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INVITATION FOR BIDS

FOR

WESTERN REGIONAL WATER SUPPLY FACILITY IMPROVEMENTS PHASE 3B

SPECIFICATIONS - VOLUME II

PROJECT MANUAL

FOR THE

**WESTERN REGIONAL WATER SUPPLY FACILITY
IMPROVEMENTS PHASE 3B**

Volume 2 of 2

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ORANGE COUNTY
WESTERN REGIONAL WATER SUPPLY FACILITY IMPROVEMENTS
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DIVISION 11

EQUIPMENT

SECTION 11213

VERTICAL TURBINE WELL PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Furnish all labor, materials, equipment and incidentals required and install, place in operation, and field test vertical turbine well pumps, and motors as hereinafter specified.
2. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment application. It is, however, intended to cover the furnishing, the shop testing, the delivery and complete installation and field testing, of all materials, equipment and appurtenances for the complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.
3. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not, as required for an installation incorporating the highest standards for this type of service.

B. Related Work Described Elsewhere

1. Concrete work is included in Division 3.
2. Painting, except as specified herein, is included in Division 9.
3. Mechanical piping, valves, pipe hangers and supports are included in their respective Sections of Division 15.
4. Electrical work and motors, except as hereinafter specified, is included in Division 16.
5. Concrete bases for pumps and pump motors and installation of anchor bolts is included in Division 3, but anchor bolts shall be furnished under this Section.

C. General Design

1. Three (3) vertical turbine well pumping units are required for this Contract. These pumps will be of the above base discharge, and will be of the constant speed type. The pumping units shall be located and arranged as shown on the Drawings. The pumping units will draw raw water from the Floridan Aquifer.
2. All working parts of identical pumps and motors, such as bearings, wearing rings, shafts, sleeves, motors, etc., shall be of standard dimension built to limit gauges or formed to templates such that parts will be interchangeable between like units and such that the Owner may at any time in the future obtain replacement and repair parts for those furnished in the original machines. All parts shall be properly stamped for identification and location in the machines as shown on the Operation and Maintenance Manuals furnished.
3. All equipment, coatings, and materials that come in contact with raw water shall comply with ANSI-NSF standard 61. The pump manufacturer shall certify in writing that all components that come into contact with water are fabricated of NSF approved materials in accordance with Standard 61.

1.02 QUALITY ASSURANCE

- A. 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.
- B. The pumps covered by these Specifications are intended to be standard pumping equipment of proven ability as manufactured by a reputable manufacturer having long experience in the production of such pumps. The pumps furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed. Pumps shall be manufactured in accordance with the Hydraulic Institute Standards.
- C. All equipment furnished under this Specification shall be new and unused and shall be the standard product of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein a minimum of five (5) years.

1.03 SUBMITTALS

A. Materials and Shop Drawings

Copies of all materials required to establish compliance with the specifications shall be submitted in accordance with the provisions of Section 01340:

Shop Drawings, Working Drawings and Samples. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.
2. Descriptive literature, bulletins, and/or catalogs of the equipment.
3. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves, based on actual shop tests of similar units, which show that they meet the specified requirements for head, capacity, efficiency, NPSHR, and horsepower. Curves shall be submitted on 8-1/2-inch by 11-inch sheets, at as large a scale as is practical. Curves shall be plotted from no flow at shut off head to pump capacity at minimum specified total head.
4. Data including principle dimensions, materials of construction, space required, clearances, piping and electrical connections and requirements, controls, type of finish, installation instructions and other pertinent information.
5. A complete total bill of materials of all equipment including the weights of equipment furnished.
6. A list of the manufacturer's recommended spare parts in addition to those specified in Paragraph 2.04, with the manufacturer's current price for each item. Include gaskets, packing, etc., on the list. List bearings by the bearing manufacturer's numbers only.
7. Complete motor data, including RTD information and wire termination diagrams.
8. Copies of all factory test results, as specified in PART 2 - PRODUCTS of this Section of the Specifications.

9. Discharge plan for well development and disinfection.
10. Submit written certification from the pump manufacturer that all components and coatings that come in contact with water are fabricated of NSF approved materials in accordance with Standard 61.

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.

C. Operating Instructions

1. Operating and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Section 01730: Operating and Maintenance Data.
2. A factory representative of all major component manufacturers, who has complete knowledge of proper operation and maintenance, shall be provided to instruct representatives of the Owner and the Engineer on proper operation and maintenance. With the Owner's permission, this work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3 - EXECUTION. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. 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.
- H. Heaters in the electric motors shall be temporarily wired.

1.05 WARRANTY AND GUARANTEES

- A. Provide equipment warranty as specified in Section 01740: Warranties and Bonds.
- B. Certifications: Furnish certifications as specified in Section 01650: Start-Up. 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. Has been accurately aligned and proper running clearances set.
 - 4. Is free from undue stress imposed by piping or mounting bolts.
 - 5. Is ready to be operated on a continuous basis, and is free from any known defects.

PART 2 - PRODUCTS

2.01 EQUIPMENT GENERAL REQUIREMENT'S

- A. Pump curves shall have no more than one specific flow rate corresponding to one specific head condition except for shut-off head.
- B. Material Service Requirements: Pumps and all related equipment shall be constructed of materials suitable for the intended applications.
- C. Data Plates:
 - 1. All data plates shall be of stainless steel suitably attached to the pump with stainless steel screws. Pump data plates shall contain the manufacturer's name, pump size and type, serial number, speed, impeller diameter, design capacity and head, and other pertinent data.
 - 2. Motor data plates shall contain the manufacturer's name and model number, serial number, rpm, hp, frequency, voltage, phase, efficiency, and service factor.
- D. Hardware: All machine bolts, nuts, and cap screws shall be of the hex head type 316 stainless steel (18-8). Hardware requiring special tools or wrenches shall not be used.
- E. Parts Numbering: Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Identical parts for separate units shall have the same number.
- F. Miscellaneous Parts: The equipment shall be furnished with shims, stainless steel anchor bolts, couplings, motor flanges, and any other miscellaneous materials necessary to properly mount and install pump and motor.
- G. Painting: All external parts of the pump, motor, drive unit, base, and accessories shall be primed and finish painted (1 coat) at the factory prior to shipping. Surface preparation, priming, and finish coating shall be in accordance with Section 09900. All coatings used for shop painting shall be the products of the same manufacturer as the coating to be used for field painting to assure coating compatibility. Color of finish coating shall be medium gray. All coatings that come in contact with pumped water shall be suitable for potable water service as approved by the National Sanitation Foundation (NSF) Standard 61.

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

2.02 VERTICAL TURBINE PUMP

- A. General: The vertical turbine pumps shall be open lineshaft type with a vertical drive hollow shaft motor capable of pumping from the location and in the configuration shown on the Drawings at designed capacities as noted and shall conform to the applicable requirements of ANSI/AWWA Standard E101, latest revision, Vertical Turbine Pumps - Line Shaft and Submersible Types.
- B. Manufacturers: Acceptable manufacturers are listed in Table 11213.
- C. Pump assembly shall meet the requirements specified in Table 11213.
- D. Bowl Assembly: Pump bowls shall be cast iron meeting ASTM A48, Class 30, free from blow holes, sand holes, and all other faults, accurately machined and fitted to close dimensions. Each pump bowl shall be fitted with a replaceable bronze bowl wear ring to restrict the leakage flow at the impeller skirt. Pump bowl interior shall be coated with porcelain or a smooth vitreous enamel.

The exterior of the pump bowls shall be coated with a high build modified epoxy of 10 mils dry film thickness. The coatings shall be compatible for pump service and suitable for potable water use, meeting the approvals of the National Sanitation Foundation (NSF) Standard 61.

- E. Impeller: Pump impellers shall be heavy cast bronze meeting ASTM B-584-C87600, alloy, accurately machined and finished and shall be of the enclosed or semi-open type. Impellers shall be hydraulically and dynamically balanced at normal pump speed. They shall be securely fastened to the impeller shaft with Type 316 stainless steel keys, tapered bushings, or lock nuts. They shall be adjustable vertically by means of a nut in the motor head. Each impeller shall be supported by an upper and lower bearing.
- F. Impeller Shaft: The impeller shafting shall be ANSI Type 416 ASTM A276 stainless steel pump shaft shall be turned, ground and polished. All impeller shaft shall be supported in the bowl by a combination of water lubricated bronze ASTM B-505-C84400 bearings above and below each impeller. The size of the shaft shall be determined by the procedure described in AWWA Standard E101. The straightness and machining tolerance shall be the same as those given under "Lineshafts".

G. Lineshafts:

1. The line shafting shall be manufactured of Type 416 ASTM A276 stainless steel, and shall be turned, ground, and polished precision shafting. The line shaft shall be no less than 1 1/4-inch diameter for motors rated less than 125 Hp and no less than 1 7/16-inch diameter for motors rated for 125 Hp or higher. The shaft couplings shall be designed with a safety factor of 1 1/2 times the shaft safety factor and shall have a left-hand thread to tighten during pump operation. The line shaft shall be coupled to the motor shaft (head shaft) above the discharge head. To ensure accurate alignment of the shafts, they shall be straight within 0.005-inch total indicator reading for the entire length, the butting faces shall be machined square to the axis of the shaft, and the maximum permissible error in the axial alignment of the thread axis with the axis of the shaft shall be 0.002-inches in 6 inches.
2. Line shaft bearings shall be designed for vertical turbine pump service and be lubricated by the liquid pumped. Bearings shall be mounted in retainers which shall be held in position in the column couplings by means of the butted ends of the column of not more than 10 feet separation. Line shaft bearings shall be neoprene with ductile iron or bronze line shaft bearing retainers.

H. Column Pipe: The column pipe shall be standard 10-foot lengths with screwed coupled connections. The column size shall be such that the friction loss will not exceed 4 feet per 100 feet at the rated capacity of the pump. The column pipe shall be Schedule 40 steel pipe conforming to AWWA C200, supplied with butt threaded connections and coated internally and externally with a high build modified epoxy of 10 mils dry film thickness. Column pipe shall be tack-welded at each connection. Coating shall be compatible for pump service and suitable for potable water use as approved by the National Sanitation Foundation (NSF) Standard 61. The pipe shall be faced parallel and machined with threads to permit ends to butt to ensure proper alignment when assembled.

I. Discharge Head: The discharge head shall provide for above-ground mounting, be of high-grade cast iron construction, in accordance with ASTM A48, Class 30, and shall provide machined surfaces for base support, motor attachment, discharge pipe flange attachment, and column pipe attachment. Discharge head shall support vertical electric motor, pump column, and bowls. Drive shaft shall be coupled above the stuffing box in the discharge head to facilitate easy removal and replacement of the driver. The discharge flange shall be drilled for 125 pound template (ANSI Standard B16.1). Lifting lugs shall be provided with the capacity to support the weight of the entire pump unit. The interior of the discharge head not exposed to view shall have a coating of high build modified epoxy of 10 mils

dry film thickness. Coating shall be compatible for pump service and suitable for potable water use as approved by the National Sanitation Foundation (NSF) Standard 61.

- J. **Stuffing Box:** The discharge head of the well pumps shall be fitted with a stuffing box, having a bronze bearing, cage ring, split type packing gland and not less than six (6) rings of graphited fiber packing. The bearing grease fitting shall extend to the exterior of the discharge head. Provide a water slinger above the stuffing box and a connection for discharge of the stuffing box water to the exterior of the discharge head. The discharge head design shall permit the shaft to be coupled above the stuffing box to facilitate easy removal and replacement of the driver. Access to the stuffing box shall be through windows placed 90 degrees from the discharge. Fit the windows with stainless steel wire fabric guards conforming to OSHA standards. Guards shall be supplied by the pump manufacturer.

- K. **Foundation Plate:** A suitable foundation plate of fabricated steel or cast iron 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. Omission of foundation plates will not be permitted.

- L. **Strainer:** Provide a 316 stainless steel threaded cone type strainer for installation on the suction bell. Strainer shall be provided by pump manufacturer.

2.03 PUMP MOTORS

- A. The pump manufacturer shall be responsible for supplying the motor and shall ensure proper coordination for mounting of the motor on the pump. He shall properly select and size the drive unit for the pump inclusive of thrust bearing capacity for all conditions as start-up, runout, and shutoff. Motors shall meet the requirements of Section 16405 unless otherwise specified herein.

- B. The motor bearing loading for the driver shall include the total pump lineshaft downthrust. The motor bearings shall be designed to withstand any momentary total upthrust.

- C. Adjusting nut shall be provided at the top of the motor for varying the impeller clearance.

- D. The pump motor shall be a vertical hollow shaft, high thrust, specially built NEMA Style "P" base, squirrel cage induction type, with low starting current and

normal starting torque characteristics. The motor shall be designed for continuous operation with a 460 volt, 3 phase, 60 Hertz power supply with a maximum speed as provided in Table 11213.

- E. Pump motor shall be provided with a non-reverse ratchet coupling assembly. Motor windings shall be double dipped and baked with epoxy and finally shall be coated with a fungicidal varnish suitable for tropical environments. Rotation of the vertical shaft shall be counter clockwise when viewed from above.
- F. The motor shall be non-overloading, without use of the service factor, at any point on the driven pump's performance curve. The motor shall be NEMA Design B, and shall be designed, constructed and tested in accordance with applicable IEEE, NEMA, AFBMA and ANSI standards as manufactured by U.S. Electrical Motors, or an equal approved by the Engineer.
Motors shall be given a short commercial test in accordance with IEEE standards and furnished with the following construction features before shipping to the pump manufacturer testing facility:
 - 1. Construction: All cast iron construction for frame, end brackets, conduit box and fan shroud. Motor shall be supplied with lifting lugs or "O" type bolts on the top of the motor.
 - 2. Enclosure: Totally Enclosed Fan Cooled (TEFC) design with forced air circulation by integral fan.
 - 3. Horsepower: Motor horsepower shall meet requirements as specified in Table 11213.
 - 4. Efficiency: Premium, 95 (minimum) percent at full load capacity
 - 5. Insulation: Class F
 - 6. Temperature Rise: Class B based upon 40 degrees C ambient
 - 7. Service Factor: 1.15
 - 8. Epoxy coated rotor and stator windings.
 - 9. Motor windings for stator and rotor and motor leads shall be manufactured using solid copper wire.
 - 10. Shielded, regreasable, vacuum degassed steel ball bearings. Motor thrust bearings shall have ample capacity to carry the weight of all rotating parts

plus the hydraulic thrust of the pump impellers with an ample safety factor. Minimum B-10 bearing life of 100,000 hours.

11. Corrosion resistant hardware and grease plugs.
12. Gasket between motor frame and conduit box.
13. Gasketed cast iron conduit box.
14. Stainless steel nameplate fastened with stainless steel pins.
15. Accessories: Each motor shall be provided with a heat overload protection device to protect the motor from overheating during operation. Heat overload protection shall be accomplished through 100 ohms Platinum material, three wires RTDs embedded in the motor windings, two RTD's per pahse, for a total of six (6) RTD's per motor. RTD leads shall be brought out to a separate outlet box with a terminal strip and mounted to the motor. RTD transducers will be provided and installed in the PLC control panel by the I&C Contractor. Motor supplier shall coordinate with I&C supplier for the RTD transducers type requirements and Electrical Contractor for cables requirements. Motor shall be provided with a 120-volt single phase strip heater to maintain a motor temperature of at least 40 degrees C, or 10 degrees C above ambient, whichever is greater, when the motor is not running.
16. Vibration and Sound limits: Vibration shall not exceed Hydraulic Institute Standards and sound pressure level shall not exceed 80 dbA at 5 feet under full load conditions in accordance with IEEE standard 85.
17. A grounding lug shall be provided in the conduit box.

