	NA	NA	NA	NA	HDPE Liner (Min 2 mm for Manhole / Min 5 mm for Pump Station)	
		GU Liner	NA	NA	NA	NA	Reinforced Plastic Liner	
		L & F Manufacturing	NA	NA	NA	NA	Fiberglass Liner	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Precast Concrete Structures	Heat Shrink Seal	**Heat Shrink Seal - Precast structures shall be primed with manufacturer approved primer prior to application of heat shrunk encapsulation.**						
		Canusa-CPS	NA	NA	NA	NA	Wrapid Seal with WrapidSeal Primer (Canusa G Primer)	
		Pipeline Seal & Insulator, Inc (PSI)	NA	NA	NA	NA	Riser Wrap with Polyken 1027 or 1039 primer	
	Jointing Material	**Jointing Material Min. 2" width for all products to ensure squeeze out with manufacturer approved primer.**						
		Henry Company	NA	NA	NA	NA	Ram-Nek	with Primer
		Martin Asphalt Company	NA	NA	NA	NA	Evergrip 990	with Primer
		Trelleborg Pipe Seals	NA	NA	NA	NA	NPC – Bidco C-56	with Primer
	Pipe Seals Gravity	**Resilient Connector Pipe Seals, Manhole - Gravity less than 12-inch and less than 15-ft deep**						
		Atlantic Concrete	NA	NA	NA	NA	A-Lok (cast-in-place)	
		Hail Mary Rubber	NA	NA	NA	NA	Star Seal (cast-in-place)	
		IPS	NA	NA	NA	NA	Wedge Style	
		NPC	NA	NA	NA	NA	Kor-N-Seal Model WS	
		Press seal gasket	NA	NA	NA	NA	PSX Direct Drive	
	Pipe Seals Gravity	**Cast in Place Pipe Seals, Manhole - Gravity Greater Than or Equal to 12-inch and all pipe sizes greater than 15-ft deep**						
		Atlantic Concrete	NA	NA	NA	NA	A-Lok	cast in place
		Hail Mary Rubber	NA	NA	NA	NA	Star Seal	cast in place
	FM Pipe Seals	**Modular Pipe Seals for Wet Well and Valve Box penetrations and all forcemain connections to existing and new precast concrete structures. EPDM Rubber with 316 SS Hardware**						
		CCI Pipeline Systems	NA	NA	NA	NA	Wrap-It Link WL-SS Series	
		Pipeline Seal & Insulator, Inc / Link Seal	NA	NA	NA	NA	Link-Seal S-316 Modular Seal	
		Proco Products, Inc	NA	NA	NA	NA	PenSeal ES-PS Series	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Generator	Gen	**Generator Systems, Fixed Shall be UL 2200 Certified.**						
		Caterpillar	NA	NA	NA	NA	CAT Diesel Generator Set	
		Cummins Power Generation	NA	NA	NA	NA	Diesel Generator Set	
	Fuel Tanks	**Generator Fuel Tanks. Shall be UL2085 certified.**						
		Convault	NA	NA	NA	NA	CVT-3SF or CVT-3FF	
		Phoenix	NA	NA	NA	NA	Envirovault	
	GR	**Generator Receptacle (GR)**						
		Cooper Crouse-Hinds	NA	NA	NA	NA	AR2042 (230V, 200A, 3P, 4W)	With AJA1 Angle Adaptor
		Cooper Crouse-Hinds	NA	NA	NA	NA	AR2042-S22 (460V, 200A, 3P, 4W)	With AJA1 Angle Adaptor
		Pyle National	NA	NA	NA	NA	JRE-4100 (230V, 100A, 3P, 4W)	
	ATS	**Generator Transfer Switch**						
		Russelectric	NA	NA	NA	NA	RMTD Series with model 2000 controller	NEMA 12/3R 316SS Enclosure
Odor Control Units	Biotrickling Filters	**Biotrickling filters**						
		BioAir	NA	NA	NA	NA		
		Biorem	NA	NA	NA	NA	Biosorbens BTF	
		Envirogen	NA	NA	NA	NA	BTF	
		Siemens	NA	NA	NA	NA	Zabocs BTF	
	Carbon Adsorption Units	**Carbon Adsorption Units**						
		Calgon	NA	NA	NA	NA		
		Pure Air Filtration	NA	NA	NA	NA		
		Siemens	NA	NA	NA	NA		
Pressure Gauges	Pressure Gauges	**Pressure Gauges shall have Diaphragm Seals. Oil filled.**						
		Ashcroft	NA	NA	NA	NA	10 1008SL 02L 60# 25 200SS 02T XYTSE	Gauge Diaphragm Seal
		Trerice	NA	NA	NA	NA	D83LFSS4002LA100 - Gauge M51001SSSS - Diaphragm Seal D99100 Fill and Mount Charge	
		Winter Gauges	NA	NA	NA	NA	PFQ770 0-60 PSI D70950 top D70954 Bottom	
Pumps	Pumps	**Submersible Pumps**						
		ABS	NA	NA	NA	NA		
		Flygt	NA	NA	NA	NA		

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pumps	Floats	**Float Regulator (FR) - Duplex and Triplex Pump Stations**						
		Atlantic Scientific	NA	NA	NA	NA		Roto-Float
	Radar	**Radar - Pulse Burst Radar Transmitter. Input 24 VDC and Output 4-20 mA**						
		Magnetrol	NA	NA	NA	NA		R82-520A-011
Pump Station Main Ser	Main Srvc Disconne	**Main Service Disconnect Breaker**						
		Square D	NA	NA	NA	NA		H or J Frame 3 Pole 600 Volt (HGL or JGL determined by amperage)
	Surge Protector Device	**Surge Protector - UL 1449, 3rd Edition listed and labeled, minimum 10 year warranty, NEMA LS-1 and IEEEC62, 41/45 tested with NEMA 4X enclosure, internal fusing, voltage and phase to match service. Rated 80,000 amps per mode for Duplex & Triplex stations and 150,000 Amperes per mode for Master Stations. All devices shall be provided with a NEMA 4X Plastic enclosure which is approved in lieu of stainless steel.**						
		Current Technology (Power & Systems	NA	NA	NA	NA		XN-80, TG-150 or CurrentGuard 150 Plus Series
		Josyln AKA (Total Protection Solutions)	NA	NA	NA	NA		TSS-ST 160 Series, ST 300 Series or JSP-300 Series
		Surge Suppressors, Inc	NA	NA	NA	NA		LSE Series or SHL Series
Sub Panel	Sub Panel	**Sub-Panel Enclosure - NEMA 12/3R Enclosure 316SS, white polyester Powder coated-finish inside and out, With 3 Point Pad lockable Handle, and Door Stop**						
		Hoffman	NA	NA	NA	NA		
		Schaefer	NA	NA	NA	NA		
		Universal enclosure systems	NA	NA	NA	NA		
Pump Station Control Panel	Control Panel	**Control Panel Supplier**						
		ECS	NA	NA	NA	NA		
		Sta-Con Inc	NA	NA	NA	NA		
	Enclosure	**Enclosure - NEMA 12/3R Enclosure 316SS, white polyester Powder coated finish inside and out, With 3 Point Pad lockable Handle, and Door Stop**						
		Hoffman	NA	NA	NA	NA		
		Schaefer	NA	NA	NA	NA		
		Universal enclosure systems	NA	NA	NA	NA		
	Mnts	**Mounting Channel for Enclosures**						
		Unistrut Stainless Steel	NA	NA	NA	NA		1" 5/8 x 1" 5/8 316 SS
	Seal-off	**Explosion-Proof Sealoff**						
		Cooper Crouse-Hinds	NA	NA	NA	NA		EYSR - 2 Inch Min.
	FL	**Flasher (FL)**						
		MPE	NA	NA	NA	NA		025-120-105
		SSAC	NA	NA	NA	NA		FS-126

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pump Station Control Panel	AL	**Alarm Light / With Base and Globe (AL)**						
		American Electric	NA	NA	NA	NA	F32552	
		Red Dot Globe	NA	NA	NA	NA	VGLR-01	
		Red Dot Base					VA-01	
	AH	**Alarm Horn (AH)**						
		Wheelock	NA	NA	NA	NA	3IT-115-R	
	Fuse	**Fuses (F)**						
		Bussmann	NA	NA	NA	NA	FNQ-R or KTK-R	
	HOA	**Hand-Auto-Off Selector (HOA)**						
		Square D	NA	NA	NA	NA	9001-SKS43B	
	HSS	**Horn Silence Button (HSS)**						
		Square D	NA	NA	NA	NA	9001-SKR1RH5	
	Inter-lock	**Mechanical Interlock**						
		Square D	NA	NA	NA	NA	S29354	
	Breakers	**Control Panel Main Circuit Breaker (MCB) With S29450 Circuit Breaker Auxiliary Switch**						
		Square D	NA	NA	NA	NA	H or J Frame 3 Pole 600 Volt (HGL or JGL determined by amperage)	
		Emergency Circuit Breaker (ECB) With S29450 Circuit Breaker Auxiliary Switch						
		Square D	NA	NA	NA	NA	H or J Frame 3 Pole 600 Volt (HGL or JGL determined by amperage)	
		Motor Circuit Breaker (MB)						
		Square D	NA	NA	NA	NA	H or J Frame 3 Pole 600 Volt (HGL or JGL determined by amperage)	
		Control Circuit Breaker/ GFCI Receptacle Breaker/ SCADA Breaker						
		Square D	NA	NA	NA	NA	QOU120	
	MS	**Motor Starter (MS)**						
		Square D	NA	NA	NA	NA	Type S Class 8536	
	OL	**Overload Heater(OL)**						
		Square D	NA	NA	NA	NA	Part number will vary with size needed	
	OR	**Overload Reset**						
		Square D	NA	NA	NA	NA	9066-RA1	
	Transformer	**Control Circuit Transformer (XMFR)**						
		Square D	NA	NA	NA	NA	9070TF75D23	120/24 Volt .075 KVA
		Main Circuit Transformer (MCT)						
		Square D	NA	NA	NA	NA	9070T2000D1	480/120 2KVA
	SPB	**Supplemental Protector Breaker - 3 pole, 1-amp for Phase Monitor**						
		Square D	NA	NA	NA	NA	MG24532	