2.04 PUMP AND MOTOR COUPLING GUARD

- A. Provide a coupling guard on the discharge head to prevent personal injury from the rotating pump and motor coupling. The guard shall be manufactured of 316 stainless steel and shall comply with all applicable OSHA requirements. The guard shall be fastened to the pump base with Type 316 stainless steel bolts and nuts or screws and shall be easily removable for access to the pump and motor coupling.

2.05 ACCESSORIES

- A. Sampling Tap and Pressure Gauge Tap: A sampling tap shall be provided for the purpose of taking samples on each pump discharge header. One suitably sized pressure gauge with isolation valve shall be supplied as specified in Section 15050. The gauge tap and sample tap shall be connected to the pump discharge header upstream of the check valve. The sample tap shall be smoothed nosed type (no connection threads are permitted).
- B. Miscellaneous Parts: The equipment shall be furnished with shims, Type 316 stainless steel anchor bolts, couplings, motor flanges, and any other miscellaneous materials necessary to properly mount and install pumps and motors.
- C. Lubricants: Pump and drive units shall be delivered with the equipment fully lubricated insofar as possible. If any point cannot be serviced, it shall be clearly marked to the effect that it is not lubricated and requires servicing prior to operation. An adequate supply of proper lubricant, with instructions for its application, shall be supplied with the equipment for each point not lubricated prior to shipment.
- D. Spare Parts: Furnish the recommended spare parts, properly boxed and labeled for each size and type of pump provided for the Project, as a minimum, the following:
 - 1. 2 sets of packing, lantern rings and stuffing box bearing.
 - 2. 2 sets of shaft sleeves, keys, and accessories.
 - 3. One year supply of each type of lubricant required
 - 4. One (1) set of pressure gauges.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Existing wells where the pump is being replaced shall not be taken out of service for more than 30 days.
- B. Installation of pumping equipment shall be in strict accordance with the respective manufacturer's instructions and recommendations in the locations shown on the Drawings. Equipment shall be installed by experience and mechanically skilled workmen with previous experience in similar installations. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.
- C. All necessary piping, fittings, valves, air relief valves, vents, concrete foundation, anchor bolts, grouting, etc. shall be provided to ensure a complete and satisfactory installation of the pumping equipment including pump, electric motor, line shafting, column pipe, electrical connections and piping connections.
- D. Install pressure gauges on the pump discharge piping as shown on the Drawings, including an isolation valve and pressure gauge at each location.
- E. Hardware: All anchor bolts, nuts and washers shall be Type 316 stainless steel. All brackets and the hardware items shall be Type 316 stainless steel.
- F. Install piping, fittings, valves and other appurtenances to the pump installation in accordance with the manufacturer's installation instructions, the requirements of referenced sections included with these specifications and as shown on the Drawings. Equipment shall be installed in a workmanlike manner so that individual equipment will function properly and freely and no individual parts shall be strained.
- G. Noise and Vibrations: all equipment containing moving parts shall be installed level and plumb, unless otherwise indicated in the Drawings or in the specifications; and shall be anchored securely in order that noise be suppressed to a minimum and that vibrations do not cause damage while in operation.

3.02 COATINGS

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

- B. Gears, bearing surfaces, and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust resistant coating. This coating shall be maintained as necessary to prevent corrosion during periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.
- C. Field painting is specified under Painting: Section 09900. The primer and paint used in the shop shall be products of the same manufacturer as the field paint to assure compatibility.
- D. Pump finish color shall match the pipe color to which it is attached. Pump motor finish color shall be white.

3.03 FACTORY SERVICE REPRESENTATIVE

- A. The equipment manufacturer shall furnish the services of a competent and experienced representative who has complete knowledge of proper operation and maintenance of the equipment for a period of not less than two (2) eight (8) hour days in two separate visits to inspect the installed equipment, supervise the initial test run, and to provide instructions to the plant personnel. The first visit will be for checking and inspecting the equipment after it is installed. The second visit will be to operate and supervise the initial field test. At least four (4) hours of the second day shall be allocated solely to the instruction of plant personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten days in advance with the Owner and shall take place prior to acceptance by the Owner. The final copies of Operation and Maintenance manuals specified in Section 01730 must have been delivered to the Engineer prior to scheduling the instruction period with the Owner.

3.04 INSPECTION AND TESTING

- A. After pump has been completely installed, the Contractor shall conduct, in the presence of the Engineer, testing of all mechanical equipment and piping as in operation to demonstrate capacity, correct alignment, smooth operation, proper adjustment, and freedom from noise, vibration, over-heating and leaking, and to ensure satisfactory compliance with the Specifications. All defects shall be corrected. The Contractor shall supply all oil, grease, electric power, water, and all other material necessary to complete the field tests.
- B. If the pump performance does not meet the Specifications, corrective measures shall be taken by the Contractor, or pump shall be removed and replaced with a pump which satisfies the conditions specified.

- C. Motor Field Testing: Motor shall be disconnected from the pump and run for four (4) hours. Following the run-in test, reconnect the motor to the pumping equipment and reinstall all coupling guards.
- D. Pump Field Testing:
 - 1. Upon completion of all the mechanical work, the Contractor shall conduct testing as specified herein to demonstrate that the equipment performs in accordance with all Specifications.
 - 2. The Contractor shall perform initial testing of the equipment to ensure himself that the tests listed in the Demonstration Test paragraph below can be completed.
 - 3. The Demonstration Test shall demonstrate that all items of these Specifications have been met by the equipment, as installed, and shall include the following tests:
 - a. That the pump can deliver the specified pressure and discharge flow at rated efficiency.
 - b. That the pump controls perform satisfactorily.
 - 4. In the event that the equipment does not meet the Demonstration Test, the Contractor shall, at his own expense, make sure changes and adjustments in the equipment which he deems necessary and shall conduct further tests until written certification is received from the Engineer.
- E. All piping, fittings and valves shall be hydrostatically tested in accordance with Section 15044 - Pressure Testing of Piping.
- F. All piping, fittings, and valves shall be disinfected and bacteriologically cleared for service in accordance with Section 15050.

3.05 PUMP CURVES

- A. Submit to the Engineer six (6) of the certified performance curve for each pump, 8 1/2-inch by 11 inch in size, laminated in plastic. The pump curve shall indicate the pump number, type of service, manufacturer, model number, serial number, location in the plant and other data specific to the pump as required above for submittals.

3.06 DISINFECTION

- A. Following installation of the well pumps, the Contractor shall disinfect each well and clear bacteriologically as required by the Florida Department of Environmental Protection (FDEP).

Disinfection shall be in accordance with the latest revision of AWWA C654 Standard for Disinfection of Wells and as set forth in Chapter 62-555.315, Florida Administrative Code (F.A.C.).

- B. For well No. 11, a minimum of 20 samples taken on separate but consecutive days shall be collected for bacteriological testing in accordance with 62-555.315 F.A.C.

3.07 DISCHARGE PLAN

- A. Contractor shall submit a discharge plan for the disposal of all water used in start-up, testing, and disinfection of the well and pump for review and approval by the County.

TABLE 11213

VERTICAL TURBINE WELL PUMP PERFORMANCE REQUIREMENTS

Pump No.	Well Pump No. 4 (WP-404)	Well Pump No. 7 (WP-407)	Well Pump No. 11 (WP-411)
Quantity	1	1	1
Service	Well Pump	Well Pump	Well Pump
Well Casing Diameter (in)	24	24	24
No. of Stages (maximum)	3	3	3
Maximum Pump Design Speed (rpm)	1,800	1,800	1,800
Discharge Size (inches)	12	12	12
Column Diameter (inches)	12	12	12
Column Depth (ft)	140	150	150
Primary Operating Flow (gpm)	3,000	3,000	3,000
Primary Operating TDH (ft)	150	150	150
Secondary Operating Flow (gpm)	3,600	3,600	3,600
Secondary Operating TDH (ft)	111	111	111
Minimum Efficiency @ Primary flow & TDH (%)	80	80	80
Minimum Shut Off Head (ft)	220	220	220
Maximum Allowable ⁽¹⁾ NPSH Required (feet)	55	55	55
Maximum Motor Size (Hp)	150	150	150
Motor Type	TEFC	TEFC	TEFC
Pump Discharge pressure Gauge (psi)	0-100	0-100	0-100
Pump Manufacturers	A. Goulds – Model DWT-FFTM, 14RHHC B. Ingersoll/Rand C. Peerless – Model 16HXB		

⁽¹⁾At all points on the pump curve

General Notes:

1. If the required motor to meet the design conditions is larger than the motor size specified above, the pump manufacturer is responsible for providing adequate wiring and starter for the larger motor.
2. Pump shall not exceed motor rating over the entire pump curve.

END OF SECTION

DIVISION 12

FURNISHINGS
(NOT USED)

DIVISION 13

SPECIAL **CONSTRUCTION**

SECTION 13205

PRESTRESSED CIRCULAR CONCRETE TANKS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Requirements specified in Conditions of Contract and Division 1: General Requirements form a part of this Section. Provide for the design and construction of the following tanks: one (1), 2.0 MG potable water ground storage tank. Prestressed concrete tanks shall have domed top and shall conform to the dimensions and locations shown on the Drawings. The tank construction company shall furnish all engineering services required for the preparation of design calculations and detailed design drawings, and furnish all materials, labor and equipment for the construction of the prestressed tank as shown on the Drawings and as specified herein.
2. The prestressed concrete tanks shall be of composite steel-shotcrete, wire-wound, prestressed construction. The wire-wound prestressed composite wall shall include a shotcrete core wall in which a steel shell diaphragm of a height equal to the full wall height has been encased. All prestressing shall be done with high tensile wire permanently bonded to the tank wall. The tank floor shall be of concrete or shotcrete construction containing no less than 0.6 percent of reinforcing steel.
3. Concrete tank manufacturer shall match the appearance of the existing two (2) ground storage tanks. Existing ground storage tanks were constructed by the Crom Corporation, Gainesville, Florida.

B. Related Work Described Elsewhere:

1. Excavation, Backfilling and Compaction: Section 02200.
2. Concrete Reinforcement: Section 03200.
3. Cast-In-Place Concrete: Section 03300.
4. Leakage Testing of Hydraulic Structures: Section 03800.
5. Reinforced Unit Masonry: Section 04230.

6. Miscellaneous Metal: Section 05510.
7. Metal Fabrication: Section 05500.
8. Fiberglass Reinforced Plastic Components: Section 06615.
9. Painting: Section 09900.
10. Process and Utility piping, fittings, valves and accessories: Division 15.

C. General Design

1. The thickness of the core wall shall be calculated so as to accept the initial compressive forces applied by prestressing, hydrostatic stresses induced by contents, and other applicable loads such as soil backfill and wind.
2. Backfill loads shall not be used in the design of the core wall to counteract hydraulic loads or provide residual compression in the wall.
3. All prestressing shall be done with high tensile steel wire in which a substantial allowance shall be made for loss of prestress due to shrinkage and plastic flow in the shotcrete and to relaxation in the steel wire and diaphragm.
4. Size and Configuration of Tank: The dimensions of the prestressed circular concrete tanks including the floor slopes, sumps, tank diameters and vertical wall heights shall be as indicated on the Drawings.
5. Design of the prestressed tanks shall accommodate the following differential and total settlements. Settlement values are as reported in the geotechnical soils report titled, "Final Report of Geotechnical Engineering Investigation Western Service Area, Phase III, Western Regional Water Supply Facility, Orange County, Florida" dated March 28, 2008.

<u>Tank</u>	<u>Differential Settlement (in)</u>	<u>Total Tank Settlement (in)</u>
Potable Ground Storage Tank No. 3	TBD \leq 0.75	TBD \leq 2.8

- D. The Contractor shall be responsible for coordinating all activities between the prestressed concrete tank construction company required for a complete installation. Activities requiring extensive coordination would include but not be limited to shop drawing submittals, embedded items required to be installed during construction of the prestressed concrete tank.

Construction of the prestressed concrete tank shall not commence until all key dimensions, equipment and pipe locations, and any other interdependent items are approved by the Engineer and any conflicts or ambiguities are resolved. It shall remain the Contractor's sole responsibility to resolve any errors or conflicts arising during construction due to improper coordination between the prestressed concrete tank construction company.

1.02 QUALITY ASSURANCE

- A. Design Standards: Unless otherwise indicated, all materials, workmanship and practices shall meet all requirements of the following standards, latest revisions.
1. Standard Building Code.
 2. ACI 301: Specifications for Structural Concrete for Buildings.
 3. ACI 318: Building Code Requirements for Reinforced Concrete.
 4. ACI 506R: Guide to Shotcrete.
 5. ACI 372R-03: Design and Construction of Circular Wire and Strand Wrapped Prestressed Concrete Structures.
 6. AWWA D110-04 - Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.
 7. ASTM A821/A821M - Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks.
 8. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy With Improved Formability.
 9. ASCE Standard 7-05 - Minimum Design Loads for Buildings and Other Structures.
 10. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 11. ASTM A416/A416M - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
 12. ASTM A884/A884M - Standard Specification for Epoxy Coated Steel Wire and Welded Wire Reinforcement.

13. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
14. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
15. ACI 305R - Hot Weather Concreting.
16. ACI 306R - Cold Weather Concreting.
17. ACI 350 - Building Code Requirements for Environmental Engineering Concrete Structures and Commentary.
18. ASTM C31/C31M - Test Methods for Making and Curing Concrete Test Specimens in the Field.
19. ASTM C39/C39M - Test Method for Compressive Strength of Cylindrical Concrete Specimens.
20. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
21. ASTM C143 - Standard Test Method for Slump of Hydraulic -Cement.
22. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
23. ASTM C33/C33M - Specification for Concrete Aggregates.
24. AWWA C652 - Disinfection of Potable Water Storage Tanks.
25. ASTM D1056 - Standard Specification for Flexible Cellular Material.

B. Qualifications and Experience of Tank Construction Company: The tank construction company shall have the following qualifications and experience:

1. The tank construction company shall specialize in the design and construction of wire-wound circular prestressed composite steel-concrete tanks. The tank construction company shall give satisfactory evidence that it has the skill, reliability and financial stability to design, build and guarantee the tank in accordance with the quality required by these specifications.

The tank construction company shall have at least ten (10) years experience in this specialty and shall have built completely in its own name in the past five years no less than ten (10) prestressed composite tanks of comparable size, which meet these specifications and are now demonstrating satisfactory service.

2. The tank construction company staff shall include a full-time Professional Engineer Registered in the State of Florida having no less than ten (10) years experience in the design and field construction of circular prestressed composite tanks who will be the responsible engineer in charge of the work to be done. All Working Drawings and design calculations shall carry the seal of such Registered Professional Engineer.
3. Acceptable Tank Manufacturers: The tank shall be as manufactured by the Crom Corporation, Gainesville, Florida or Precon Corporation, Newberry, Florida, no substitutions.

C. Design Criteria: To compensate for bending moments and for shrinkage, differential drying, and temperature stresses, the following reinforcing steel shall be incorporated in the core wall:

1. The top 2 feet of core wall shall have not less than 1% circumferential reinforcing.
2. The bottom 3 feet of core wall shall have not less than 1% circumferential reinforcing.
3. Inside Face:
 - a. 26-gauge steel shell diaphragm continuous the full wall height, without horizontal splices.
 - b. Additional vertical and horizontal reinforcing steel bars as required by design computations.
4. Outside Face:
 - a. Vertical reinforcing steel: Minimum of #4 bars at 12-inch center to center.
 - b. Additional vertical and horizontal reinforcing steel bars as required by design computations.