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	Comments
Pump Station Control Panel	PM	**Phase Monitor (PM)**						
		MPE 240 V.	NA	NA	NA	NA	001-230-118-OVG5	
		MPE 480 V.	NA	NA	NA	NA	002-480-123-OVG5	
	Pump Alternator	**Pump Automatic Alternator (PAA)**						
		Diversified Duplex	NA	NA	NA	NA	ARA-120-ACA	
		Diversified Triplex	NA	NA	NA	NA	ARA-120-AME	
		MPE Duplex	NA	NA	NA	NA	008-120-13SP	
		MPE Triplex	NA	NA	NA	NA	009-120-23P	
		MPE Triplex Socket	NA	NA	NA	NA	SD-12-PC	
	Alt. Test Switch	**Alt. Test Switch**						
		Carling Technologies	NA	NA	NA	NA	6GG5E-78	
		Honeywell	NA	NA	NA	NA	2TL1-50	
	Relay	**Relay**						
		Potter Brumfield 24 Volt	NA	NA	NA	NA	KRPA-11AN-24	
		Potter Brumfield 120 Volt	NA	NA	NA	NA	KRPA-11AN-120	
		Square D 24 Volt	NA	NA	NA	NA	8501KP12P14V14	
		Square D 120Volt	NA	NA	NA	NA	8501KP12P14V20	
	Relay Base	**Relay Base**						
		IEDC 8 Pin Relay Base 600 Volt	NA	NA	NA	NA	SR2P-06	
	Duplex Receptacle / GFCI	**Duplex Receptacle/GFCI (DR) Upgraded to 20 Amp**						
		Hubbell	NA	NA	NA	NA	GFTR20BK	
		Pass & Seymour	NA	NA	NA	NA	2095TRBK	
	ETM	**Elapse Time Meter (ETM)**						
		Reddington	NA	NA	NA	NA	711-0160	
	Grounding	**Grounding System**						
		Marathon	NA	NA	NA	NA	Neutral Isolation Block 1421570	
		Panduit	NA	NA	NA	NA	Ground Lug LAM2A 1/0 - 014 -6Y	
		Square D	NA	NA	NA	NA	Ground Buss PK7GTA	
	TS	**Terminal Strip (TS)**						
		Marathon	NA	NA	NA	NA	Series 200	
		Square D	NA	NA	NA	NA	9080GR6	
	TS	**Terminal Strip End Blocks and End Clamps**						
		Square D	NA	NA	NA	NA	9080GM6B & 9080GH10	

APPENDIX D **LIST OF APPROVED PRODUCTS - PUMP STATION SYSTEMS** **FEBRUARY 11, 2011**

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pump Station Control Panel	PL	**Pilot Light (PL) 24 Volt with 1819 Bulb**						
		Dialight	NA	NA	NA	NA	803-1710	
		Lighting Components & Design	NA	NA	NA	NA	Littlelight 930507X	
	RL	**Run Indicator Light (RL) 120 Volt**						
		Dialight	NA	NA	NA	NA	803-1710	
		Lighting Components & Design	NA	NA	NA	NA	Littlelites 930507X With 120MB Bulb	
	MT	**Moisture and Temperature Failure Light (MT) 120 Volt with 120MB Bulb**						
		Dialight	NA	NA	NA	NA	803-1710	
		Lighting Components & Design	NA	NA	NA	NA	Littlelites 930507X	
Sluice	Sluice Gate	**Sluice Gate for Wet Well with Motorized Operator**						
		BNW	NA	NA	NA	NA	Model 77 - 316 SS	
		Fontaine	NA	NA	NA	NA	Model 20 - 316 SS	
VFD	VFD	**Variable Frequency Drives**						
		Square D	NA	NA	NA	NA		

APPENDIX B

GEOTECHNICAL REPORT

Subsurface Soil Exploration and
Geotechnical Engineering Evaluation
Proposed Improvements at
Eastern Regional Water Supply Facility
Orlando, Orange County, Florida

Ardaman & Associates, Inc.

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Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

September 28, 2010
File No. 10-6416

Tetra Tech
201 East Pine Street
Suite 1000
Orlando, Florida 32801

Attention: Mr. Jonathon C. Bundy, P.E.

Subject: Subsurface Soil Exploration and
Geotechnical Engineering Evaluation
Proposed Improvements at
Eastern Regional Water Supply Facility
Orlando, Orange County, Florida

Gentlemen:

As requested and authorized by you, 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 improvement 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 improvements is located at the existing water supply facility located on the southwest corner of the intersection of Curry Ford Road and Econlockhatchee Trail in Orange County, Florida (Section 7, Township 23 South, Range 31 East). The general site location is shown superimposed on the Orlando East, Florida U.S.G.S. quadrangle map presented on Figure 1.

The site is currently developed with the existing water supply facility. The improvements consist of various new buildings and structures that are proposed to be constructed in "greenspace" areas adjacent to or close to existing structures. In addition, a new pond may be excavated in the relatively level open grassed field located in the same general vicinity as the two main existing wet ponds. The Econlockhatchee River is located a short distance to the south of the overall site, a small tributary of which meanders through a conservation easement located within the boundaries of the water treatment plant property.

PROPOSED CONSTRUCTION AND GRADING

It is our understanding that the proposed development includes the following new structures.

- High Service Pump Building Extension
- Standby Generator Building
- Fuel Storage Tank(s)
- Carbon Dioxide (CO2) Feed Connection
- Chemical Building including CO2 Storage Vessel(s), Fluoride and Electrical Room and Pump Slab
- Aeration and Air Quality Towers
- Transfer Pump Station
- Four Supply Well Shelters

The proposed structures will consist of load bearing masonry walls and interior columns with slab-on-grade floors, or equipment supported on reinforced concrete mats. For the purposes of our analysis, we have assumed the maximum loading conditions for the structures to be as presented in the below table.

Building	Approximate Dimensions (Feet)	Assumed Maximum Loads		
		Wall (klf)	Column (kips)	Floor (psf)
High Service Pump Building Extension	40 x 46	6 - 7	N/A	250
Standby Generator Building	40 x 72	3 - 4	N/A	500
Fuel Storage Tank	30 x 40	N/A	N/A	700
Chem Bldg - CO2 Storage Vessel(s)	92 x 42	N/A	N/A	700
Chem Bldg - Fluoride/Electrical	20 x 63	3 - 4	N/A	150
Chem Bldg - Pump Slab	36 x 26	N/A	N/A	150
Aeration and Air Quality Towers	76 x 115	N/A	N/A	250
Transfer Pump Station	32 x 35	N/A	N/A	1,500
Four Supply Well Shelters	16 x 18	3 - 4	N/A	100

Based on the provided information, the transfer pump station will be founded on the order of 23 to 24 feet below the existing ground surface.

Grading plans are not complete at this time, therefore we have assumed that 0 to 3 feet of fill is required to raise the structure and parking/drive areas to final elevations. If actual structure loads or fill height exceed our assumptions, then the recommendations in this report may not be valid.

We understand that the stormwater run-off is to be retained on-site by means of a retention pond(s).

REVIEW OF SOIL SURVEY MAPS

Based on the 1989 Soil Survey for Orange County, Florida, as prepared by the U.S. Department of Agriculture Soil Conservation Service, the site is located in an area mapped with the following soil series:

- Basinger fine sand, depressional
- Ona fine sand
- Samsula-Hontoon-Basinger association, depressional
- Sanibel muck
- Smyra fine sand

Please refer to Figure 2 for the mapped locations of the individual soil units.

The "Basinger fine sand, depressional" soil series consists of nearly level sandy soil in shallow depressions and sloughs and along the edges of freshwater marshes and swamps. The internal drainage of the "Basinger fine sand, depressional" soil series is poor and the soil permeability is rapid throughout. According to the Soil Survey, the seasonal high water table for the "Basinger fine sand, depressional" soil series is typically above the ground surface for 6 to 9 months or more each year and within 12 inches of the ground surface for the rest of the year.

The "Ona fine sand" soil series consists of nearly level sandy soil in broad areas on the flatwoods. The internal drainage of the "Ona fine sand" is poor and the soil permeability is rapid in the surface and subsurface layers, and is moderate in the subsoil. According to the soil survey, the seasonal high water table for the "Ona fine sand" soil series is within 10 inches of the surface for 1 month to 2 months. It recedes to a depth of 10 to 40 inches for periods of 6 months or more.

The "Samsula-Hontoon-Basinger Association, depressional" soil series consists of nearly level soil in freshwater swamps, depressions, sloughs, and broad, poorly defined drainageways. The surface layer may include muck from 16 to about 34 inches thick. The internal drainage of the "Samsula-Hontoon-Basinger Association, depressional" soil series is very poor and the soil permeability is rapid in Samsula and Hontoon soils and very rapid in Basinger soil. According to the soil survey, the seasonal high water table for the "Samsula-Hontoon-Basinger Association, depressional" soil series is ponded for 6 to 9 months or more each year.

The "Sanibel muck" soil series consists of nearly level soil in depressions, freshwater swamps and marshes, and in poorly defined drainageways. Typically, this soil has an organic surface layer of black muck about 11 inches thick. The internal drainage of the "Sanibel muck" is poor and the soil permeability is rapid throughout. According to the Soil Survey, the seasonal high water table for the "Sanibel muck" soil series is typically ponded for 6 to 9 months or more except during extended dry periods. The water table fluctuates between depths of about 10 inches and the surface for 2 to 6 months.

The "Smyrna fine sand" soil series consists of nearly level sandy soil on broad flatwoods. The slopes are smooth and range from 0 to 2 percent. The internal drainage of the "Smyrna fine sand" is poor and the soil permeability is rapid in the surface and subsurface layers and in the substratum, and it is moderate to moderately rapid in the subsoil. According to the Soil Survey, the seasonal high water table for the "Smyrna fine sand" soil series is typically within 10 inches of the

natural ground surface for 1 month to 4 months and it recedes to a depth of 10 to 40 inches for more than 6 months.

FIELD EXPLORATION PROGRAM

SPT and Auger Borings

The field exploration program included performing 16 Standard Penetration Test (SPT) borings and 3 auger borings. The SPT borings were performed within or as close as possible to the proposed "footprints" of the structures. The borings were advanced to depths ranging from 20 to 40 feet below the ground surface using the methodology outlined in ASTM D-1586. A summary of this field procedure is included in the Appendix. 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 performed in the proposed stormwater retention pond area. They were drilled using a truck-mounted, 4-inch diameter, continuous flight auger to a depth of 20 feet below the ground surface. A summary of this field procedure is included in the Appendix. 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 upon completion of drilling. The borings were then backfilled with soil cuttings.

Field Permeability Test

Two field permeability tests were performed at the location of the proposed stormwater pond. The field permeability tests were performed by installing a solid-walled PVC casing snugly fit into a 4-inch diameter auger borehole. The bottom of the pipe was open and raised 1 foot above the bottom of the borehole. The bottom 1 foot of the borehole was gravel-packed. The pipe was then filled to the top with water. The tests were performed as "falling head" tests in which the rate of water drop within the pipe was measured.

Test Locations

The approximate locations of the borings are schematically illustrated on a site plan shown on Figure 3. The permeability tests were conducted adjacent to Borings AB-1 and AB-2. These locations were determined in the field by tape measuring/estimating distances from existing site features and should be considered accurate only to the degree implied by the method of measurement used.

LABORATORY PROGRAM

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 were visually classified in general accordance with the Unified Soil Classification System (ASTM D-2488). The resulting soil descriptions are shown on the soil boring profiles presented on Figures 4 through 8.

In addition, we conducted 2 organic content tests (ASTM D2974-87), 2 natural moisture content tests (ASTM D2216) and 9 percent fines analyses (ASTM D1140) 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 4 through 8.

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 4 through 8. 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:

Depth Below Ground Surface (feet)	Description
0 - 5	Fine sand (SP) to fine sand with silt (SP-SM)
5 - 12	Medium dense to dense fine sand (SP) to fine sand with silt (SP-SM) or silty fine sand (SM)
12 - 25	Loose to medium dense fine sand (SP) to fine sand with silt (SP-SM) or clayey fine sand (SC)

We note that as an exception to the above table, the boring designated TH-11 (conducted relative to the proposed transfer pumping station) encountered very loose fine sand (SP) to fine sand with silt (SP-SM) between a depth of approximately 13 and 37 feet below the existing ground surface, underlain be an approximate 1-foot thick layer of clay to 38 feet and very dense clayey fine (SC) to the boring termination depth of 40 feet. A loss of drilling fluid circulation also occurred at a depth of approximately 13 feet below the existing ground surface.

The above soil profile is outlined in general terms only. Please refer to Figures 4 through 8 for soil profile details.

Groundwater Level

The groundwater level was measured in the boreholes on the day drilled after stabilization of the downhole water level. As shown on Figures 4 through 8, groundwater was encountered at depths that ranged from 3 to 9 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 2 feet above the groundwater levels measured at the time of our field exploration.

ENGINEERING EVALUATION AND RECOMMENDATIONS

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 buildings and structures on conventional shallow foundation systems. Spread footings and/or mat foundations should provide an adequate support system for the structures.

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 and/or architect, parts of which should be incorporated into the project's specifications.

Evaluation of Existing Fill (High Service Pump Bldg Extension and Aeration Tower Vicinity)

The character of the existing fill should be further explored to verify that unsuitable materials are not present within or covered by the fill. We recommend excavating test pits to further explore the nature of the existing fill. Test pits can be excavated before or during the initial phases of construction. The test pit excavations should be monitored by a representative of Ardaman & Associates. Unsuitable materials, if encountered, should be removed and replaced with suitable compacted fill during site construction.

Excavation (Transfer Pump Station)

It is our understanding that the proposed transfer pump station will be founded on the order of 23 to 24 feet below the existing ground surface. This places the bottom of the structure well below the loss of drilling fluid circulation encountered in Boring TH-11 at a depth of approximately 13 feet. If the bottom of the proposed structure is revised higher, then Ardaman & Associates should be immediately notified so that we can re-evaluate our recommendations relative to this particular structure.

We anticipate that the fine sand and fine sand with silt can be excavated with standard earth moving equipment (e.g., front-end loaders and backhoes). The soils below the bottom of the excavation should be disturbed as little as possible by the excavation process. The actual method(s) of excavation should be determined by the contractor, however, the excavation should be safely braced to prevent injury to personnel or damage to equipment. The foundation elements of any existing nearby structures must be adequately supported during excavation and placement of the proposed structure to prevent loss of foundation support for the existing structures.

Following excavation to the founding level of the proposed structures, the bottom of the excavation should be compacted to achieve a firm and unyielding condition. The excavated ground surface should be inspected by a representative of Ardaman & Associates using visual observation and probing. Any areas of deleterious, very loose or soft soils should be overexcavated and backfilled.

Excavation and backfilling (as necessary) should be performed "in the dry". Therefore, dewatering may be necessary to lower the groundwater level 2 to 3 feet below the bottom of the excavation. Dewatering is further discussed in the "Dewatering" section of this report.

The excavation should be safely braced to prevent injury to personnel or damage to equipment. Temporary safe slopes should be cut at a minimum in accordance with OSHA, 29 CFR Part 1926 Final Rule, Excavation Requirements. Flatter slopes should be used if deemed necessary. Surcharge loads should be kept a horizontal distance away from the excavation equivalent to the depth of the excavation.

Stripping and Grubbing

The "footprints" of the proposed buildings and 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. Specifically, the organic topsoil should be stripped.

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. Based on the boring log information, significant root concentrations are estimated to be within the upper 1 to 2 feet. The actual depth(s) of stripping and grubbing must be determined by visual observation and judgment during the earthwork operation.

All existing foundations, slabs, asphalt, and any other underground structures should be removed from the proposed construction area. If pipes or any collapsible or leak prone utilities are not removed or completely filled (with grout or concrete), they might serve as conduits for subsurface erosion resulting in excessive settlements. Over-excavated areas resulting from the removal of underground structures and unsuitable materials should be backfilled in accordance with the fill soils section of this report. This excavation must not undermine the existing building foundations. Provide shoring, bracing, and/or underpinning of existing footings as necessary to protect from failure.

It has been our experience that soils surrounding existing buildings sometimes contain pockets of construction debris or other deleterious materials requiring removal and replacement with compacted clean fine sands. Therefore, we strongly recommend that the stripped surface be inspected by Ardaman & Associates, Inc.

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 building 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. The number of passes can be reduced to 3 within the proposed parking/drive areas.

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 building/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.

Due to the relatively high groundwater level at this site, 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. Depending on the time of year, a 12- to 18-inch layer of clean fine sand (SP) fill may be required prior to proof-rolling.

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 performed within 200 feet of existing structures.

Suitable Fill Material and the 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 No. 1 and 2 without roots, as shown on Figures 4 through 8) are suitable for use as fill materials and, with proper moisture control, should densify using conventional compaction methods. The silty fine sand and fine sand with clay (Strata No. 3 and 4 on Figures 4 through 8) may also be used as fill, but will be more difficult to moisture condition and compact due to their inherent nature to retain excess soil moisture. Soils with more than 12 percent passing the No. 200 sieve can be used in some applications, but will also 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.

The use of soils with relatively high fines content (i.e; silty and clayey soils) as fill should be avoided near the ground surface in green-space areas since these relatively low permeability soils promote ponding of water during and following rainfall. Also, in high groundwater areas, silty and clayey soils may cause a rise in the water table elevation due to capillary action. Additionally, these relatively low permeability soils should not be used directly beneath any pavement section as they may trap water within the pavement section leading to premature pavement failure.

Foundation Support by Spread Footings and Foundation Compaction Criteria

Excavate the foundations to the proposed bottom of footing elevations and, thereafter, verify the in-place compaction for a depth of 2 feet below the footing 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 3,000 pounds per square foot (psf) may be used in the foundation design. This bearing pressure should result in foundation settlement within tolerable limits (i.e., 1 inch or less).