5.	Allowable Tensile Stress	f_s	18,000 psi
	Yield Strength	f_y	40,000 psi

6. Design Loads: Wind loads, including uplift and overturning shall be as required by the Florida Building Code and any local amendments to the Code ASCE-7, or shall be for 155-mph wind loading, whichever is greater.
7. Qualifications of Workmen: The foreman, nozzle men and gunmen shall be skilled in their duties and certified in accordance with the guidelines by ACI Committee 506 Certification as outlined in Publication CP-60, latest revision. The Contractor shall submit the names of the men performing the above duties, with a statement of certification as to their qualifications. Certification will be accomplished by a recognized authority such as ELF/FC&PA*, ACI, or approved equal.

*ELF - Engineering Laboratory Forum, Florida Institute
of Consulting Engineers
FC&PA - Florida Concrete and Products Association

1.03 SUBMITTALS

- A. Shop Drawings: The Contractor shall submit a complete set of detailed shop drawings signed and sealed by a Florida Registered Professional Engineer for the work to be done. Inside dimensions, pipe openings and provisions for mechanical equipment shall be maintained as established by the Engineer. Shop drawings must be approved before construction may begin.
- B. Design Computations: The Contractor shall submit complete design computations. The design shall be done under the direction of a Florida Registered Professional Engineer and shall be signed or sealed by name of the design engineer. The design computations shall include all components of the tank, including wall, cantilevered launders, floor and sumps, baffle wall, wall penetrations, pipe supports, the wall reaction to the bottom slab, and the loads imposed by concrete dome covers. The design shall include consideration of temperature differentials under various conditions, stresses at wire winding and completed stages with tank empty and full, flexure in walls and base, anticipated movement of base under circumferential wire stresses, special stresses at wire anchorages and a construction procedure listing in chronological order the various operations of construction. The design computations shall be submitted for approval at least 30 days before the materials are assembled at the job site.
- C. Shop drawings shall be submitted showing complete details, dimensions, materials, fastenings, anchorages and special details of wall reinforcement at attachment of accessories and details of interior launder construction.

- D. If a sliding waterstop is used in the floor/wall joint, submit load/shear/deflection data to support shear and deflection calculations for base of wall. Tests shall have been generated for the particular waterstop configuration proposed.
- E. Submit to the Engineer a guarantee document as specified in Paragraph 1.04, herein following tank construction.

1.04 WARRANTY

- A. The tank construction company shall guarantee workmanship and materials on the entire tank structure and all accessories, including shrinkage cracks, for a period of five (5) years from Final completion. In case leakage or other defects appear within the five (5) year period, the tank construction company shall promptly make repairs at its own expense, upon written notice by the Owner that such defects have been found.
- B. To satisfy the five-year guarantee, acceptable tank construction companies listed under paragraph 1.02B.3. above shall be required to furnish a written company warranty for the five-year period.
- C. Leakage is defined as the stream flow of liquid appearing on the exterior surface of the tank, or leakage through the base slab, the source of which is from the inside of the tank. Leakage shall be determined by leakage testing as defined in Section 03800, Leakage Testing of Hydraulic Structures.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Concrete
 - 1. Concrete shall have a 28 day compressive strength of 4000 psi and shall be in conformance with the requirements of Section 03300: Cast-in-Place Concrete. Cement shall be Type II.
- B. Shotcrete: Shall be in accordance with ACI Standard 506, latest revision, except as indicated otherwise herein. Proportions for all shotcrete shall be one part cement to 4 parts moist sand by weight, except that proportions of 1 to 3 shall be used for the cover coat on each side of the steel shell diaphragm and over the wire wrapping; these richer cover coats shall be at least 1/4-inch thick (measured from the outside of the wire for wire wrapping coat). Sand shall be composed of hard, strong, durable, uncoated grains of quartz in accordance with gradation limits in ACI 506, except that the fineness modulus maybe reduced to 2.0.

1. Compressive strength (f_g) shall be 4000 psi or greater at 28 days.
2. Allowable compressive stress (f_g) shall be determined by the formula $1250 + 75t$ with $0.45 f_g$ maximum where t is the core wall thickness.
3. Allowable compressive stress (f_g) due to initial prestressing force shall be $0.50 f_{gi}$ or less, with a minimum of 2000 psi, where f_{gi} is defined as compressive strength at time initial prestressing force is applied.
4. Cement shall be in accordance with the requirements of Section 03300: Cast-in-Place Concrete. Cement shall be Type II.

C. Prestressing Wire:

1. Cold drawn, high-carbon steel wire complying with ASTM A-821 Type B.
2. Wire size shall be 0.162 inch diameter (8 gauge) or larger, but no larger than 0.250 inch.
3. Working stress for wire in the wall (f_s) shall be 115,000 psi.
4. Allowable tensile stress before losses (f_{is}) shall be 145,000 psi or no greater than $0.70 f_s$.
5. Ultimate tensile strength (f_{su}) shall be 231,000 psi or greater.

D. Reinforcing Bars:

1. In conformance with ASTM A615, Grade 60, and with the requirements of Section 03200: Concrete Reinforcement.
2. Floor slab bar supports shall be reinforced steel bolster.

E. Wire Fabric Reinforcement:

1. Welded wire fabric shall conform to ASTM A185: Welded Wire Fabric for Concrete Reinforcement. Wire fabric shall be electrically welded and not galvanized wire. Welded wire fabric shall be furnished in flat sheets, rolled WWF is not permitted.
2. Welded wire fabric supports shall be plastic bolsters with bar ties galvanized.

F. Steel Shell Diaphragm:

1. Steel tank shell diaphragm shall be cold rolled sheet, minimum 26-gauge, conforming to ASTM A1008 for Commercial Quality Cold Rolled Steel, with a Class 2, rolled finish or approved equal.

G. PVC waterstops shall have minimum thickness of 3/8 inch in areas exposed to hydraulic loads.

2.02 ACCESSORIES

A. Accessories to be provided with of the 2.0 MG Potable Water Ground Storage Tank is as follows:

1. Accessories

- a. Two (2) access manholes.
- b. One (1) set of exterior aluminum stairs.
- c. One (1) interior fiberglass ladder with TS safety rail.
- d. Eight (8) precast concrete overflow outlets.
- e. Three (3) fiberglass access hatch for dome access. (Sizes are shown in the Drawings.
- f. One (1) fiberglass dome vent.
- g. Aluminum handrailing around the dome hatch openings and around the tank dome perimeter.
- h. Three (3) dome probe curbs (as shown in the Drawings).
- i. Eight (8) sample ports with smooth nozzle sample taps.
- j. CMU baffle wall.

Accessories shall be provided and installed by the prestressed concrete tank construction company. Accessories shall be as specified below.

B. Access Manholes:

1. Two (2) access manholes shall be provided for the prestressed concrete storage tank. The access manholes shall be located on the vertical wall of the tank, at the locations shown on the Drawings. Each access manhole shall include a fabricated stainless steel frame and a fabricated stainless steel cover. The frame and cover shall be fabricated of aluminum. The cover plate shall be suitably gasketed as necessary to provide permanent water tightness. The manhole shall have a waterstop and be sealed with epoxy on the inside perimeter to preclude leakage. The manhole opening shall be in the shape of a round-ended slot approximately 17 inches high and 36 inches long.

2. All bolting materials shall be ASTM A320, B8M, Class 2, Type 316 stainless steel, high strength bolts and nuts. Washers shall be Type 316 stainless steel. Nuts shall have a hardness that is lower than that of the bolts and the washers by a difference of 50 Brinnell hardness to prevent galling.

C. Aluminum Handrails, Platforms and Grating:

Aluminum platforms shall be designed to support the intended live and dead loads with a minimum factor of safety of 2.0. The maximum deflection for platforms shall be limited to a maximum of 1:360 of the maximum span. Aluminum used for fabrication shall be structural aluminum shapes in accordance with Section 05500 - Miscellaneous Metals. Aluminum grating used for platforms shall be in accordance with Section 05500 - Miscellaneous Metals. Aluminum handrailing installed around the dome access hatch and the aluminum access platforms shall be a three rail type handrail system, with a 4-inch toe board. Handrailing shall be constructed of 1 1/2-inch (1.90" o.d.), Schedule 40 aluminum pipe, Alloy 6063-T6, in accordance with Section 05500 - Miscellaneous Metals.

D. Exterior Access Stairs:

Aluminum stairs with handrail, kick plates and landings shall be fabricated from aluminum alloy 6061-T6, or equal and shall meet all OSHA requirements. Stairs shall be designed with three (3) flights and landings and shall be located approximately where shown in the Drawings. Provide structural calculations signed and sealed by a Florida licensed professional Engineer.

E. Fiberglass Ladders:

Fiberglass ladders shall be completely fabricated of fiberglass reinforced plastic (FRP) structural shapes. Ladder uprights shall be 2-inch square tubing with a 1/8 inch wall thickness and shall be spaced 18 inches apart. Supports shall be 3/8-inch by 2-inch Type 316 stainless steel bars bent to shape and shall be spaced not over 5 feet apart. Ladders shall be rigidly supported not less than 7 inches from adjacent surfaces and shall be secured to the shotcrete wall by 316 stainless steel bolts embedded in the shotcrete during construction of the wall. Rungs shall be not less than 1-inch diameter, solid fiberglass bars, spaced 12 inches on centers with the ends fitted into and bonded to the uprights with epoxy. Fiberglass shapes for ladder fabrication shall be in accordance with Section 06615 – Fiberglass Reinforced Plastic Components. An approved ladder safety device with stainless steel TS rail and two safety harnesses shall be provided with the ladder, which shall be Saf-T-Climb as manufactured by Norton Company Safety Division, Climbers Buddy Corporation, or equal. The ladder, and safety device shall be

designed, fabricated, and erected in accordance with Part 1910 of the Occupational Safety and Health Standards of the Department of Labor.

F. Fiberglass Hatch Cover:

Fiberglass hatch covers shall be fabricated of 1/4- inch thick laminated fiberglass. Laminated Fiberglass fabrications shall be in accordance with Section 06615 - Fiberglass Reinforced Plastic Components. Dimensions of the hatch cover shall be as shown on the Drawings. The hatch cover shall be mounted onto a precast concrete curb cast into the dome cover.

The oversized frame for the fiberglass cover shall lap over and down the side of the precast concrete curb to provide weather-tightness. The fiberglass frame shall have an integrally fabricated curb for mounting of the access hatch. The access hatch shall lap over and down the side of the fiberglass frame curb to provide weather-tightness. The fiberglass frame and access hatch shall be gasketed with a suitable neoprene gasket to prevent the entrance of water and insects. The hatch cover shall have a smooth, even, snug bearing in the locked position. All frame anchor bolts, hinges, lock loop, fasteners and other hardware shall be Type 316 stainless steel.

The fiberglass hatch cover shall conform to the applicable requirements of Part 1910 of the Occupational Safety and Health Standards of the Department of Labor.

G. Fiberglass Vent:

Fiberglass vents shall be fabricated of 1/4-inch thick laminated fiberglass. Laminated fiberglass fabrications shall be in accordance with Section 06615 - Fiberglass Reinforced Plastic Components. The vent shall be mounted onto a precast concrete curb cast into the dome cover. A neoprene gasket shall be provided between the concrete curb and the fiberglass vent to prevent the entrance of water and insects. The fiberglass vent shall have a throat opening of 50-inches in diameter. The vent area shall be adequate for air venting at tank fill and withdrawal rates of 47.5 MGD. To prevent the entry of birds, animals and insects, the vent throat area and vent rim openings shall be covered with 24x24 mesh, vinyl covered fiberglass screening. All vent anchor bolts, fasteners and other hardware shall be Type 316 stainless steel.

H. Precast Concrete Overflow Vents:

Overflow outlets for domed tanks shall be precast concrete with 24x24 mesh, vinyl covered fiberglass insect screen and fiberglass frame attached with Type 316 stainless steel bolts of the size and number required. The precast concrete overflow outlets shall be cast into the dome cover. Each overflow outlet shall be sized for a 4.0-MGD minimum outflow.

I. CMU Baffle Wall:

Design of the CMU baffle wall shall be the responsibility of concrete tank manufacturer and shall match the dimensions and location shown in the Drawings. CMU shall be in accordance with Specification Section 04230 and coating shall be in accordance with Specification Section 09900. Design of the concrete tank floor by the concrete tank manufacturer shall account for additional loads from the CMU baffle wall.

PART 3 - EXECUTION

3.01 CONSTRUCTION

- A. Excavation and Compaction: Excavation and compaction prior to tank construction shall be in conformance with the applicable requirements of Section 02200: Excavation, Backfilling and Compaction.
- B. Floor:
1. The completed subgrade shall be wetted to a saturated condition just prior to placement of the concrete floor.
 2. Concrete membrane floors (4 inches thick) shall have a minimum thickness of 8 inches of concrete over all pipe encasements. The minimum percentage, 0.6 percent, of reinforcing steel applies to these thickened sections and shall extend a minimum of 2 feet in to the adjacent 4 inches thick floor.
 3. Floors shall be vibratory screeded to effect consolidation of concrete and proper encasement of floor reinforcing steel.
 4. The floor shall be sloped to drain with the finishing criteria stated in Section 03300: Cast-in-Place Concrete, except that the finishing tolerance shall be 1/2 inch in 10 feet, as determined by a 10-foot straightedge placed anywhere on the slab in any direction. The floor shall have a light broom finish.
 5. Floors shall be continuously water cured until tank construction is completed.

C. Core Wall:

1. The core wall shall be constructed of shotcrete, encasing a steel shell diaphragm continuous the full wall height without horizontal splices. The shotcrete shall be placed in accordance with ACI 506 as outlined in ACI Certification Public CP-60: A Guide to Shotcrete, latest revision.
2. The thickness of the core wall shall be calculated so as to resist the initial compressive forces applied by prestressing, backfill, and other applicable loads. The wall may taper uniformly on the outside face from top to bottom as required by design computations. In no case shall the core wall be less than 3-1/2 inch thick. Horizontal sections of the wall shall form true circles without flats, excessive bumps, or hollows.
3. To compensate for bending moments and for shrinkage, differential drying, and temperature stresses, the following reinforcing steel shall be incorporated in the core wall, as a minimum:
 - a. The top 2 feet of core wall shall have not less than 1 percent circumferential reinforcing.
 - b. The bottom 3 feet of core wall shall have not less than 1 percent circumferential reinforcing.
 - c. Inside Face:
 - 1.) Vertical reinforcing steel: minimum of #4 bars at 12 inches center to center.
 - 2.) Additional vertical and horizontal reinforcing steel as required by design computations.
 - d. Outside Face:
 - 1.) Vertical reinforcing steel: minimum of #4 bars at 12 inches center to center.
 - 2.) Additional vertical and horizontal reinforcing steel bars as required by design computations.
4. Curing:
 - a. Interior core wall shall be continuously water cured for a minimum of 7 days or until prestressing starts.

b. Exterior core wall shall be continuously water cured for a minimum of 7 days or until prestressing starts.

5. Tolerances:

a. Tank Radius: The maximum permissible deviation from the specified tank radius shall not be greater than 0.1 percent of the radius or 60 percent of the core wall thickness, whichever is less.

b. Vertical Walls: Walls shall be plumb within 3/8 inch per 10 feet of vertical dimension.

D. Steel Shell Diaphragm:

1. A 26 gauge steel tank shell diaphragm, complying with ASTM A1008 for Commercial Quality Cold Rolled Steel, shall be used within and throughout the core wall, providing a positive waterstop. The steel shell diaphragm shall be encased and protected with shotcrete no less than 1 inch thick at all places. The steel shell is to be formed and erected such that a mechanical key between shotcrete and diaphragm will be created. The sheets of steel diaphragm shall be continuous from top to bottom of wall; horizontal joints or splices shall not be permitted.