All bearing wall foundations should be a minimum of 24 inches wide and column foundations 24 inches wide. A minimum soil cover of 24 inches should be maintained from the bottom of the foundations to the adjacent finished grades.

We note that minimum foundation width can be reduced to 18 inches and minimum soil cover can be reduced to 18 inches, however, the allowable soil bearing pressure must be reduced to 2,000 pounds per square foot (psf) for these footing dimensions.

Any proposed foundations near existing buildings should be positioned so that the bottom elevation of the proposed foundations is equal to the bottom elevation of the existing foundations. The purpose of this is to reduce additional stress on the existing building's wall. It is noted that the foundation elements of existing buildings and structures must be adequately supported during excavation and placement of proposed foundations. Methods of supporting existing foundations should be the responsibility of the Contractor.

Some settlement of existing structure's foundations should be expected relative to new construction. Settlement may result in cracking of existing structures. The majority of the cracking, if it occurs, is expected to take place during and soon after construction. Money should be allocated in the project budget to repair damage to existing structures which may occur as a result of construction.

Foundation Support by Mat Foundation and Foundation Compaction Criteria for Fuel Storage Tanks, CO2 Storage Vessel(s), Chemical Bldg Pump Slab and Aeration and Air Quality Towers

Excavate the foundation area to the proposed bottom of the mat foundation elevation and, thereafter, verify the in-place compaction for a depth of 2 feet below the mat bottom. 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 bottom. Based on the existing soil conditions and, assuming the above outlined proof-rolling and compaction criteria is implemented, an allowable soil bearing pressure of up to 800 pounds per square foot (psf) may be used in the foundation design for the proposed pads and mats. This bearing pressure should result in foundation settlement within tolerable limits (i.e., 1 inch or less). The mat foundations should be stiffened, as necessary, to accommodate differential settlement.

For the mat foundations, a minimum soil cover of 12 inches should be maintained from the bottom of the exterior foundation to the adjacent outside finished grades. A modulus of subgrade reaction of 125 pounds per cubic inch (pci) may be used in mat foundation design. This value is based on empirical correlation to the results expected from a 12-inch diameter plate load test. Please note that modulus of subgrade reaction is not a soil constant, but is a function of bearing pressure and settlement that will vary based on foundation load and dimensions.

Foundation Support by Mat Foundation and Foundation Compaction Criteria for the Transfer Pump Station

Excavate the foundations to the proposed bottom of foundation elevations and, thereafter, verify the in-place compaction for a depth of 2 feet below the foundation 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 foundation bottoms. Based on the existing soil conditions and, assuming the above outlined proof-rolling and compaction criteria are implemented, a net increase in allowable soil bearing pressure of 800 pounds per square foot (psf) may be used in the foundation design. This maximum net increase in bearing pressure should result in foundation settlement within tolerable limits (i.e., 1 inch or less).

Buoyancy and lateral earth pressures are discussed in the "Uplift Resistance", the "Earth Pressure on Shoring and Bracing", and the "Lateral Earth Pressures" subsections of this report.

There are alternative installation techniques for wet wells (e.g.; caisson method) other than installing the structure in a dewatered excavation. If an installation technique other than installation in a dewatered excavation is planned, we should be retained to review the proposed methods. We can then modify our recommendations as appropriate.

Floor Slab Moisture Reducer and Slab Compaction Requirements

Compaction beneath all floor slabs should be verified for a depth of 12 inches and meet the 95 percent criteria (modified Proctor, ASTM D-1557).

Precautions should be taken during the slab construction to reduce moisture entry from the underlying subgrade soils. Moisture entry can be reduced by installing a membrane between the subgrade soils and floor slab. Care should be exercised when placing the reinforcing steel (or mesh) and slab concrete such that the membrane is not punctured. We note that the membrane alone does not prevent moisture from occurring beneath or on top of the slab.

If interior columns are isolated from the floor slab, an expansion joint should be provided around the columns and sealed with a water-proof sealant.

Dewatering

Based on the groundwater conditions encountered, the control of the groundwater may be required to achieve the necessary stripping and subsequent construction, backfilling, and compaction requirements presented in the preceding sections. The requirement for control of groundwater should particularly be anticipated for footing and utility excavations. 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 any excavation or compaction surface to preclude "pumping" and/or compaction-related problems with the foundation soils.

Dewatering should be accomplished with the knowledge that the permeability of soil tends to decrease with an increasing silt and clay content. Therefore, a silty fine sand is typically less permeable than a fine sand. The SP, SP-SM, and some SM type soils can usually be dewatered by well pointing or ditch/sump methods.

Lateral Earth Pressures

Lateral loads acting on embedded structures will include at-rest earth pressures as well as hydrostatic pressures and surcharge loads. The lateral earth pressure will be a function of both the depth below ground surface and the soil unit weight (submerged or moist) plus hydrostatic pressure (if applicable). The following equations can be used to determine the lateral at-rest earth pressure:

$\sigma_h = K_o \gamma_m h$ (above groundwater table)
$\sigma_h = K_o [\gamma_m h_w + \gamma_b (h - h_w)]$ (below groundwater table)

Where:

- σ_h = lateral earth pressure (psf)
- K_o = coefficient of at-rest earth pressure (0.5) (this value assumes that the backfill is lightly compacted yet not overcompacted)
- γ_m = moist unit weight of soil = 110 pcf for compacted moist soil above the water table.
- γ_b = buoyant unit weight of soil = 56 pcf for compacted saturated soil below the water table.
- h = vertical depth (feet) below grade at which lateral earth pressure is determined
- h_w = vertical depth (feet) below grade to groundwater table

For design, an appropriate factor of safety should be applied to the lateral earth pressures calculated using the above equations. Lateral pressure distributions determined in accordance with the above do not include hydrostatic pressures or surcharge loads. Where applicable, they should be incorporated in the design.

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 unit shearing resistance may be determined by the following formula:

Unit Shearing Resistance, $F=K_o\gamma_m h(2/3 \tan\phi)$. (above groundwater table)

Unit Shearing Resistance, $F=K_o [\gamma_m h_w+\gamma_b(h-h_w)] (2/3 \tan\phi)$. (below groundwater table)

Where:

F = unit shearing resistance (psf)
K_o = coefficient of at-rest earth pressure = 0.5
γ_m = moist unit weight of soil = 110 pcf
γ_b = buoyant unit weight of soil = 56 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

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. Appropriate safety factors should be applied to the Unit Shearing Resistance calculated using the preceding equations.

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 dewatered around the excavations. For such dewatered excavations, we recommended using the following uniform pressure distribution over the full braced height as follows:

Uniform Soil Pressure Distribution, $p = 0.65 K_a \gamma_s H$
where:

p = uniform pressure distribution for design of braced excavation
K_a = coefficient of active earth pressure = 0.33
γ_s = saturated unit weight of 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).

Retention Pond

For this study, soil conditions were explored in the proposed pond area with three auger borings to a depth of 20 feet.

Soil Profile and Soil Permeability

The fine sand and fine sand with silt (Strata 1 and 2 on Figures 4 through 8) are generally considered to be relatively permeable. The underlying silty fine sand, fine sand with clay and clayey fine sand (Strata 3, 4 and 5 on Figures 4 through 8) are likely less permeable than the fine sand and fine sand with silt, and should be considered to be aquitards for retention pond drawdown evaluation.

The results of the falling head field permeability tests are presented in the following table:

Test Location	Test Depth (feet)	Measured Permeability (inches/hour)
AB-1	5 - 6	0.5
AB-2	3 - 4	0.2

It is noted that a suitable factor of safety should be used with these values. In addition, for the type of soils tested, a transformation ratio of 1 horizontal to 1 vertical is appropriate (i.e; the estimated ratio of horizontal to vertical permeability).

Other Retention Pond Considerations

For dry bottom retention ponds, pond performance will be significantly influenced by the soil permeability and the vertical separation between the pond bottom and the seasonal high groundwater level. Because of the high groundwater level and poor draining soil conditions at this site, underdrains may be necessary to prevent growth of aquatic vegetation and for pond volume recovery. An outfall (i.e., stormwater drain, ditch, canal, natural low areas, etc.) will be necessary to utilize underdrains.

Wet detention ponds should be excavated to depths necessary to obtain a sufficient water depth to limit growth of aquatic vegetation. For the purpose of wet detention pond design, we estimate the normal low groundwater level to be 3 feet lower than the water levels encountered in the borings.

We estimate the average wet season groundwater level (the average level between May and October during a year of normal rainfall) to be at the groundwater levels measured at the time of our field exploration.

Ardaman & Associates, Inc. would be pleased to assist in evaluating the design exfiltration rates, underdrains and/or groundwater baseflow as pond geometry and stormwater volume requirements become available.

QUALITY ASSURANCE

We recommend establishing a comprehensive quality assurance program to verify that all site preparation and foundation and pavement 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 all 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 floor 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.

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. Additional tests should be performed in backfill for manholes, inlets, etc.

In proposed structural areas, the minimum frequency of in-place density testing should be one test for each 2,500 square feet of structural area. 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. For continuous or wall footings, density tests should be performed at a minimum frequency of one test for every 50 linear feet of footing, and for a depth of 2 feet below the bearing surface.

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 4 through 8 and the assumed and/or provided 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.

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.

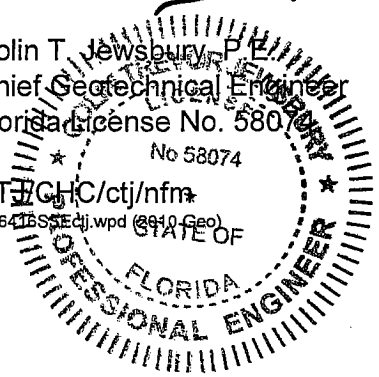
This report has been prepared for the exclusive use of Tetra Tech in accordance with generally accepted geotechnical engineering practices. In the event any changes occur in the design, nature, or location of the proposed facility, we should review the applicability of conclusions and recommendations 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.

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

C. T. Jewsbury 9-28-10.

Colin T. Jewsbury, P.E.
Chief Geotechnical Engineer
Florida License No. 58074



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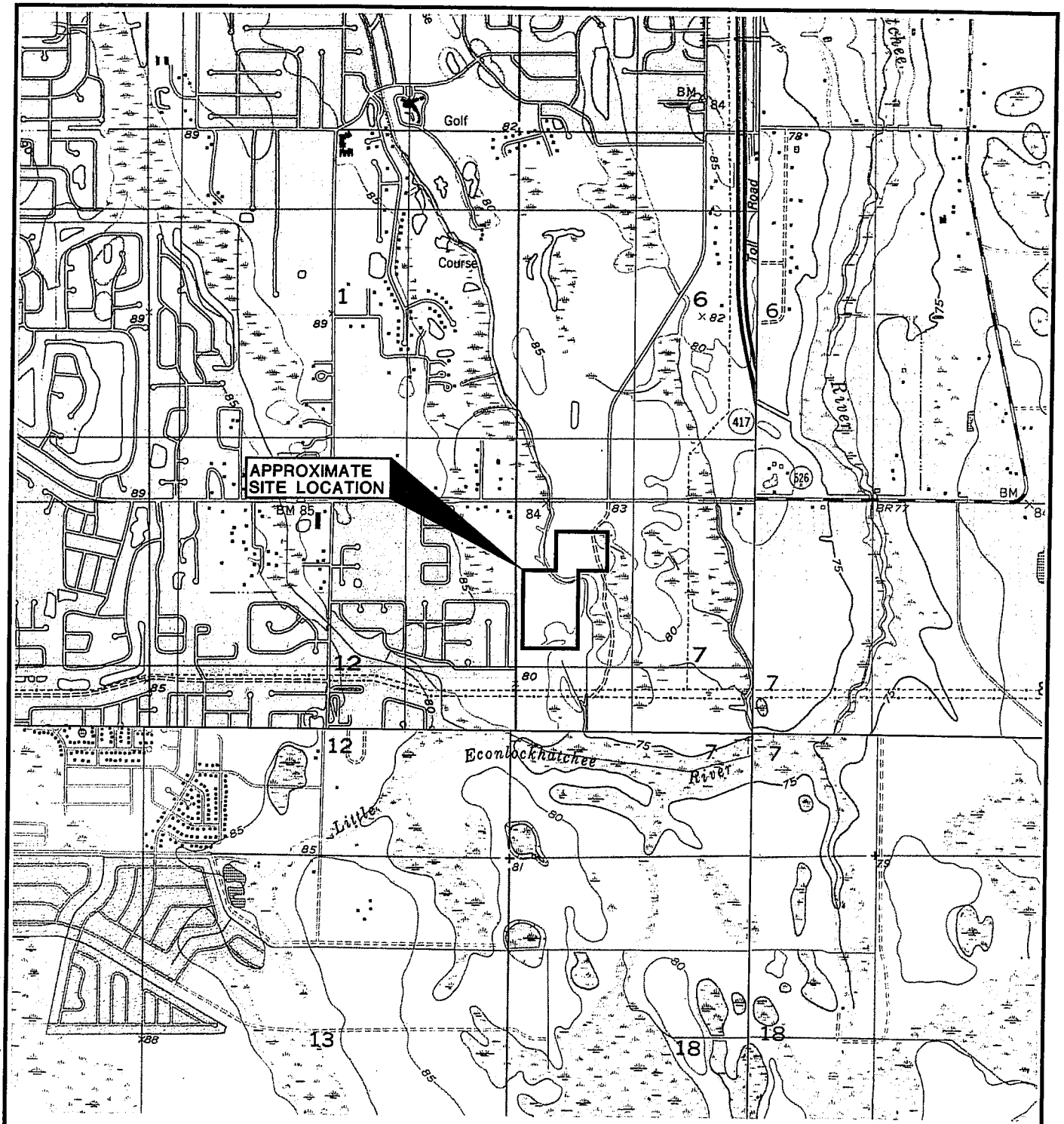
Charles H. Cunningham, P.E.
Division Manager
Florida License No. 38189



SECTION 7
TOWNSHIP 23 SOUTH
RANGE 31 EAST

OBTAINED FROM U.S.G.S. QUAD MAP: ORLANDO EAST, FLORIDA 1994

N

0 1000 2000

APPROXIMATE SCALE: 1"=2000'

QUADRANGLE LOCATION

SITE LOCATION MAP

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUBSURFACE SOIL EXPLORATION
PROPOSED IMPROVEMENTS AT ERWSF
ORANGE COUNTY, FLORIDA

DRAWN BY: CD	CHECKED BY:	DATE: 09/21/2010
FILE NO. 10-6416	APPROVED BY:	FIGURE: 1

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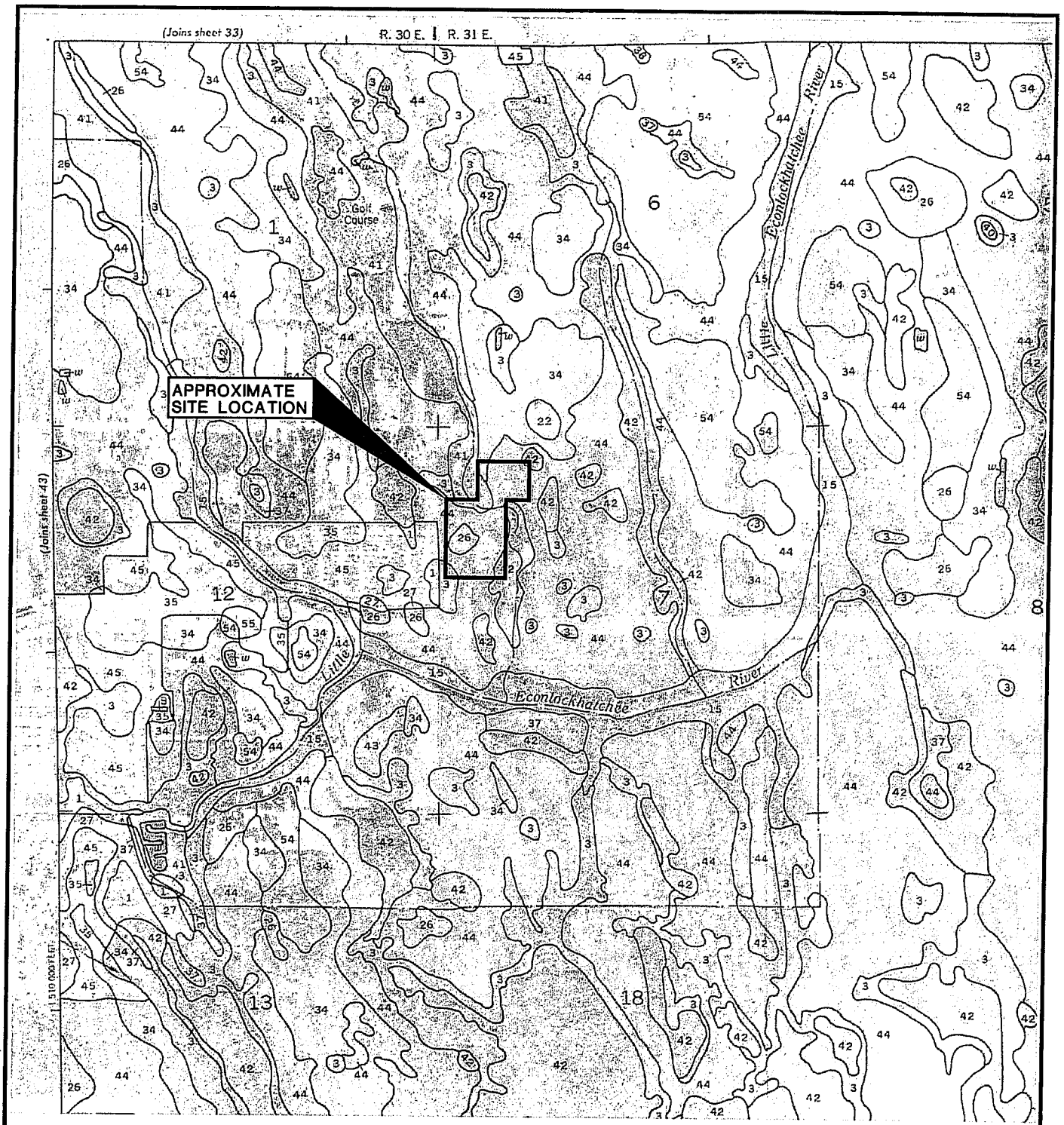

OBTAINED FROM: SOIL SURVEY OF ORANGE COUNTY, FLORIDA
ISSUED DATE: AUGUST 1989

LEGEND

3 - BASINGER FINE SAND, DEPRESSIONAL
26 - ONA FINE SAND
34 - POMELLO FINE SAND, 0 TO 5 PERCENT SLOPES
41 - SAMSULA-HONTOON-BASINGER ASSOCIATION, DEPRESSIONAL
42 - SANIBEL MUCK
44 - SMYRNA FINE SAND