2. All vertical joints in the diaphragm shall be sealed watertight by epoxy injection. This epoxy injection shall be carried out from bottom of wall to top of wall, using a pressure pumping procedure, after the steel shell diaphragm has been full encased, inside and outside with shotcrete. The epoxy sealant shall be suitable for bonding to concrete, shotcrete, and steel. The sealant shall conform to the requirements of ASTM C881, Type III, Grade 1, and shall be 100 percent solids, moisture insensitive, low modulus epoxy system. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77 degrees Fahrenheit (°F).

3. The steel shell diaphragm design and the epoxy injection procedure shall have been used and proven satisfactory in the ten (10) tanks required for the tank construction company's experience record.

4. No nail or other holes shall be made in the steel shell for erection or other purposes except for inserting pipe sleeves, reinforcing steel, bolts, or other special appurtenances. Such penetrations shall be sealed with an approved epoxy sealant.

5. In all tanks designed to use a waterstop at the floor/wall joint, the steel shell diaphragm shall be epoxy bonded to this waterstop.

6. The steel shell diaphragm shall be suitably supported by temporary braces to preclude movement during construction. If the steel shell diaphragm is warm when ready for applications, the steel surfaces shall be sprayed with water for cooling approximately 30 minutes or less before shotcreting and again a few minutes before shotcreting.

E. Shotcrete:

1. All shotcrete shall be placed in accordance with ACI 506, latest revision, and shall be applied by or under direct supervision of experienced nozzlemen certified in accordance with guidelines by ACI Committee 506 as outlined in ACI Certification. Certification shall be accomplished by an independent testing laboratory.
2. Shotcrete mixes, measured by weight, shall be:
 - a. First coat on steel shell diaphragm and prestressing wire: One (1) part cement to three (3) parts fine aggregate.
 - b. All other shotcrete: One (1) part cement to four (4) parts fine aggregate.
3. Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer. No shotcrete shall be applied to reinforcing steel or diaphragm which is encrusted with overspray.

F. Horizontal Prestressing:

1. Circumferential prestressing of the tank walls shall be achieved by the application of cold-drawn, high-carbon steel wire complying with ASTM A821 Type B, placed under high tension. A substantial allowance shall be made for prestressing losses due to shrinkage and plastic flow in the shotcrete and due to relaxation in the prestressing steel wire.
2. Placement of the prestressing steel wire to the core wall shall be in a continuous and uniform helix of such pitch as to provide in each lineal foot of core wall height an initial predetermined force and unit compressive stress equivalent to that shown on the approved shop drawings. Splicing of the wire shall be permitted only when completing the application of a full coil of wire, or when removing a defective section of wire.
3. Areas to be prestressed shall contain not less than ten (10) wires per foot of vertical wall. A maximum of 24 wires per layer per vertical foot will be allowed. Shotcrete shall be used to completely encase each individual

wire, and protect it from corrosion. To facilitate this encasement, the clear space between adjacent wires is to be no less than one (1) wire diameter.

4. Prestressing shall be accomplished by a machine capable of continuously inducing a uniform initial tension in the wire before it is positioned on the tank wall. Tension in the wire shall be generated by methods not dependent on cold working or re-drawing of the wire. In determining compliance with design requirements, the aggregate force of all tensioned wires per foot of wall shall be considered rather than the force per individual wire, and such aggregate force shall be no less than that required by the approved Shop Drawings.
5. No circumferential movement of the wire along the tank wall shall be permitted during or after stressing of the wire. The steel wire bands on the core wall shall be so placed that the prestress "working force" per foot of wall height shall exceed the hydraulic ring tension forces by not less than 5 percent. The "working force" shall be defined as the force determined by multiplying the area of steel wire by the unit wire stress after an allowance for losses of 20,000 psi has been made from the initial unit wire stresses. Such initial unit wire stress readings shall be made the same day the wire is placed, or if made later and after some stress losses have already occurred due to creep of wire, plastic flow and shrinkage of core wall, allowances shall be made for such losses. The clear space between adjacent wires is to be no less than one wire diameter.

G. Measurement of Wire Stress:

1. Equipment shall be supplied at the construction site by the tank construction company to measure tension in the wire after it is positioned on the tank wall. This stress measuring equipment shall include: electronic, direct reading, stressometer or other device which can demonstrate not less than 2 percent accuracy; calibrated dynamometers; and a test stand to field verify the accuracy of the stressometer.

H. Exterior Covercoat:

1. After circumferential prestressing wires have been placed by the wire winding machine, they shall be protected by encasement in shotcrete. This shotcrete encasement shall completely encapsulate each wire, and shall permanently bond the wire to the tank wall. The shotcrete over cover shall have a thickness of no less than 1 inch over the wire. When multiple layers of wire are required, shotcrete cover between layers shall be no less than 1/8 inch thick.

I. Wall Openings:

1. When it is necessary for a pipe, access manhole or other appurtenance to pass through the vertical tank wall, the bottom of such appurtenance shall be no less than 18 inches above the floor slab. The prestressing wires required at the pipe or appurtenance elevation shall be distributed equally above and below the opening, leaving an unbanded strip around the entire tank. Ordinarily, unbanded strips shall have a vertical dimension of no more than 36 inches. All pipe sleeves passing through the wall shall be sealed to the steel shell diaphragm by epoxy injection.

J. Shotcrete Finishes:

1. The interior and exterior vertical surfaces of the tank walls shall have a fine, hairbrush broom finish to provide a finely textured, sandy type finish suitable for finish coating. Following finishing, all interior and exterior surfaces of the tank shall be lightly brushed to remove all loose particles of shotcrete or aggregate.

K. Curing of Shotcrete: The finish surfaces of walls shall be cured, starting as soon as possible without damaging surface and not later than two (2) hours after placing, by any of the following methods:

1. Moist-mat cure or moist-cure for seven (7) days.
2. Moist-mat curing shall be moist-curing by covering with at least two (2) layers of burlap, cotton mats, or other approved material. The mat shall be continuously sprayed or intermittently saturated by hosing not less than four (4) times during daylight hours. If intermittently saturated, the mat shall be saturated before 8:30 a.m. and within one and one-half hours of sundown. Saturating of the mat through the night hours will not be required except as may be directed during hot nights if humidity is low and the breeze is more than 5 mph.
3. Moist-curing shall be accomplished by keeping the surface of the concrete continuously wet with water. Sprinklers or soaker hoses may be used to insure continuous complete water coverage of the concrete surfaces. The sprinklers, soaker hoses or other watering equipment shall be operated 24 hours a day for the duration of the curing period. The duration of the curing period shall be seven (7) days. To ensure that sprinkling water is not blown away by wind from its intended location, special attention shall be given to the number and location of sprinklers so that all concrete surfaces are kept continuously wet. The Contractor shall have personnel at the site check the operation of all wetting equipment, the equipment shall be checked out not less than once each daylight hour and once every four hours during the night hours. Daylight hours shall be considered to be

from one hour after sunrise to one hour before sundown. The remainder of the day shall be considered night hours.

4. Curing during the multi-layered shotcrete construction: The following curing procedures shall be used for any layer of shotcrete that will remain in place more than three (3) hours before the next layer of shotcrete is applied. During hot weather, to reduce cracks caused by quick drying shrinkage, each layer of shotcrete shall be moist-mat cured or moist-cured within one hour after application. The mat, if used, shall be kept moist until it is removed and shall not be removed until just before the next layer of shotcrete is applied. The mat shall be against the shotcrete surface enough to avoid circulation of warm air between the mat and the shotcrete. The exterior surface of the core wall (the surface to receive wire wrapping) shall not receive curing compound, but shall be continuously cured for at least seven (7) days using the moist-mat or moist-cured procedure. In hot weather, the surface of shotcrete shall be fogged as soon as possible after application before other curing methods are started to avoid quick loss of moisture from the fresh shotcreted surface.

3.02 FIELD QUALITY CONTROL

A. Shotcrete Compressive Testing:

1. All tests shall be performed by the tank manufacturer. Each test of shotcrete compressive strength shall consist of the preparation and breaking of five (5) cylinders. The high and low strength cylinders shall not be counted and the strength of the test shall be the average compressive strength in pounds per square inch of the three (3) remaining cylinders.
2. If cylinders are made for determining when wire wrapping can begin, they shall be stored at the site and cured the same as the applicable portion of the structure. All other cylinders shall be removed the next day and stored in a testing laboratory vault similar to standard concrete cylinders. The test cylinders shall be the same mix used in the permanent construction.
3. One test shall be made for each 50 cy of concrete, but not less than 2 sets for the inside core wall, 2 sets for the outside core wall and 2 sets for the over coat. Capping and breaking of cylinders shall be done similarly to standard concrete cylinders and shall be done by a recognized testing laboratory approved by the Engineer.

B. Leakage Testing:

1. Each tank shall be slowly filled with water and examined for leakage. Water for leakage testing shall be made available to the Contractor by the Owner. Leakage shall be defined as a loss of water. Hydraulic testing of the tank shall be in accordance with the requirements of Section 03800: Leakage Testing of Hydraulic Structures.

3.03 PAINTING

- A. All piping, supports, and other ferrous metal surfaces shall be coated in accordance with the applicable requirements of Section 09900: Painting. All interior concrete surfaces of tank walls and tank domes shall be coated prior to leakage testing in accordance with the applicable requirements of Section 09900: Painting. All interior surfaces (except floor) of the storage tanks shall be coated with a coating system that is NSF-61 approved for use with potable water. All curing compounds that shall contact potable water shall be NSF approved.

END OF SECTION

SECTION 13300

INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

- A. The I&C 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. The phrase "I&C Contractor" and "Contractor" shall refer to Instrumentation and Controls Contractor in this specification.
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. All wires in control panels must be permanently tagged and shown on the as-built drawings. This includes all spare and abandoned wires and cables. Spare and abandoned 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.
 3. 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.
 4. Contractor shall modify the existing PLC system, SCADA screens, and Report generation requirements at the existing Western Regional Plant to include all the proposed modifications as part of this project. Contractor shall update the iFIX database.
 5. Provide and install new PLC control system for new supply well (Well No.11) including Modicon Quantum PLC, input-output cards, fiber optic communication, as shown on drawings and as described in the specifications complete in place.
 6. All PLC's that need to communicate with other area PLC's in the network shall use I/O scanning. The SCADA I/O server shall poll/pull each PLC in the entire network for data to be used in process control.
 7. Contractor shall provide and install new Hirschmann Switch or owner approved equal in the new PLC control panel as shown on instrumentation

drawings. If contractor is allowed to substitute by the Owner, it is Contractor's responsibility to ensure that the unit functions properly within the plant SCADA and instrument control system as intended.

8. There is no iHistorian Server Computer in the Western Regional WSF but Contractor shall update the existing iHistorian Server Computer located at the Eastern Regional Water Supply Facility located at Curry Ford Road to include the iFIX data tags related to this project. Use existing spare iHistorian tags for this project.

- 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. Acceptance Testing, including 30-day system acceptance test.

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

1. For I&C equipment and ancillaries provide the following:
 - a. Completing 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 Contractor 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 Contractor, but directly connected to equipment required by I&C Contractor:
 - 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 Contractor:

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

D. I&C Contractor's 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 INTEGRATOR

- A. The Contractor shall assign to the Single Instrument and Control (I&C) System Integrator, including software engineer, full responsibility for the functional operation of all new instrumentation systems. The Contractor shall have said I&C System Integrator perform all engineering necessary in order to select, to furnish, to program, to supervise installation, connection, to calibrate, to place into operation of all sensors, instruments, alarm equipment, control panels, accessories, and all other equipment as specified herein.
- B. The single instrument and controls system integrator 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 Integrator shall have a UL approved shop and shall build all panels according to UL 508A. The single I&C Integrator shall be Corning certified contractor.

Instrumentation and Controls System Integrator shall be **Curry Controls or Revere Control, "No approved equal"**.

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 Contractor 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 I&C Integrator/I&C software Engineer 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, Contractor shall also provide fully documented version of PLC programming and HMI programming on the CD and hard paper copy.

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 System Integrator (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. Submit report copies of fiber testing and findings after fiber optic testing is completed.

1.06 GUARANTEE

- A. The Contractor shall guarantee all equipment and installation, as specified herein, for a period of one (1) year warranty from Final Completion. To fulfill this obligation, the Contractor shall utilize technical service personnel designated by the Single I&C System Integrator 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 ± 0.7 percent of full scale and a minimum repeatability of ± 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 Contractor/ I&C System Integrator through the General 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 System Integrator designated at the time of bidding. The quantity of submittal sets required shall be six (6), unless otherwise noted. 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, unless otherwise noted, 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; and
- m. Tagging and numbering style.

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 integrator.

Schematic and wiring diagram criteria shall be followed as established in NEMA Standards Publication ANSI/NEMA ICS-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 (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 and other items listed in section 2.10 of this specification. 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 2.10 of this specification. The Contractor 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 entry ways and custom fit for locations as shown on the drawings.

- B. CONSTRUCTION:

- 1. CONTROL ROOM:

Control room panels shall be Nema 4X with three point latch mechanism. The enclosures shall be manufactured of 14 gauge steel.

2. BUILDING:

Control panels inside a building (not in a control room) shall be Nema 4X with 3 point latch mechanism, 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.

Furnish and install high temperature switch (similar to other existing well control panel) inside new well PLC control panel and wire auxiliary contact output to the PLC to monitor "well control panel high temp. alarm".

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 15 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 THHN and shall be rated 600 volts. Wire for control signal circuits and alarm input circuits shall be 16 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 Contractor. Ethernet cable shall be Category 5e(Enhanced).

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 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. Label each end of the fiber optic cables according with County's standards. All fiber optic cable, including spares, shall be terminated or spliced in fiber optic patch panels. Provide patch cables as required. All patch panel indoors shall be provided with NEMA 12 enclosures, all

panels outdoors shall be located in NEMA 4X enclosures and shall handle at least 12 pair of fiber. Corning is an acceptable fiber optic cable manufacturer and shall provide a 25 year warranty on fiber cable. Fiber optic cable shall be installed by a Corning certified I&C installer with a 25 year warranty guarantee for the Owner/County.

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 4 analog inputs and 4 analog outputs on the card and digital I/O cards that have 4 digital input and 4 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.

Coordinate with Owner and other drawings for the requirements of either dry contact or powered input and provide accordingly.

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. POWER SUPPLIES

Input/output (I/O) subsystem power supplies shall be provided for each PLC control panel and shall be sized to power all 2-wire and 4-wire discrete and analog DC circuits under full-load conditions including allowances for specified spares. The incoming power source to the I/O subsystem power supplies shall be 115 VAC from the associated panelboard. Transformation, rectification and smoothing circuitry shall be furnished to provide a regulated 24 volt DC power supply. The DC power supply shall be converted to other DC voltage levels as required. Provide redundant 24VDC power supplies with diode protection and alarm (PLC input) in case of either power supply failure, if shown on drawings... The DC power supply shall be converted to other DC voltage levels as required. The PLC power supply shall have sufficient capability to handle the power requirements for all the PLC components and I/O points, including the following:

- a. 25 percent input/output active spare capacity.
- b. 25 percent input/output expansion capability.

6. PLC SYSTEM

A minimum of 8MB of RAM memory shall be installed. Battery-backed memory modules shall maintain memory integrity for a minimum of 24 hours to eliminate the need for down-loading system programs from the host computer following temporary (short-term) power failures. The PLC systems shall include processor, power supplies, communications circuitry, process input and output modules, and battery-backed timing and memory modules. The latest revision of the programming software shall be installed as of substantial completion. Programmable Logic controllers and accessory equipment shall be Modicon Quantum system as shown on Instrumentation drawings. New well 11 PLC Control Panel shall match the existing wells.

7. PLC SPARE PARTS

- a. One PLC controller with memory.
- b. One of each type I/O module including: Analog Input, Analog Output, Digital Input, and Digital Output.
- c. One PLC power supply.
- d. One of each type of communication module.

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 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.