N

0 1000 2000

APPROXIMATE SCALE: 1"=2000'

SOIL SURVEY MAP

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUBSURFACE SOIL EXPLORATION
PROPOSED IMPROVEMENTS AT ERWSF
ORANGE COUNTY, FLORIDA

DRAWN BY: CD	CHECKED BY:	DATE: 09/21/2010
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PROPOSED HIGH SERVICE PUMP BUILDING EXTENSION

PROPOSED STANDBY GENERATOR BUILDING

EXISTING HIGH SERVICE PUMP BUILDING

EXISTING GROUND STORAGE TANK NO. 3

EXISTING GROUND STORAGE TANK NO. 1

EXISTING GROUND STORAGE TANK NO. 2

PROPOSED FUEL STORAGE

SJRWMD CONSERVATION EASEMENT

SJRWMD CONSERVATION EASEMENT

PROPOSED LIFT STATION

PROPOSED AERATION AND AIR QUALITY TOWERS

PROPOSED CO_2 SYSTEM BOOSTER PUMPS AND FEED PANELS

PROPOSED CHEMICAL BUILDING

ABANDONED CHLORINE BUILDING

EXISTING STABILIZATION BUILDING

EXISTING CHEMICAL TRENCH

EXISTING MCC BUILDING

EXISTING AERATION AND AIR QUALITY TOWERS

SJRWMD CONSERVATION EASEMENT

SPACE FOR FUTURE EXPANSION OF AERATION AND AIR QUALITY TOWERS

TEMPORARY SODIUM HYDROCHLORITE FACILITIES (TO BE REMOVED)

CONNECT TO EXISTING 48" RW

CONNECT TO EXISTING 48" AW

CONNECT TO EXISTING 48" RW

SEE NOTE NO. 1

CONNECT TO EXISTING 48" AW

EXISTING MCC BUILDING

EXISTING FLUORIDE BUILDING (TO BE REMOVED) REPLACE WITH PROPOSED TRANSFER PUMP STATION

EXISTING TRANSFER PUMPING STATION

EXISTING SODIUM HYPOCHLORITE BUILDING

EXISTING POND

TRAIL

24" DIA. WELL CASING

12" DIA. WELL CASING

TH-1 TH-2 TH-3 TH-4 TH-5 TH-6 TH-7 TH-8 TH-9 TH-10 TH-11 TH-12 TH-WH1 TH-WH3 TH-WH4

AB-1 AB-2 AB-3

N

0 30 60

SCALE: 1"=60'

LEGEND

TH STANDARD PENETRATION TEST (SPT) BORING LOCATION

AB AUGER BORING LOCATION

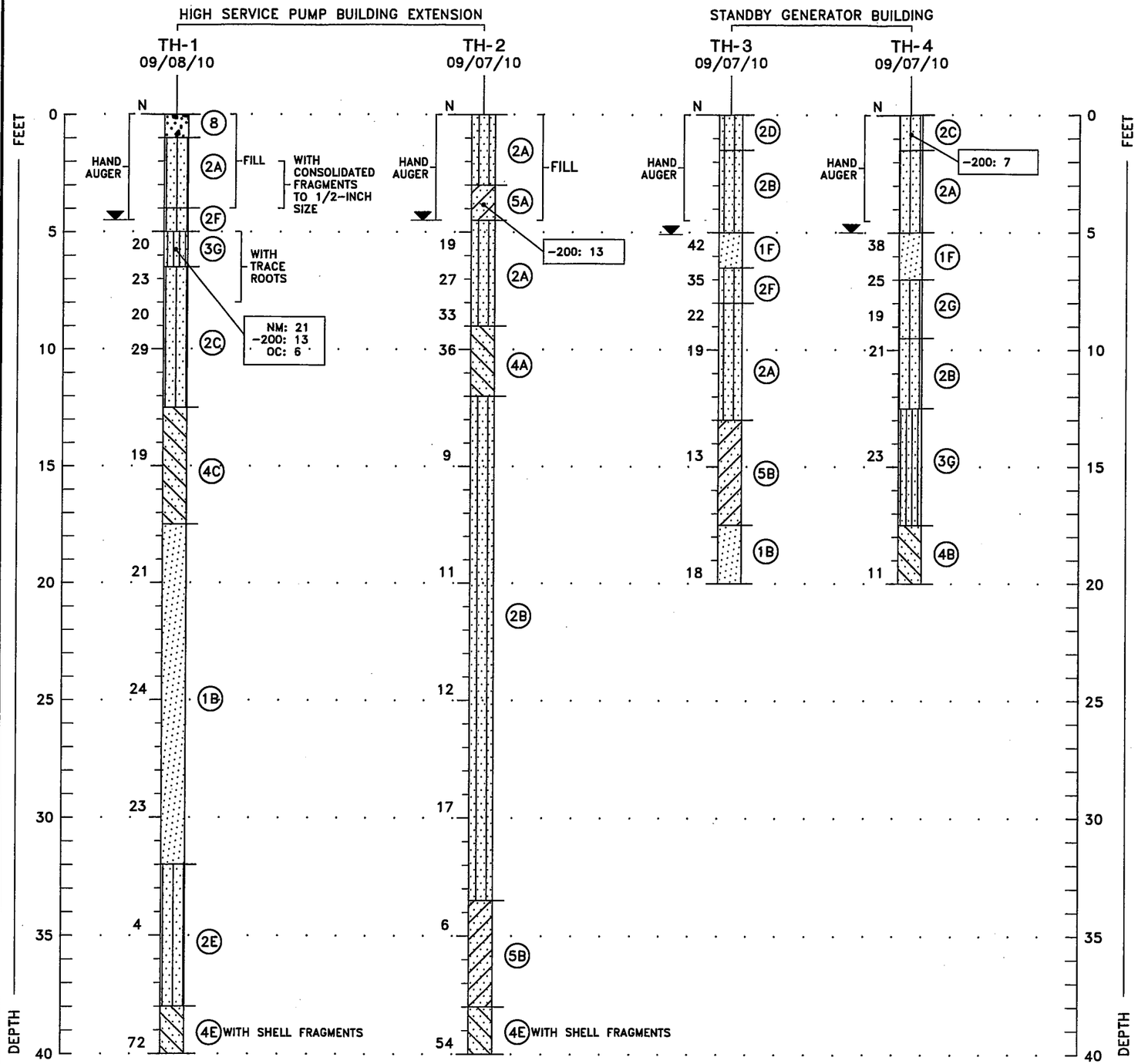
NOTE: THE BASE MAP FOR THE BORING LOCATION PLAN IS A SITE PLAN BY TETRA TECH, DATED 05/17/10.

BORING LOCATION PLAN

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUBSURFACE SOIL EXPLORATION
PROPOSED IMPROVEMENTS AT ERWSF
ORANGE COUNTY, FLORIDA

DRAWN BY: CD	CHECKED BY:	DATE: 09/23/2010
FILE NO. 10-6416	APPROVED BY: C.T. Ardaman	FIGURE: 3



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LEGEND

SOIL DESCRIPTIONS

1. FINE SAND (SP)
2. FINE SAND WITH SILT (SP-SM)
3. SILTY FINE SAND (SM)
4. FINE SAND WITH CLAY (SP-SC)
5. CLAYEY FINE SAND (SC)
6. CLAY (CH)
7. ORGANIC TOPSOIL
8. ASPHALTIC CONCRETE AND BASE

COLORS

A. GRAYISH BROWN OR DARK BROWN
B. LIGHT BROWN TO BROWN
C. REDDISH BROWN TO DARK REDDISH BROWN
D. ORANGE-BROWN
E. GRAY TO GREENISH GRAY
F. LIGHT GRAY TO GRAY
G. VERY DARK GRAY OR VERY 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)
OC	ORGANIC CONTENT IN PERCENT (ASTM D-2974)
▼	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
SP,SP-SM SM,SC,CH	UNIFIED SOIL CLASSIFICATION SYSTEM

NOTE: UPON COMPLETION OF EACH BORING, THE BOREHOLE WAS BACKFILLED WITH SOIL CUTTINGS.