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 or equal by Surge Suppression Incorporated, Current Technology, or Joslyn. Match surge suppressor type with existing well control panels.

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. Match surge suppressor type with existing well control panels.

For field mounted four-wire 120VAC instruments, the TVSS shall be in a NEMA 4X polycarbonate enclosure, Edco SLAC series, Phoenix, MTL, or DEHN. Match surge suppressor type with existing well control panels.

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.
1. 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.
2. 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.

3. Provide a hand held keypad programmer or calibrator for startup.
4. Unless shown otherwise on the instrument schedule, provide NEMA 4X corrosion resistant, oil tight, dust tight, and weatherproof housing for indoor or outdoor locations.
5. Provide all stainless steel mounting hardware for surface, panel or handrail mounting as required by location.
6. Provide front mounted visible data display behind clear, shatterproof viewing cover.
7. Systems shall be Manufactured by Siemens-Milltronics/Sitrans Model Multiranger 200 with a level transducer.

L2: NOT USED

L3: SUBMERSIBLE LEVEL TRANSDUCER

The submersible level transmitters shall be constructed of a fully welded titanium pressure module with a diameter of .69" and length of 7.8", utilizing a micro-machined silicon piezo-resistive pressure sensor. The overall accuracy shall be $\pm 0.25\%$ FS BSL with a temperature error band of $\pm 2.0\%$ FS. The pressure transmitter shall be a loop powered device with a supply voltage of between 9 and 30 Volts dc and have an output of 4 - 20mA. The cell is to be a gauge version with 4mA representing atmospheric pressure. The polyurethane cable containing a vent tube is to be molded to the transducer body. The operating temperature range shall be -5 to 150°F (-20 to 60°C). The pressure transmitter shall be supplied with the following optional equipment:

Desiccant shall be NEMA 4X Desiccant Kit / Junction box with clear cover for maintaining a dry environment for the cell vent and termination of the polyurethane cable. Desiccant shall be removable for regeneration when baked in an oven. Mount desiccant box on stanchion support as close as possible where cable comes out of fluid.

Kellems Grip for cable support and attachment to the well pipe head.

The pressure transmitter shall be In-Situ Inc., model: PXD, no approved equal.

F1: NOT USED

F2: FLOW ELEMENT AND TRANSMITTER, PROPELLER:

1. General:
 - a. Function: Measure flow rate of a process liquid.
 - b. Type: Flanged tube, propeller meter with magnetic coupled drive.
2. Service:
 - a. Fluid: Water.
 - b. Pressure: 150 psi standard, 250 psi when noted.
 - c. Temperature: 100 degrees F maximum.
 - d. Flow Direction: Bi-directional measurement when noted.
3. Performance:
 - a. Accuracy: Plus or minus 2 percent of flow rate.
4. Element:
 - a. Materials:
 - 1) Cover Plate: Cast iron.
 - 2) Propeller: Molded thermoplastic.
 - 3) Gearbox: Bronze
 - 4) Bearings: Stainless steel.
 - b. Mounting:
 - 1) Type: In-line tube.
 - 2) Materials: Carbon steel.
 - c. Line Size: As noted.
 - d. Process Connections: AWWA 150-pound flanged end connections.
5. Totalizer:
 - a. Type: Six-digit, nonreset.
 - b. Unit Digit Value: As noted.
6. Indicator: Digital L, c
 - a. Type: Digital display.
 - b. Scale Range: As noted.
7. Transmitter: When noted.
 - a. Performance:
 - 1) Accuracy: 0.-5 percent of full scale.
 - b. Type: Two-wire, requiring external de power supply.
 - c. Signal Interface:
 - 1) Output: 4 to 20 mA de for load impedance 0 to 400 ohms minimum for 24V dc supply without load adjustments.
 - d. Enclosure:
 - 1) Type: NEMA 4X

8. Flowmeter shall be calibrated at both factory and onsite after installation. Provide factory calibration certificate/document and onsite calibration certificate/ document to the Owner before start-up.
9. Manufactures:
 - a. Water specialities (McCrometer, Inc.) model ML-04 with model TR-28-1 indicator/totalizer or Orange County Approved equal. Confirm with Owner for model during shop drawing phase and adjust as needed.

P1: NOT USED.

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 Ashcroft, ITT NeoDyn Series 132P or Owner approved equal. Confirm with Owner for model during shop drawing phase and adjust as needed.

2.09 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 Contractor shall include an additional 16 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:

- Analog switches at the PLC will monitor the flow signal value from the flow meter transmitter and initiate high or low alarm functions whenever the flow signal value exceeds the predetermined high and low flow switch set points.

- Analog switches at the PLC will monitor the discharge pressure signal value from the pressure sensor on the discharge pipe and initiate alarm functions whenever the pressure signal value exceeds the predetermined high and low switch set point values.
- A temperature switch installed in the motor windings by the manufacturer will initiate an interlock at the SSRVS to shutdown the pump motor if the motor winding temperature exceeds the manufacturer's established set point of the temperature switch.
- A high pressure switch installed on each pump discharge and interlocked with the pump starting circuitry through a time delay relay will initiate the shut down of the pump motor should a high pump discharge pressure condition exist following the time out of the relay.
- Whenever a predetermined low low level occurs at the ground storage tanks a level switch at the PLC will cause the high service pumps to sequence off. When the ground storage tank level rises to an acceptable level, the pumps are permitted to restart.
- Check valve alarm logic for each well pump. After the well pump is running for a preset adjustable time (30 seconds) and the flowmeter (FIT-0411) does not show greater than a preset adjustable flow value (XX gpm), the PLC logic shall provide a "check valve alarm" signal.
- Contractor shall field verify the existing control strategy of existing wells and implement similar strategy to the new wells.

2.10 INSTRUMENT LIST

TAG NO.	COMPONENT CODE	COMPONENT TITLE	COMPONENT OPTIONS	REMARKS
LE/LIT-0411	L3	Well#11 Level	0-150 feet	
FE/FIT-0411	F2	Well#11 Flow	0-4,000 gpm	
PI-0411	P2	Pressure Gauge	0-150 PSI	
PSH-0411	P3	High Pressure Switch	100 PSI Trip	
LE/LIT-1013	L1	Ground Storage Tank#3 Level	0- 50 feet	
Provide 1 spare well level transducer (Component Code L3).				
Provide 1 spare pressure gauge (Component Code P2).				

2.11 PROGRAMMING SOFTWARE

The Contractor is responsible for using the PLC programming software with the same version 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.

2.12 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: WEST_FLU_P1_VENT-ST; this represents facility "WEST", process "FLU", pump "P1", device "VENT", and status "ST". All tags developed for this project shall follow this tag convention.

- D. Submit sample tagging and numbering systems to Owner for approval.

PART 3 - EXECUTION

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

A. GENERAL:

Under the supervision of the Contractor, 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 Contractor to demonstrate compliance with this specification during the Factory Acceptance Test (FAT). The Contractor 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 Contractor 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 System Integrator'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 Contractor shall test the entire control system. The test shall take place at the I&C System Integrator's factory. The I&C System Integrator 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. Owner and Owner's Consultant will participate and witness in FAT. Provide a minimum of 2 weeks' notice to the Owner/Engineer before conducting testing.

Prior to commencement of the FAT, the Contractor 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 System Integrator 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 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. With approval of the ENGINEER or OWNER certain tests may be conducted by the I&C System Integrator and Witnessed by the OWNER and ENGINEER during START-UP.

Contractor shall include in his bid allowance for travel expenses for 1 person (1 from Owner) for entire system FAT – duration maximum 5 days. Travel expenses shall include per diem for travel for each person during FAT period.

See section 3.02 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.

3. 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.
4. The Contractor shall have a technical field representative of the I&C Contractor 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.
5. Where primary elements (supplied by Contractor) shall be part of a mechanical system, the Contractor shall coordinate the installation of the primary elements with the mechanical system manufacturer.
6. Fiber Optic Installation:
 - a. Fiber optic cable shall be furnished by the Contractor and installed by the Corning certified I&C provider with a 25 year warranty guarantee. The Contractor shall provide the services of an experienced fiber optic cable terminator and tester. The Contractor 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.
 - b. Fiber optic cable system shall be designed to minimize cable splicing. Where splicing becomes necessary perform fusion splice with loss not to exceed 0.2 dB. Test all splices with an Optical Time Domain Reflectometer (OTDR) bi-directionally to verify splice loss at the time of splicing. Redo any splices not conforming to Specifications. Provide means to protect the unspliced portions of the cable from intrusion of moisture and other foreign matter. Identify required splices in the submittal. Splices not identified in the submittal shall not be acceptable unless approved by the ENGINEER.
 - c. After the fiber optic data link is in place, test the attenuation from hub to hub bi-directionally and document test results. 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 Contractor to replace the defective sections and retest until the attenuation is below the attenuation allowed per kilometer at the wavelengths cited.

- d. The Contractor 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.
7. 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.
8. The field representative of the Contractor 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 integrator 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 3.02 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 System Integrator. 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 System Integrator shall test each loop (discrete and analog) to determine if it is functioning correctly. The I&C System Integrator 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 System Integrator 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 System Integrator shall coordinate repairs for the CONTRACTOR to correct whatever is wrong with the loop. The I&C System Integrator 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, recalibration 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 Contractor 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.

I. COORDINATION WITH OTHER CONCURRENT PROJECTS

The Contractor shall coordinate extensively with other Contractors 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, CD's of training sessions if applicable.
4. Provide Ethernet Switch Onsite Training as stated in section 3.02.C.

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.

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

INSTRUMENTATION CALIBRATION SHEET

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

<input type="checkbox"/> INDICATE/ RECORD <input type="checkbox"/> TRANS/ CONVERT	RANGE CHART SCALE INPUT OUTPUT	VALUE _____	UNITS _____	<input type="checkbox"/> COMPUTE FUNCTIONS	<input type="checkbox"/> CONTROL ACTION (DIRECT/REVERSE) MODES (P/I/D) <input type="checkbox"/> SWITCH UNIT RANGE (VALUE/UNITS) DIFFERENTIAL (FIXED/ADJUSTABLE) RESET (AUTOMATIC/MANUAL)
--	--	----------------	----------------	---	--

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

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

DIVISION 14

CONVEYING SYSTEMS
(NOT USED)

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 without 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 or approved equal.
- 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 Construction Manager and also, to the satisfaction of any local or state inspector having jurisdiction.
 - a. Provide not less than three days notice to the Construction Manager and the authority having jurisdiction when it is proposed to make the tests.
 - b. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Construction

Manager shall be retested in part or in whole as directed by the Construction Manager.

- c. The piping systems may be tested in sections as the work progresses by no joint or portion of the system shall be left untested.
3. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.
4. All defects and leaks observed during the tests shall be corrected and made tight in an approved manner and the tests repeated until the system is proven tight.
5. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.
6. Provide test pumps, gauges, or other instruments and equipment required for the performance of all tests. Provide all temporary bracing, test plugs, additional restraint, and thrust blocking which may be required for test pressures above normal working pressures.
7. All tests shall be maintained for as long a time as required to detect all defects and leaks but not less than the duration specified for each type of pipe or piping system in this Division.

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. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.
- C. Lubrication: Grease and lubricating oil shall be applied to all bearings and similar items as necessary to prevent damage during shipment and storage.
- D. Marking: Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.
- E. Fabricated sub-assemblies, if any, shall be shipped in convenient sections as permitted by carrier regulations and shall be properly match-marked for ease of field erection.
- F. Responsibility:
 1. The Contractor shall be responsible for all material, equipment, and supplies sold and delivered to the site under this Contract until final inspection of the work and acceptance thereof by the Owner. In the event any such material, equipment, and supplies are lost, stolen, damaged, or

destroyed prior to final inspection and acceptance, the Contractor shall replace same without additional cost to the Owner.

2. Should the Contractor fail to take proper action on storage and handling of equipment supplied under this Contract within seven days after written notice to do so has been given, the Owner retains the right to correct all deficiencies noted in previously transmitted written notice and deduct the cost associated with these corrections from the Contractor's Contract. These costs may be comprised of expenditures for labor, equipment usage, administrative, clerical, engineering, and any other costs associated with making the necessary corrections.

G. Delivery: The Contractor shall arrange deliveries of products in accordance with construction schedules and coordinate to avoid conflict with work and condition at the site.

1. The Contractor shall deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
2. Immediately on delivery, the Contractor shall inspect shipments to assure compliance with requirements of Contract Documents and accepted submittals, and that products are properly protected and undamaged.
3. Under no circumstances shall the Contractor deliver equipment to the site more than one month prior to installation without written authorization from the Construction Manager. Operation and maintenance data shall be submitted to the Engineer for review prior to shipment of equipment as described in Section 01730: Operating and Maintenance Data.

H. Storage and Protection of Products:

1. The Contractor shall furnish a covered, weather-protected storage structure providing a clean, dry noncorrosive environment for all mechanical equipment, valves, architectural items, electrical and instrumentation equipment, and special equipment to be incorporated into this project. Storage of equipment shall be in strict accordance with the "Instructions for Storage" of each equipment supplier and manufacturer including connection of space heaters, and placing of storage lubricants in equipment. Corroded, damaged, or deteriorated equipment and parts shall be replaced before acceptance of the project. Equipment and materials not properly stored will not be included in a payment estimate.
 - a. The Contractor shall store products subject to damage by the elements in weathertight enclosures.

- b. The Contractor shall maintain temperature and humidity within the ranges required by manufacturer's instructions.
 - c. The Contractor shall store fabricated products above the ground, on blocking or skids, to prevent soiling or staining. The Contractor shall cover products which are subject to deterioration with impervious sheet coverings and provide adequate ventilation to avoid condensation.
 - d. The Contractor shall store loose granular materials in a well drained area on solid surfaces to prevent mixing with foreign matter.
- 2. All materials and equipment to be incorporated in the work shall be handled and stored by the Contractor before, during, and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting, and any injury, theft, or damage of any kind whatsoever to the material or equipment.
 - 3. Cement, sand, lime shall be stored under a roof and off the ground, and shall be kept completely dry at all times. All structural and miscellaneous steel and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt, or grease, and in a position to prevent accumulations of standing water, staining, chipping, or cracking. Brick, block, and similar masonry products shall be handled and stored in a manner to reduce breakage, chipping, cracking and peeling to a minimum.
 - 4. All materials which, in the opinion of the Construction Manager, have become damaged and are unfit for the use intended or specified, shall be promptly removed from the site of the work, and the Contractor shall receive no compensation for the damaged material or its removal.
 - 5. The Contractor shall arrange storage in a manner to provide easy access for inspection. The Contractor shall make periodic inspections of stored products to assure products are maintained under specified conditions, and free from damage or deterioration.
 - 6. Protection After Installation: The Contractor shall provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. The Contractor shall remove covering when no longer needed.
- I. Extended Storage Requirements For Equipment: Because of the long period allowed for construction, special attention shall be given to extended storage and

handling of equipment onsite. As a minimum, the procedure specified herein shall be followed:

1. If equipment will be stored onsite for more than one month prior to incorporation into the Work, the Contractor shall submit a written request to the Construction Manager outlining any special provision to be made to protect and maintain the equipment while it is being stored. All such provisions shall be acceptable to the Construction Manager. No equipment shall be stored onsite for more than one month without prior written authorization from the Construction Manager.
2. All equipment having moving parts including gears, electric motors, and/or instruments shall be stored in a temperature and humidity controlled building accepted by the Construction Manager, until such time as the equipment is to be installed.
3. All equipment shall be stored fully lubricated with oil and grease unless otherwise instructed by the manufacturer.
4. Manufacturer's storage instructions shall be carefully studied by the Contractor and reviewed by him with the Construction Manager. These instructions shall be carefully followed and a written record of this review kept by the Contractor.
5. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, and operate loaded when possible, weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.
6. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. Mechanical equipment to be used in the work, if stored for longer than ninety days, shall have the bearings cleaned, flushed, and lubricated prior to testing and startup, at no extra cost to the Owner.
7. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested, and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be

judged to be defective, and it shall be removed and replaced at the Contractor's expense.