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT "N"
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	>50

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 IMPROVEMENTS AT ERWSF
ORANGE COUNTY, FLORIDA

DRAWN BY: CD	CHECKED BY:	DATE: 09/21/2010	
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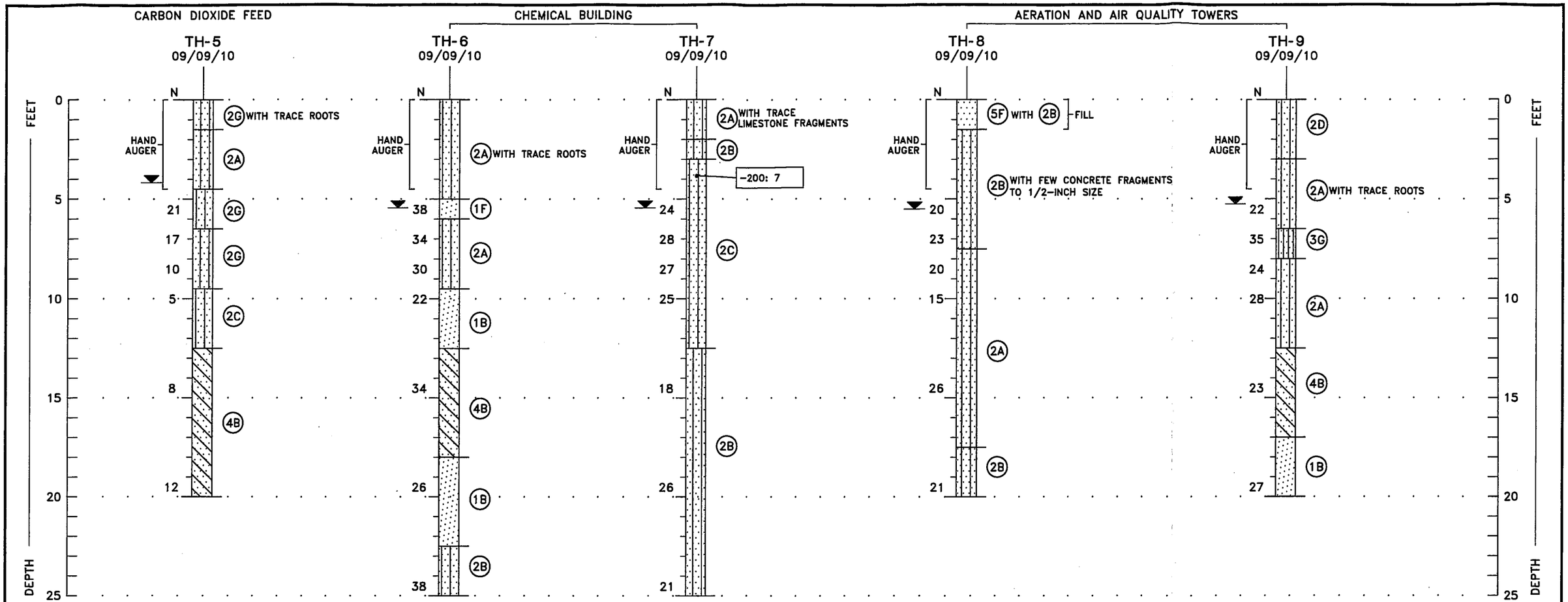

LEGEND

SOIL DESCRIPTIONS

1. FINE SAND (SP)
2. FINE SAND WITH SILT (SP-SM)
3. SILTY FINE SAND (SM)
4. FINE SAND WITH CLAY (SP-SC)
5. CLAYEY FINE SAND (SC)
6. CLAY (CH)
7. ORGANIC TOPSOIL
8. ASPHALTIC CONCRETE AND BASE

COLORS

A. GRAYISH BROWN OR DARK BROWN
B. LIGHT BROWN TO BROWN
C. REDDISH BROWN TO DARK REDDISH BROWN
D. ORANGE-BROWN
E. GRAY TO GREENISH GRAY
F. LIGHT GRAY TO GRAY
G. VERY DARK GRAY OR VERY DARK BROWN

TH	STANDARD PENETRATION TEST (SPT) BORING
N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
-200	PERCENT PASSING NO. 200 SIEVE SIZE (PERCENT FINES)(ASTM D-1140)
▼	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
SP,SP-SM SM,SC,CH	UNIFIED SOIL CLASSIFICATION SYSTEM

NOTE: UPON COMPLETION OF EACH BORING, THE BOREHOLE WAS BACKFILLED WITH SOIL CUTTINGS.

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT "N"
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	>50

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 IMPROVEMENTS AT ERWSF
ORANGE COUNTY, FLORIDA

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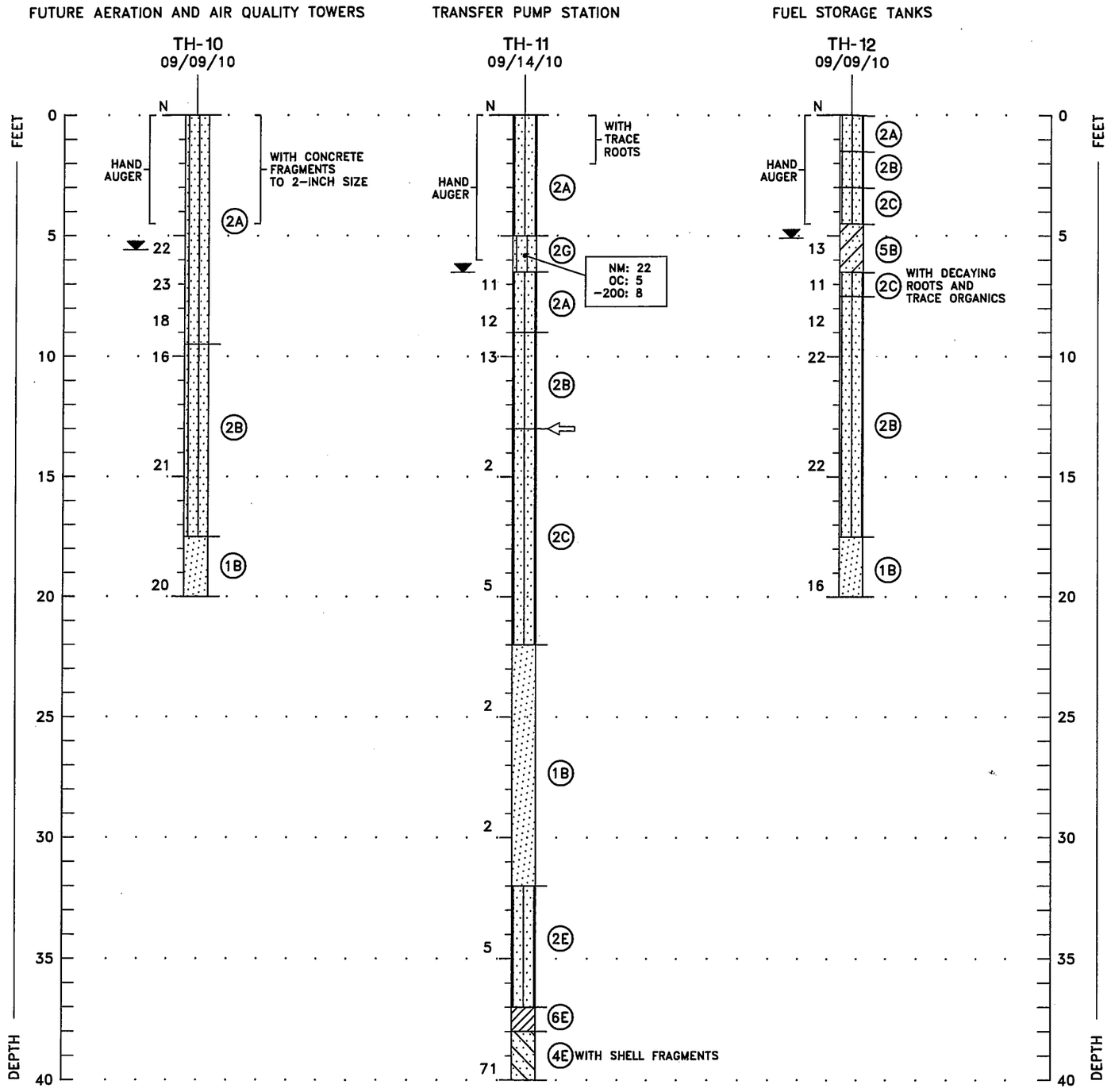

LEGEND

SOIL DESCRIPTIONS

1. FINE SAND (SP)
2. FINE SAND WITH SILT (SP–SM)
3. SILTY FINE SAND (SM)
4. FINE SAND WITH CLAY (SP–SC)
5. CLAYEY FINE SAND (SC)
6. CLAY (CH)
7. ORGANIC TOPSOIL
8. ASPHALTIC CONCRETE AND BASE

COLORS

A. GRAYISH BROWN OR DARK BROWN
B. LIGHT BROWN TO BROWN
C. REDDISH BROWN TO DARK REDDISH BROWN
D. ORANGE–BROWN
E. GRAY TO GREENISH GRAY
F. LIGHT GRAY TO GRAY
G. VERY DARK GRAY OR VERY 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)
OC	ORGANIC CONTENT IN PERCENT (ASTM D–2974)
▼	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
⇦	PARTIAL LOSS OF DRILLING FLUID CIRCULATION
SP,SP–SM SM,SC,CH	UNIFIED SOIL CLASSIFICATION SYSTEM

NOTE: UPON COMPLETION OF EACH BORING, THE BOREHOLE WAS BACKFILLED WITH SOIL CUTTINGS.

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT "N"
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	>50

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 IMPROVEMENTS AT ERWSF
ORANGE COUNTY, FLORIDA

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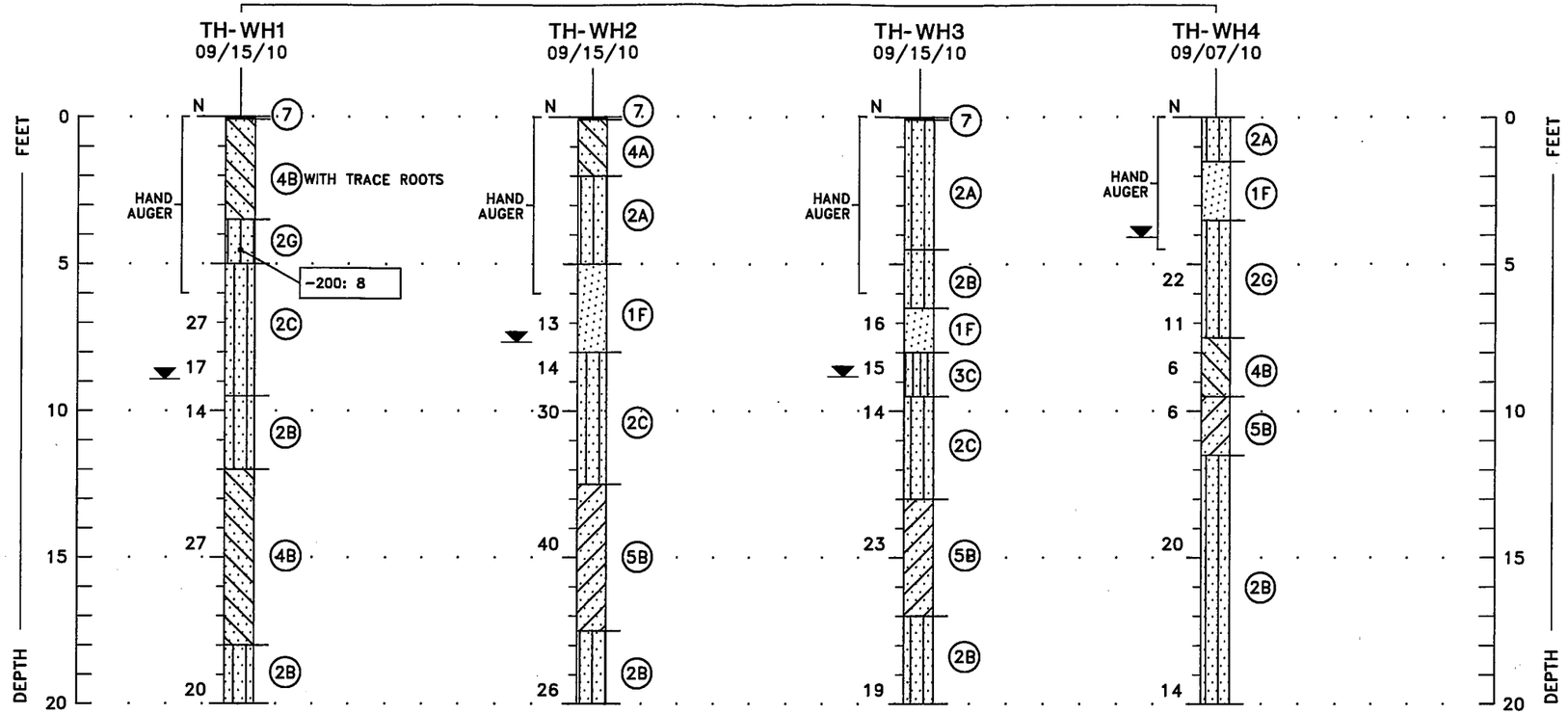
SUPPLY WELL SHELTERS



LEGEND

SOIL DESCRIPTIONS

1. FINE SAND (SP)
2. FINE SAND WITH SILT (SP–SM)
3. SILTY FINE SAND (SM)
4. FINE SAND WITH CLAY (SP–SC)
5. CLAYEY FINE SAND (SC)
6. CLAY (CH)
7. ORGANIC TOPSOIL
8. ASPHALTIC CONCRETE AND BASE

COLORS

- A GRAYISH BROWN OR DARK BROWN
- B LIGHT BROWN TO BROWN
- C REDDISH BROWN TO DARK REDDISH BROWN
- D ORANGE–BROWN
- E GRAY TO GREENISH GRAY
- F LIGHT GRAY TO GRAY
- G VERY DARK GRAY OR VERY DARK BROWN

TH	STANDARD PENETRATION TEST (SPT) BORING
N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
–200	PERCENT PASSING NO. 200 SIEVE SIZE (PERCENT FINES)(ASTM D–1140)
▼	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
SP,SP–SM SM,SC,CH	UNIFIED SOIL CLASSIFICATION SYSTEM

NOTE: UPON COMPLETION OF EACH BORING, THE BOREHOLE WAS BACKFILLED WITH SOIL CUTTINGS.

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT "N"
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	>50

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.
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SUBSURFACE SOIL EXPLORATION
PROPOSED IMPROVEMENTS AT ERWSF
ORANGE COUNTY, FLORIDA

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FILE NO. 10-6416	APPROVED BY:	FIGURE: 7

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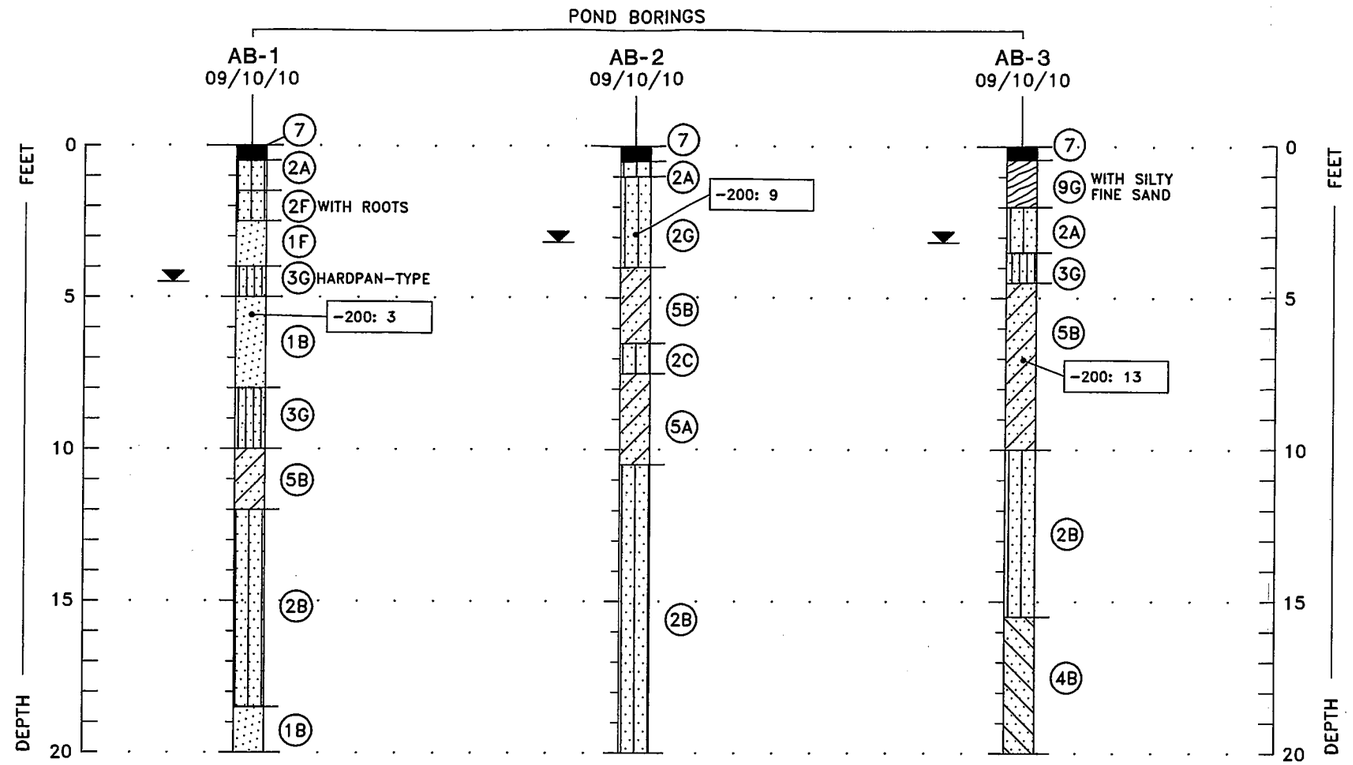

LEGEND

SOIL DESCRIPTIONS

1. FINE SAND (SP)
2. FINE SAND WITH SILT (SP–SM)
3. SILTY FINE SAND (SM)
4. FINE SAND WITH CLAY (SP–SC)
5. CLAYEY FINE SAND (SC)
6. CLAY (CH)
7. ORGANIC TOPSOIL
8. ASPHALTIC CONCRETE AND BASE
9. DECAYING WOOD FRAGMENTS

COLORS

- A GRAYISH BROWN OR DARK BROWN
- B LIGHT BROWN TO BROWN
- C REDDISH BROWN TO DARK REDDISH BROWN
- D ORANGE–BROWN
- E GRAY TO GREENISH GRAY
- F LIGHT GRAY TO GRAY
- G VERY DARK GRAY OR VERY DARK BROWN

AB	AUGER BORING
–200	PERCENT PASSING NO. 200 SIEVE SIZE (PERCENT FINES)(ASTM D–1140)
▼	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
SP,SP–SM SM,SC,CH	UNIFIED SOIL CLASSIFICATION SYSTEM

NOTE: UPON COMPLETION OF EACH BORING, 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.

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.

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SOIL BORING PROFILES

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SUBSURFACE SOIL EXPLORATION
PROPOSED IMPROVEMENTS AT ERWSF
ORANGE COUNTY, FLORIDA

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APPENDIX

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. However, more frequent or continuous testing is done by our firm through depths where a more accurate definition of the soils is required. 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 at every 5 feet of drilled depth and from every different stratum 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. After completion of a test boring, the hole is kept open until a steady state groundwater level is recorded. The hole is then sealed, if necessary, and backfilled.

AUGER BORINGS

Auger borings are used when a relatively large, 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 C

PERMITS

(PENDING)