8. A maintenance log shall be maintained by the Contractor outlining the schedule of maintenance required for each piece of equipment as well as the date on which the maintenance was actually performed and the initials of the individual performing the work. Submit a copy of the maintenance log monthly with the progress pay application.

1.05 WARRANTY AND GUARANTEES

- A. The manufacturer's written warranty shall be submitted for all 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.

2.02 MATERIALS AND EQUIPMENT

- A. Fabrication and Manufacture:
 1. Workmanship and Materials:
 - a. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage or other failure. Materials shall be suitable for service conditions.
 - b. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and gages so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be

interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

- c. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch thick.

2. Lubrication:

- a. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. 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 from 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 tap 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 for fuel contributed, and 50 for smoke developed. Rating shall be determined by ASTM Designation E84, "Surface Burning Characteristics of Building Materials". Corresponding ratings determined by Underwriters' Laboratories, Inc., UL-723, "Test Method for Fire Hazard Classification of Building Materials", will also be acceptable.
- b. Flameproofing treatments will not be acceptable.

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.
- D. Disinfection plan.

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 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 (PRE-FLUSH)

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 (POST FLUSH)

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 PIPELINE 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, 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 station 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

1. Disinfect all piping as indicated on the Piping Schedule in the drawings per AWWA.
2. Disinfect (internally and externally) any piping inside the following structures:
 - a. Ground Storage Tank

3.11 DISINFECTION OF STRUCTURES

1. Disinfect per AWWA C652, Method 2.
2. Disinfect the interior of the following structures:
 - a. Ground Storage Tank No. 3
3. Remove any chlorine solution which accumulates in the bottom of the structure each day.
4. 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.

3.12 DISINFECTION OF WELLS

SEE SECTION 11213.

3.13 DISINFECTION PLAN

Contractor shall submit a disinfection plan outlining proposed schedule, disinfection, test facility locations, and discharge plan for review and approval by the County.

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 15062: Ductile Iron Pipe and Fittings.
 - 2. Section 15070: Schedule 80 Polyvinyl Chloride (PVC) Pipe, Fittings and Valves.
- 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 Table 15044-A 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) |

4. Repair and retest any pipes showing leakage rates greater than that allowed.

C. Pneumatic Test For Pressure Piping:

1. Do not perform on PVC or CPVC pipe.
2. Fluid: Oil-free, dry air.
3. Procedure:
 - a. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections, examine for leakage.
 - b. Correct visible leaks and repeat preliminary test until visible leaks are corrected.

- c. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
 - d. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
 - e. Correct visible leakage and retest as specified.
- 4. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.
 - 5. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

D. Hydrostatic Test For Gravity Piping:

- 1. Testing Equipment Accuracy: Plus or minus 1/2 gallon of water leakage under specified conditions.
- 2. Maximum Allowable Leakage: 0.16 gallon per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.
- 3. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.
- 4. Exfiltration Test:
 - a. Hydrostatic Head:
 - 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 Table 15044-A and at a minimum shall be 1.5 times the normal working pressure of the pipe.

3.04 START-UP AND INSTRUCTION (Not Applicable)

TABLE 15044-A

Service	Legend	Maximum	
		Operation Pressure (psig)	Test Pressure (psig)
Drain	DR	Gravity	15 ft. WCH
Plant Service Water	SVW	70	150
Raw Water	RW	25	100
Sample Line	SA	70	150
Water Main	WM	70	150

Legend: WCH = Water Column Height

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. 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 (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. 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. 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, or approved equal.

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: ANSI/AWWA A21.53/C153
 - 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.

3. 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 pipe 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. All buried joints shall be restrained.

E. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a water tight plug or by other means approved by utilities to ensure absolute cleanliness in 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 DISINFECTING POTABLE PIPELINES

- A. 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.

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 contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 62-555.320(3) Florida Administrative Code.

2.02 MATERIALS AND EQUIPMENT

A. PVC 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: Where indicated on drawings, to prevent pipe joints and fittings from separating under pressure, pipe joints and fittings shall be restrained as follows:

- a. PVC pipe bell and spigot joints shall be restrained with the Uni-Flange Corp. Series 1350 Restrainer or an equal approved by the Engineer. The restraining device and Tee head bolts shall be manufactured of high strength ductile iron meeting ASTM A 536, Grade 65-45-12. Clamping bolts and nuts shall be manufactured of corrosion resistant high strength, low alloy COR-TEN steel meeting the requirements of ASTM A 242.
- b. Cast iron mechanical joint fittings used with PVC pipe shall be restrained with the Uni-Flange Corp. Series 1300 Restrainer, EBAA iron, Inc., Series 500 Retainer Gland, or an equal approved by the Engineer. The restraining device and Tee head bolts shall be manufactured of high strength ductile iron meeting ASTM A 536, Grade 65-45-12. Clamping bolts and nuts shall be manufactured of corrosion resistant high strength, low alloy COR-TEN steel meeting the requirements of ASTM 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. Standards: Installation of PVC water mains shall comply with AWWA C605, latest revision.
- B. Excavating, trenching, and backfilling shall be performed in accordance with the requirements of Section 02220, Trenching, Bedding, and Backfill for Pipe. 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. If dirt and sand adhere to the lubricated end, the spigot must be wiped clean and relubricated.
3. Insert the spigot into the bell so that it contacts the gasket uniformly. Align the pipe sections and push the spigot end into the bell until the manufacturer's reference mark on the spigot is flush with the end of the bell. The pipe should be pushed into the bell using a bar and block. The joint shall not be assembled by "stabbing" or swinging the pipe into the bell, nor shall construction machinery be used to push the pipe into the bell. 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

- A. 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) 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 piping, fittings and appurtenances specified herein. Schedule 80 PVC piping shall be used on all small diameter PVC piping systems (3 inches and smaller in diameter) which includes, but are not limited to, non-potable water, potable water and chemical feeds 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. Mechanical – General Requirements: Section 15000.
4. Pressure Testing of Piping: Section 15044.
5. Pipe Hangers and Supports: Section 15126.
6. Couplings and Connectors: Section 15129.

C. General Design:

1. Schedule 80 PVC piping shall be installed in the locations as shown on the Drawings. All plastic pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the Contractor.
2. All small diameter pipe, 3-inch diameter and smaller, shall be made of polyvinyl chloride unless specifically noted otherwise on the Drawings or in other sections of the specifications.

1.02 QUALITY ASSURANCE

- A. All plastic pipe, fittings and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications. The equipment shall be manufactured by Spears, IPEX, or an Engineer approved equal.
- B. All plastic valve 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, Hayward, or approved equal.

1.03 SUBMITTALS

- A. Materials and Shop Drawings:
 - 1. Shop drawings shall be submitted to the Engineer for approval in accordance with the General Conditions and Section 01340. All products within this specification shall be combined into a single submittal which shall include at least the following:
 - a. Dimensioning and the technical specification for all piping, fittings, and appurtenances to be furnished.
 - b. Letter of Certification from the National Sanitation Foundation International (NSF) stating compliance with Standard 14 and Standard 61.
 - c. Letter from the Manufacturer verifying chemical compatibility of all products to be used in chemical feed systems.
 - d. 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 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 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.
- 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. PVC Pipe:
 - 1. Pipe shall be made of polyvinyl chloride, Schedule 80 pipe, conforming to ASTM D1785. Schedule 80 pipe shall have solvent welded or threaded joints. Chemical feed lines shall have solvent welded joints.
- B. Fittings:
 - 1. Fittings for Schedule 80 pipe 4 inches and smaller in diameter shall be socket type, solvent welded in conformance with ASTM D 2467 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.
 - 2. Fittings for Schedule 80 pipe greater than 4 inches in diameter shall be socket type, solvent welded in conformance with ASTM D 2467. Fittings shall be a 1-piece injection molded design. Use of low pressure fabricated PVC fittings will not be permitted.
- C. Solvent Cement:
 - 1. PVC solvent cement 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 flanges shall be Type 316 stainless steel in accordance with ASTM F593 and F594, respectively. Flange hardware for PVC 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.

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, hydrofluosilicic acid.
 - 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: 9-15% Sodium Hypochlorite.
- e. Plast-O-Matic True Blue, Asahi/America DuoBloc-21, 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, hydrofluosilicic acid, 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, 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, hydrofluosilicic acid and sodium hypochlorite.
- d. Asahi/America, Hayward True Check, 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 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 pipe and fittings shall be solvent welded, flanged, or threaded. All joints shall be made watertight. All pipe cutting, threading and jointing procedures for solvent welded and threaded PVC pipe joints shall be in strict accordance with the pipe and fittings manufacturer's printed installation instructions. Thread lubricant for threaded joints shall be Teflon tape only. In making solvent welded connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth, if necessary and apply solvent cement of proper grade.
- C. Installation of valves and fittings shall be strictly in accordance with the manufacturer's instructions. Particular care shall be taken not to over-stress threaded connections at sleeves. In making solvent weld connections the solvent shall not be spilled on valves or allowed to run from joints.

- D. All piping shall have sufficient number of unions to allow convenient removal and shall be as approved by the Engineer.
- E. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and the Contractor shall verify their locations from approved piping layout Drawings and the structural Drawings.
- 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.

3.03 INSPECTION AND TESTING

- A. All PVC piping shall be hydrostatically pressure tested and flushed in accordance with the requirements in Section 15044: Pressure Testing of Piping.

3.04 DISINFECTION

- A. See Section 15041 – Disinfection of Piping and Structures.

3.05 START-UP AND INSTRUCTION (Not Applicable)

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, reseal 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: 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, or approved equal.

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 3-inch 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 – 3 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 buried 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
 - 3. Manufacturers shall be selected from one of the specified "Manufacturers" in 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: 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. Worm gears shall be constructed in accordance with AWWA C504. Actuators shall be enclosed in a ductile iron housing with outboard seals to protect the bearings and other internal components. The actuator shaft and the quadrant shall be supported on permanently angular contact bearings. Input shaft and fasteners shall be made of stainless steel. Worm gear operators shall include the following:
 - Stainless steel removable and repositionable drive sleeve
 - Amercoat 880 glass flake paint, suitable for corrosive or heavy wear environment
 - Angular contact bearings to support the worm shaft
 - 450 Ft pounds of input torque
 - Adjustable travel stops
 - Ductile Iron Gear Case
 - 316 Stainless Steel Position Indicator
 - 431 Stainless Steel Input Shaft machined from one solid piece of metal.
 - Externally adjustable open and closed position stops shall be provided. The adjustable closed position stop shall be used to set closing torque and provide adjustment to compensate for change in pressure differential or flow direction.

- b. Ground buried: Worm gear (AWWA C504), wrench nut, T-handle wrench valve box with cover for valves 8 inches in diameter and greater. Valves and gear actuators for buried or submerged service shall have seals on all shafts and gaskets on the valve and actuator covers to prevent the entry of water. Actuators shall be 90% grease filled. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. Buried valves shall incorporate the use of an Aunspach Model D87 Torq master overtorg protector. Overtorg protector sheer force shall be 450ft lbs.
 - c. 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.
 - d. Gears shall have a two year warranty from date of shipment and shall have a metal tag containing a serial number, ratio; number of turns shall be riveted to the gear for future identification. Gears shall be supplied with all gear-to-valve, valve adaptation hardware for direct replacement of existing gear.
 - e. Gear actuators shall be Rotork Gears or approved equal.
13. Internal and external surfaces shall be shop painted with two (2) coats of asphalt varnish (4 mils per coat) except for bearing surfaces.

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, or approved equal.

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 equal.
- 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 approved equal.
- C. Cushioned Swing Check Valves (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. 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.

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.

17. Check Valves shall be Tilted Disc Series 9000T (with top oil dashpot) as manufactured by Val-Matic® Valve & Mfg. Corporation, Elmhurst, IL USA, or approved equal.

D. Double Door Check Valves (Well Service Application)

1. Double door check valves shall be compact water design to fit between ANSI B16.1 Class 125 Flanges.
2. The check valve doors shall be spring loaded, normally closed, by means of one or more heavy duty stainless steel, torsion springs. Flow shall cause the doors to open and upon pump shut-down, the torsion spring shall shut the doors before reverse flow starts and at a point of zero velocity, for non-slam closure.
3. Seating shall be resilient and water tight. The seat shall be Buna-N per ASTM D2000-BG and molded to the body. The seal design shall allow for positive seating at both high and low pressures. The disc shall fully overlap the synthetic seal, preventing pressure indentations.
4. All materials of construction shall be as follows:

Description	Material	Specification
Body	Ductile Iron or Cast Iron	ASTM 536, ASTM 126, Class B
Doors	Cast Bronze or Aluminum Bronze	ASTM B584, Alloy C83600, ASTM B148, Alloy 952
Sealing element	Buna-N	ASTM D200-BG
Torsion Spring, Hinge, stop pin	Stainless Steel	ASTM Type 316

5. Disc stabilization shall be provided by the use of a stop pin. The stop and pivot pins shall be stabilized by the use of synthetic spheres to prevent wear due to vibration during operating conditions.

6. Double door check valves shall be manufactured by APCO Valve and Primer Corp., Series 9000, Val-Matic Value and Manufacturing Corp., Dual Disc check valve, or approved equal.

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, or approved equal.

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 15120
PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Scope of Work: This section includes materials and installation of the miscellaneous piping specialties.
- B. 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: 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 SOLENOID VALVES: 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 valves shall hold in both directions with no leaks regardless of pressure differential across the valve.
 - C. Tapping sleeve 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: Hose bibs shall be equal to Watts No. SC-3 or SC-4 of the size shown on the Drawings.
- 2.04 CORPORATION STOPS: 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 or approved equal.
- 2.05 CURB STOPS: 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 or approved equal.
- 2.06 QUICK CONNECT COUPLINGS FOR WATER SERVICE: 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: 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: 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 or approved equal.
- 2.09 STRAINERS FOR WATER SERVICE: 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.

PART 3 - EXECUTION

- 3.01 INSTALLATION: 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 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.

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. 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) Apco No. 55 (1/2"), No. 65 (3/4"), Val-Matic 1/2" or 3/4" No. 22.4, or 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 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. 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 an 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) Apco No. Series 140, Val-Matic No. 100, or 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 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.
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. Well Service Air Valve
 - a. Well service air valves shall be fully automatic float operated valves designed to exhaust air which is present in the pump column on pump startup and allow air to re-enter the column on pump shutdown or should a negative pressure occur. The dual port throttling device (3-inch and smaller valves) shall provide adjustable control of the exhaust rate and allow free flow into the valve through a separate inlet port.
 - b. Valves shall be manufactured and tested in accordance with AWWA Standard C512. Valves used in potable water service shall be certified in ANSI/NSF 61 Drinking Water System Components.
 - c. Valves sizes 3-inch and smaller shall have full size NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for a wrench connection.
 - d. The valve shall have two (2) additional NPT connections for the addition of air release valves, gauges, testing, and draining.

- e. The valve body shall provide a through flow area equal to the nominal valve size. A bolted cover with alloy screws and flat gasket shall be provided to allow for maintenance and repair.
- f. Floats shall be unconditionally guaranteed against failure including pressure surges. The float shall have a hexagonal guide shaft supported in the body by circular bushings to prevent binding from debris. The float shall be protected against direct water impact by an internal baffle.
- g. The resilient seat shall provide drop tight shut off to the full valve pressure rating. The seat shall be a minimum of .5-inches thick on 2-inch and larger valves and secured in such a manner as to prevent distortion.
- h. Valves 3-inch and smaller will be equipped with a dual port throttling device to control the discharge of air from the valve and allow full vacuum flow through a separate port. The device shall have an externally adjustable screw and locknut for adjusting the discharge control disc. The disc shall be sized to allow a 5% flow area when fully throttled. The vacuum port shall be equipped with a spring loaded disc to allow flow into the valve during negative pressure conditions. Throttling devices with a common exhaust and vacuum port are not acceptable. The material of the body shall be consistent with the well service air valve. The spring shall be ASTM A313 Type 316 stainless steel.
- i. The well service air valve body, cover, and baffle shall be constructed of ASTM A126 Class B cast iron for Class 125 and Class 250 valves.
- j. The float, guide shafts, and bushings shall be constructed of Type 316 stainless steel. Non-metallic guides and bushings are not acceptable. Resilient seats shall be Buna-N.
- k. The manufacturer shall demonstrate a minimum of five (5) years experience in the manufacture of air valves. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.
- l. Well service air valves shall be Series 102ST as manufactured by Val-Matic and Manufacturing Corporation or approved equal.

B. 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.

C. 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.

D. 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 affect 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, reseal 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

<u>Pipe Size, Inches</u>	<u>Anvil Fig. No.</u>
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:

<u>Pipe Size, Inches</u>	<u>Min. Rod Diameter, In.</u>
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 1-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 is provided), and adjustable pipe saddle type supports shall be used where lateral 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 $\frac{1}{3}$ to $\frac{1}{2}$ of the pipe. Top edges and vertical corners of each concrete support shall have 1-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 McCulloch 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 piping 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 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 GURANTEES

- 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 device. 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 nipple type 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.

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) Dresser Manufacturing Co. - Style 38
 - (2) Smith - Blair, Inc.- Style 411
 - (3) Or equal

2. Buried Couplings (when applicable):

- a. Cast - iron middle rings with pipe stops removed
- b. Two malleable iron follower rings with ribbed construction
- 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. 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
- e. Acceptable manufacturers:
 - (1) Dresser Manufacturing Co. - Style 38
 - (2) Smith-Blair, Inc. - Style 411
 - (3) Or equal

C. Split Type (Grooved End) Couplings (when applicable):

- 1. Constructed from malleable or ductile iron.

2. For use with grooved or shouldered end pipe with minimum wall thickness as required so as not to weaken pipe.
3. Cast in two segments for 3/4-inch through 14-inch pipe sizes, four segments for 15-inch through 24-inch pipe sizes, and six segments for pipe sizes over 24-inch.
4. Coating: Enamel
5. Bolts: Carbon steel
6. Acceptable manufacturers:
 - a. Victaulic Company of America, Style 77
 - b. Gustin-Bacon Co.
 - c. Or equal

D. Flanged Adapters (when applicable):

1. For joining plain end or grooved end pipe to flanged pipes and fittings.
2. Adapters shall conform in size and bolt hole placement to ANSI standards for steel and/or cast iron flanges 125 or 150 pound standard unless otherwise required for connections.
3. Exposed Sleeve Type (Ferrous Piping):
 - a. Constructed from steel
 - b. Coating: Enamel
 - c. Bolts: Carbon steel
 - d. Acceptable manufacturers:
 - (1) Dresser Manufacturing Co. - Style 128 for cast iron ductile iron and steel pipes with diameters of 2 inches through 96 inches.
 - (2) Or equal

4. Exposed Sleeve Type (Stainless Steel Piping):
 - a. Construction: Fabricated from Type 316L stainless steel w/ANSI flanges to match the connecting piping.
 - b. Finish: Pickled & Passivated or Electropolished to match connected stainless steel piping.
 - c. Bolts: Type 316 Stainless Steel as specified within Section 15066.
 - d. Acceptable manufacturers:
 - (1) Dresser Manufacturing Co. - Style 128-W with lock pins for thrust restraint and other options as detailed above.
 - (2) Or Engineer approved equal
5. Buried Sleeve Type:
 - a. Constructed from cast iron
 - b. Bolts and nuts for buried sleeves shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8 for bolts, and ASTM A 194, Grade 8 for nuts and washers. Bolts and nuts greater than 1 1/8 inches shall be carbon steel, ASTM A 307, Grade B, with cadmium plating, ASTM A 165, Type NS
 - c. Acceptable manufacturers:
 - (1) Dresser Manufacturing Co. - Style 127 locking type for cast iron, ductile iron, asbestos cement and steel pipes with diameters of 3 inches through 12 inches.
 - (2) Or equal
6. Split Type (Ferrous Piping):
 - a. Constructed from malleable or ductile iron
 - b. For use with grooved or shouldered end pipe
 - c. Coating: Enamel

d. Acceptable manufacturers:

- (1) Victaulic Company of America - Style 741 for pipe diameters of 2 inches through 12 inches
- (2) Victaulic Company of America - Style 742 for pipe diameters of 14 inches through 16 inches.
- (3) Or equal

E. Deflection 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, Baker Series 212 or 240, or equal.

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– ASTM A53 or A283. Grade C, minimum yield strength of 30,000 psi.

Follower Flange: Steel- ASTM A536, Ductile Iron per ASTM A536, or carbon steel, minimum yield of 30,000 psi.

Gasket: Buna-N

4. Manufacturing Smith Blair, Model 975.

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

Nominal Pipe Size (Inches)	150 psi		300 psi	
	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, Terice, 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:

<u>Item</u>	<u>Material</u>	<u>Specification</u>
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:

<u>Item</u>	<u>Material</u>	<u>Specification</u>
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.
- F. Spare Parts: Provide one (1) spare gauge for each type supplied.

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 15758

WALL MOUNTED PROPELLER VENTILATORS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide ventilating systems as indicated on the drawings and as specified herein with all accessories required for proper system balance.

1.02 REFERENCES

Air Diffusion Council (ADC)

Air Movement and Control Association (AMCA)

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

National Fire Protection Association (NFPA)

Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

Underwriters' Laboratories, Inc. (UL)

1.03 SUBMITTALS

- A. Submit catalog data and shop drawings for all materials and equipment listed under this section.

PART 2 - PRODUCTS

2.01 WALL MOUNTED PROPELLER VENTILATORS

- A. Wall Mounted Propeller Fans shall bear the AMCA Seal for air and sound performance. Fan mounting panels shall be constructed of heavy gauge steel with pre-punched mounting holes, factory formed flanges and deep spun venturi inlets. Propeller fans shall be constructed of die formed aluminum or steel and be statically and dynamically balanced. Steel fans shall be welded to steel hubs. Direct drive fan motors shall be permanently lubricated, heavy duty type matched to the fan load. Belt drive fan motors shall be of heavy duty ball bearing type, matched to the fan

load and furnished at the specified voltage, phase and enclosure.

The belt drive fan shaft shall be ground and polished steel and mounted in permanently lubricated, sealed ball bearing pillow blocks. Drives shall be sized for a minimum of 150% of driven horsepower. Bearings shall be selected for a minimum life in excess of 200,000 hours at maximum catalogued operating speed. Pulleys shall be of the fully matched cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulley shall be adjustable for final system balancing.

- B. The following accessories shall be provided when indicated in the fan schedule:
 - 1. Wall boxes shall be fully assembled of weather tight construction and constructed of heavy duty galvanized steel.
 - 2. Safety guards shall be OSHA approved constructed 1/2" x 1" mesh screen 16ga. vinyl coated wire.
 - 3. Backdraft dampers with galvanized steel frames aluminum blades with felt strips on closing edges and nylon pivot points.
- C. Manufacturers shall be Carnes, Greenheck, Shipman, Acme or approved equals.

2.02 GENERAL

- A. Provide and install fans and accessories as scheduled on the Drawings and specified in this Section.
- B. Fan air performance ratings shall be in accordance with AMCA Standard 210.
- C. Fan sound performance ratings shall be in accordance with AMCA Standard 300. Sound levels shall not exceed specified level at specified air delivery conditions.
- D. Fan performance based on sea level conditions.
- E. Equivalent fan selections shall not decrease motor horsepower (wattage), increase noise level, increase tip speed by more than 10 percent, or increase inlet air velocity by more than 10 percent, from that specified.
- F. Provide fans capable of accommodating static pressure variations of plus or minus 10 percent.
- G. Provide balanced variable sheaves for all motors with the size selected at midpoint in the adjustment.

- H. Statically and dynamically balance fans to eliminate vibration or noise transmission to occupied areas of the building.
- I. Fan wheels and housings not of aluminum or stainless steel shall be factory primed inside and outside.

PART 3 - EXECUTION

3.01 WALL MOUNTED PROPELLER VENTILATORS

- A. Set and install propeller fans as specified and indicated on the drawings.
- B. Equipment installation shall be such that motors, bearings and belts can be easily serviced.
- C. All fans shall be checked for proper rotation and be lubricated before start up.
- D. Housings on wall mounted ventilators shall be pitched 1/8"/ft. for proper drainage.
- E. Wall mounted propeller ventilators shall be installed such that the complete installation will be weather tight.

END OF SECTION

SECTION 15883

DIFFUSERS, GRILLES, REGISTERS AND LOUVERS

PART 1 - GENERAL

1.01 Work Included

- A. Provide all air distribution devices as scheduled and shown on the drawings and as specified herein.
- B. All work shall conform to the requirements of the State of Florida.

1.02 References

Air Diffusion Council (ADC)

American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE)

National Fire Protection Association (NFPA)

Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

Underwriters Laboratories, Inc. (UL)

1.03 Submittals

Submit catalog data, shop drawings and color samples for all materials and equipment listed under this section. Colors shall be selected by the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Air diffusion devices shall be fabricated and mounted to prevent all flutter, rattle and vibration.
- B. Air diffusion devices shall be provided with the type frame and for the type mounting as schedule on the drawings.

- C. Accessories for the air diffusion devices shall be those listed in the schedule on the drawings.
- D. The air diffusion devices shall be provided in the color as scheduled on the drawings.
- E. All air diffusion devices shall be provided with a gasket where they are to be mounted in a finished surface.
- F. Air diffusion device volume and pattern adjustments shall be able to be made from the face of the device.

2.02 Diffusion Devices - General

All of the diffusion devices listed herein may not be used on the project. Contractor shall provide only those devices listed in the schedule on the drawings.

2.03 Louvers

All louvers shall be AMCA Certified and Florida Product Approved. Performance Ratings based on testing in accordance with AMCA Standard 500.

A. Five Inch Drainable

Extruded Aluminum Construction
Wind-Driven Rain type
Florida Product Approved
Five Inches Deep
Bird Screen
Insect Screen (Intake louvers only)
Each blade to have single drainable channel draining into frame downspouts on either side.
Type frame (box or flange) and accessories shall be as scheduled.
Equal to: Greenheck model EHH-501X

2.04 Accessories

A. General

1. The accessories to be provided with each device shall be as shown on the drawing schedule. All accessories specified herein may not be used on this project.

2. Accessories shall be of the same material construction as the air device itself.

B. Louver Accessories

1. Extended Sill

Extended sill shall be provided with the same finish as the louver.

PART 3 - EXECUTION

3.01 General

- A. All air devices shall be installed square, straight and level and in accordance with manufacturers recommendations.
- B. All openings to be cut in finished surfaces shall be completely hidden behind flange/frame of air device.
- C. All openings in drywall surfaces for air devices shall be framed. Coordinate with general contractor.
- D. All finished surfaces of air devices that have been scratched or marred during construction shall be touched up by the contractor. All damaged areas that cannot be suitably repaired shall be replaced.

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. Modify the existing 4160V power switch center PSC-201 and provide and install complete power distribution system for the new supply well (Well No.11) including fused switches, extension bus, etc. as shown on drawings and as describes in the specifications complete in place.
 - 2. Provide and install new pad mounted transformers, motor control centers, solid state reduced voltage starters, constant speed starter, low voltage transformer, panelboard, etc. for new supply well (Well No.11) as shown on drawings and as describes in the specifications complete in place.
 - 3. Modify existing MCC located in well No.4 and 7 building as shown on drawings and as describes in the specifications complete in place.
 - 4. Provide and install new lighting systems, convenience power systems, as shown in the drawings and as described in specifications complete in place.
 - 5. Provide and install all conduit and wire to support instrumentation and control systems, unless otherwise noted in the drawings and specifications, complete in place.

6. Provide and install new lightning protection and grounding systems described in the drawings and specifications complete in place.
7. Provide all miscellaneous electrical including disconnect switches, terminations, fittings, etc. not specified but obviously necessary for complete working systems in place.
8. Provide and install all yard conduits, pullboxes, manholes, and spare conduits as described in the drawings and specifications complete in place.
9. Contractor shall coordinate with I&C, Mechanical, HVAC and Generator Contractor for all required wire, conduit, power and signal requirements for all package system. Contractor shall review all Mechanical, I&C, HVAC and other systems shop drawings for all electrical requirements and provide all materials and labor as necessary.

I. 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.

J. Emergency Power:

Not required unless temporary generator is needed by the demolition sequence.

K. Construction Constraints:

1. At least four wells shall remain operational at all times. Refer to the electrical drawing E004 for existing PSC-201 main-tie-main configuration. Provide and install complete electrical system for new well No.11.
2. 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 $\frac{1}{4}''=1'-0''$.
 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 $\frac{1}{4}''=1'-0''$ 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.

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.
 - 4. Coordinating with new or existing doors for bringing the equipment into the room or building. Make all necessary modifications to the structure or equipment without additional cost to the Owner.
 - 5. Yard conduit routings are shown for approximate location only. Contractor shall field determine the appropriate routing to avoid conflicts. All instrumentation ductbank shall have separation from the power ductbank as stated on drawings E002. All medium voltage ductbank shall have 2 feet minimum separation from 480V ductbank.

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, appropriate location and height of equipment, subject to the approval of the ENGINEER.
- B. All electrical equipment sizes and characteristics have been based on manufacturer **Eaton (Cutler-Hammer)**, accepted otherwise noted in the drawings. 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.

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 where balancing is required.
- 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 (NEC).
 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 or modified electrical distribution system at Western Regional Water Supply Facility (WSF) as part of this project, including new well 11. The end result shall be a fully protected, and properly coordinated, system with proper arc flash safety labels and personal protective equipment recommendations. All available existing distribution system one line diagrams are shown on Contract documents and other as-built drawings are available at the Plant and can be requested from the Owner. Contractor shall use recent Phase 3A improvements project fault current data at PSC-201 and perform the coordination study. Contractor shall obtain a copy of existing Phase 3A improvements coordination study report from Owner.
- 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.

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 installed under this contract 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 coordinate with Owner for any existing available data from previous projects and field verify/collect all other data 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 existing motors, services, generators and equipment, as appropriate, in the study.
 - 2. Obtain required existing equipment data from the field and FPL.
- 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 known. 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. Low voltage switchgear, switchboard and/or distribution panelboard.
4. Unit substations.
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 (if applicable).
 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 withstand 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.
- 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/cm².
- 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 new electrical equipment with appropriate Arc Flash label. Arc Flash label shall be weather resistant vinyl material type and shall be similar to the following Orange County's Standard Arc Flash label.



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-Interrupting-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.

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. 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.
- 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.

- 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.

2.02 JUNCTION AND PULL BOXES

- A. Outlet Boxes Used as Junction or Pull Box: As specified under Article 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 316 stainless steel.
 - 4. Manufacturers:
 - a. Hoffman Engineering Co.
 - b. Robroy Industries.
 - c. Or Approved Equal.
- D. Large Nonmetallic Box: (Use only if shown on drawings or 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.

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 Approved 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 Approved 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 Approved 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.
- 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 DISCONNECT 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 DISCONNECT 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.
 - 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.
 - 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.
 - 3. Manufacturers:
 - a. Bussmann; Type LPS-RK.
 - b. Gould-Shawmut; Type LLS-RK.
 - c. Or approved equal.
- F. Feeder and Service Circuits, 0- to 250-Volt:
 - 1. Amperage: 0 to 600.

2. UL 198E, Class RK-I, dual element, with time delay.
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 LED type.
- D. Pushbutton Color: Confirm with Owner during submittal.
 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.

2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
 - a. Square D; Type SK.
 - b. Cutler-Hammer; Type E34.

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.

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 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.

2.15 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.

2.16 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.

2.17 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.

2.18 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. Conduit Clamps: As shown on drawing. Otherwise use 316 stainless steel for outdoor.

E. Manufacturers:

1. B-Line.
2. Unistrut.

2.19 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.

2.20 SURGE PROTECTIVE DEVICE

- A. This section describes the material and installation requirements for transient voltage surge suppression devices (TVSS) or surge protective device (SPD) in service entrance equipment, panelboards, and control panels for the protection of all AC electrical circuits.
- B. SPD shall be listed/tested and component recognized in accordance with UL 1449 3rd edition, NEMA LS-1 and ANSI/IEEE 62,41/45 testing.
- C. SPD shall be installed and warranted by and shipped from the electrical distribution equipment manufacturer's factory.
- D. SPD 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. SPD 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 SPD that is not connected thru a breaker.
- G. SPD 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, MCC: 80kA per mode or 160kA per phase
 - c. control panels: 40kA per mode or 80kA per phase
 2. UL 1449 3rd edition Listed and Recognized Component Suppression Voltage Ratings shall not exceed the following:

<u>Voltage</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>
208Y/120	400V	400V	400V
480Y/277	800V	800V	800V
- H. SPD shall have a minimum EMI/RFI filtering of -44dB at 100kHz with an insertion ration of 50:1 using MIL STD. 220A methodology.

- I. SPD shall have a minimum warranty for a period of ten 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. Approved manufactures are:
 - 1. Surge Suppression Incorporated
 - 2. Current Technologies
 - 3. Joslyn/Total Protection Solutions
 - 4. No approved equal. Verify with latest Orange County Utilities “Standards and Construction Specifications Manual” for approved manufacturers and adjust accordingly.

2.21 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. Field verify the requirements of level arm and provide accordingly.
- B. The switch shall be UL listed as manufactured by Allen-Bradley Type 802R lever type, spring return, or approved equal.

2.22 POWER MONITOR OR POWER METER

- A. Solid-state device with LED displays.
- B. Direct voltage input up to 600 volts ac, or with step-down transformer as required.
- C. Current input via current transformer with 5-ampere secondary.
- D. Programmable current and potential transformer ratios.
- E. Programmable limits to activate up to four alarms.
- F. Selectable voltage measurements; line-to-line or line-to-neutral, and wye or delta.
- G. Simultaneous Display:

1. Volts, three-phase.
 2. Amperes, three-phase.
 3. Kilowatts.
 4. Kilowatt-hours.
 5. Power factor.
 6. Frequency.
 7. kW demand, with programmable period intervals.
 8. kVA, kVAR, kVARh.
 9. Ground leakage mA.
 10. THD.
 11. K-factor.
- H. Voltage Rating: 95 to 135 volts, ac.
- I. Individual voltage, current, and kW 4-20 mA output. KYZ pulse output representing units of energy.
- J. Power meter shall communicate over MODBUS ETHERNET communications protocol. Power meter shall communicate with Modicom Quantum PLC and shall match the type of MODBUS ETHERNET protocol used by the Quantum PLC system.
- K. Manufacturers:
1. Square D PowerLogic PMC820.
 2. Cutler-Hammer IQ Analyzer
 3. 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.

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.
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 Paragraph 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.
 - 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 TELEPHONE TERMINAL CABINET (TTC)

- A. Install TTC as per local telephone requirements.

3.12 TELEPHONE OUTLET

- A. Provide empty outlet boxes and cover plates meeting requirements of Telephone Company.

3.13 MOTOR SURGE PROTECTION

- A. Ground in accordance with NFPA 70.
- B. Low Voltage: Ground terminals to equipment bus.

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.
 4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
 5. 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.
 - j. Detectable electric warning tape.
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 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.
- B. Rigid Aluminum Conduit:
 - 1. Meet requirements of ANSI C80.5 and UL 6.
 - 2. Material: Type 6063, copper-free aluminum alloy.
- 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.
- 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.
- 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. 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.
- 5. 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.
 - b. Expansion Movement Only: Steel City; Type AF-A.
 - c. 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, as required or equal.
 - 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.

- 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. See drawings for additional requirements and manhole dimensions.
- 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: Steel, hot-dip galvanized.

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. Detectable Electric 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. 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
 - 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.

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. Use Unistrut to offset aluminum conduit from concrete wall.
- 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. Direct Earth Burial: PVC Schedule 80.
- G. Under Slabs-On-Grade: PVC Schedule 80.
- H. Corrosive Areas, Exterior: PVC Schedule 80 if not exposed to sunlight, use rigid aluminum if exposed to sunlight.
- 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/elbow 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 conduit 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: Provide factory-made rigid aluminum elbows.

2. 90-Degree Bends: Provide PVC coated rigid aluminum 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. Beveled-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. 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.
- B. Cover: Maintain minimum 2-foot cover above conduit, unless otherwise shown.
- C. Make routing changes as necessary to avoid obstructions or conflicts.
- D. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.
- E. Union type fittings not permitted.
- F. 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.
- G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.
- H. 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.
- I. Install “Detectable Electric Warning Tape” for each underground ductbank, indicated or not on drawings.
 - 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.
 - J. Concrete encased ductbank shall be installed with red dye on top of concrete and detectable electric warning tape above ductbank as shown on electrical details.
 - K. Backfill:
 1. As specified in Section 02225, TRENCH BACKFILL.
 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 02205, EXCAVATION, and Section 02225, TRENCH BACKFILL.
- 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. Detectable Electric Warning Tape: Install approximately 12 inches above underground raceways. Align parallel to, and within 12 inches of, centerline of runs, including fiber optic conduits.
- 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.

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-Plated 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-Insulated 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: Stranded copper.
 2. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Stranded copper.
 3. All Other Circuits: Stranded copper.
- C. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW insulation.
- D. Direct Burial and 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 or THHN, 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 I-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	0.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:

- a. Okonite Co.
- b. Rome Cable.
- c. Or Approved 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	0.42	45
		3	0.45	45
		4	0.49	45
10	10	2	0.54	60
		3	0.58	60
		4	0.63	60
8	10	3	0.66	60
		4	0.72	60
6	8	3	0.74	60

		4	0.81	
4	6	3	0.88	60
		4	0.97	80
2	6	3	1.01	80
		4	1.11	
1/0	6	3	1.22	80
		4	1.35	
2/0	4	3	1.32	80
		4	1.46	
4/0	4	3	1.56	80
		4	1.78	

4. Manufacturers:
 - a. Okonite Co.
 - b. Pome Cable.
 - c. Or Approved 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. Or Approved Equal.
 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 ± 2 ohms from the calculated average loop resistance value.

- b. Insulation resistance tests shall be performed by using a 500 volt megohmmeter 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. Or Approved Equal.

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.

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

Number Of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
36	1.21	80
50	1.42	80

4. Manufacturers:
 - a. Okonite Co.
 - b. Alpha Wire Corp.
 - c. Or approved Equal.

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
 - b. Approved Equal.

J. Ethernet Cat. 6e UTP Cable (Copper):

1. Section applies to all Ethernet Cable (Copper) except for Fiber Optic cable.
2. Conductor Physical Characteristics: 4 twisted pairs (8 conductors), 23 AWG solid bare Copper with Polyolefin Insulation. Overall Nominal Diameter: 0.235 inch. Operating Temperature Range: -20 degrees C to +75 degrees C. Model Number – 7881A, Belden Inc.
3. NEC/UL specification CMR, UL444, UL verified category 6.
4. Manufacturer:
 - a. Belden Inc.
 - b. Or approved equal.

2.03 GROUNDING CONDUCTORS

- A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.
- B. Direct Buried: Bare tinned 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) Plymout; 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.

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.
- F. Heat Shrinkable Insulation: Thermally stabilized, crosslinked polyofin.
1. Manufacturers and Product: Thomas & Betts; SHRINK-KON.

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.

2.09 CONDUCTORS ABOVE 600 VOLTS

- A. XLP Insulated, Shielded, Thermoplastic Jacketed Cable:
 1. Standards: ICEA Pub. No. S-66-524 (NEMA Pub. No. WC7), UL 1072, and AEIC No. 5, latest issue
 2. Type: 5kV, shielded, UL 1072, Type MV-90.
 3. Conductor: Copper, Class B compressed concentric stranded in accordance with ASTM B3, ASTM B8, and ICEA Part 2, Section 2.1 and 2.5
 4. Conductor Shield: Extruded, semi-conducting thermosetting polymeric firmly bonded to the insulation in accordance with NEMA WC 8 and AEIC CS 6.
 5. Insulation: 133 percent insulation level, XLP in accordance with NEMA WC 8, and AEIC CS 6.
 6. Insulation Thickness: 0.26 inch, 5 kV, nominal.
 7. Insulation Screen: Thermosetting, semi-conducting polymeric layer, extruded directly over insulation in accordance with NEMA WC 8, and AEIC CS 6. Over this layer shall be applied a concentric serve of #24 AWG annealed solid bare copper wires over which shall be applied a lapped non-metallic tape.
 8. Jacket: Extruded polyvinyl chloride (PVC) compound applied over the metallic shield in accordance with NEMA WC 8.

9. Operating Temperature: 90 degrees C continuous normal operations, 130 degrees C emergency operating conditions, and 250 degrees C short-circuit conditions.
10. Manufacturers:
 - a. Southwire.
 - b. Pirelli Wire and Cable.
 - c. Cablec Corp.
 - d. Okonite Co.

2.10 ACCESSORIES FOR CONDUCTORS ABOVE 600 VOLTS

A. Molded Splice Kits:

1. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
2. Capable of making splices that has a current rating equal to, or greater than the cable ampacity, conforming to IEEE 404.
3. 5 kV class, with compression connector, EPDM molded semi conductive insert, peroxide-cured EPDM insulation, and EPDM molded semi conductive outer shield.
4. Pre-molded splice shall be re-jacketed with a heat shrinkable adhesive-lined sleeve to provide a waterproof seal.
5. Manufacturers:
 - a. Elastimold.
 - b. Cooper industries.

B. Heat Shrinkable Splice Kits:

1. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
2. Capable of making splices that has a current rating equal to, or greater than the cable ampacity, conforming to IEEE 404.
3. 5 kV class, with compression connector, splice insulating and conducting sleeves, stress-relief materials, shielding braid and mesh, and abrasion-resistant heat shrinkable adhesive-lined re-jacketing sleeve to provide a waterproof seal.
4. Manufacturers:
 - a. Raychem.
 - b. 3M Co.

C. Termination Kits:

1. Capable of terminating a 5 kV, single-conductor, polymeric-insulated shielded cables plus a shield ground clamp.
2. Capable of producing a termination with a current rating equal to, or greater than, the cable ampacity, meeting Class 1 requirements of IEEE 48.
3. Capable of accommodating any form of cable shielding or construction without the need for special adapters and/or accessories.
4. Manufacturers:

- a. Raychem.
 - b. 3M Co.
- D. Bus Connection Insulation:
- 1. Heat shrinkable tubing, tape, and sheets of flexible cross-linked polymeric material formulated for high dielectric strength.
 - 2. Tape and sheet products to have coating to prevent adhesion to metal surfaces.
 - 3. Insulating materials to be removable and reusable.
 - 4. Manufacturer: Raychem.
- E. Cable Lugs:
- 1. In accordance with NEMA CCI.
 - 2. Rated 5 kV of same material as conductor metal.
 - 3. Manufacturers and Products, Uninsulated Crimp Connectors and Terminators:
 - a. Square D; Versitide.
 - b. Thomas & Betts; Color-Keyed.
 - c. ILSCO.
 - 4. Manufacturers and Products, Uninsulated, Bolted, Two-Way Connectors and Terminators:
 - a. Thomas & Betts; Locktite.
 - b. Burndy; Quiklug.
 - c. JLSCO.

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	Grounded Neutral	Gray

Three-Phase, Four-Wire	Phase A Phase B Phase C	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. Indoors: Use general purpose, flame retardant tape.
 2. 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 Section 13400, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS), leave pigtailed 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.

3.05 CONDUCTORS ABOVE 600 VOLTS

- A. Do not splice unless specifically indicated or approved by the ENGINEER.
- B. Make joints and terminations with splice and termination kits, in accordance with kit manufacturer's instructions
- C. Install splices or terminations as continuous operation in accessible locations under clean, dry conditions.
- D. Single Conductor Cable Terminations: Provide heat shrinkable stress control and outer non-tracking insulation tubing, high relative permittivity stress relief mastic for insulation shield cutback treatment, and a heat-activated sealant for environmental sealing, plus a ground braid and clamp.
- E. Install terminals or connectors acceptable for type of conductor material used.
- F. Provide outdoor rain skirts for all riser pole and outdoor switchgear terminations.
- G. Provide shield termination and grounding for all terminations.
- H. Provide necessary mounting hardware, covers, and connectors.
- I. Where elbow connectors are specified, install in accordance with manufacturer's instructions.
- J. Connections and Terminations:
 1. Install un-insulated crimp connectors and terminators for power circuit conductors No. 4 AWG through No. 2/0 AWG.

2. Install un-insulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.
 3. Install un-insulated, bolted, two-way connectors for motor circuit conductors No. 12 and larger.
 4. Insulate bus connections with heat shrinking tubing, tape, and sheets.
 5. Make all bus connections removable and reusable in accordance with manufacturer's instructions.
- K. Give 2 working days' notice to ENGINEER prior to making splices or terminations.

3.06 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.

3.07 BUSWAY

- A. Install in strict accordance with manufacturer's recommendations and NFPA 70.
- B. Maximum Support Spacing: 10 feet.

3.08 FIELD QUALITY CONTROL

- A. In accordance Section 16950, ELECTRICAL TESTING.

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. WPPI: 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.
- G. Owner Approved equal.

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-10 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 09901 PAINTING and 09902 PROTECTIVE COATINGS.
- 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 01640, MANUFACTURERS' SERVICES, 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.

10	3600	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
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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	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
	1800	93.6	93.0	92.8	91.7	79.5	79.4	82.5	82.5

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	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
	1200	94.5	94.5	93.5	93.5	79.0	82.5	79.0	82.5

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
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	80.0	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	94.37				86.8			
450	3600	94.7				89.1			
500	3600	94.7				88.3			

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 fuses, both power and control, of every size and type used.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. (EATON/Cutler-Hammer) Westinghouse.
- B. No “or-equal” or substitute products will be considered.
- C. Existing 4160V Medium Voltage Power Switch Center is manufactured by Eaton (Westinghouse) and to retain the UL rating the new MV section shall be Eaton. Existing sections are medium voltage load interrupter type switchgear and new section shall match the same type. Provide spare parts as describes in section 1.05 of this specification.

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. Where extension section is adding to the existing assembly, match new section with existing sections, including device type and instruments located on that section, where applicable.
- 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.

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.

2.05 RATING

A. Switchgear assembly ratings shall be as follows:

1. Nominal System Voltage: 4.16kV, three phase, three-wire plus ground.
2. Main Cross Bus Continuous current: 600A.
3. Maximum design voltage: 4.76kV.
4. BIL: 60kV.
5. Fuse rating: See electrical drawings.
6. Maximum Dimension: See electrical drawings.
7. 25kA RMS Symmetrical and 40kA RMS Asymmetrical, unless otherwise noted.

2.06 SWITCHGEAR CONSTRUCTION

- A. The metal-enclosed load interrupter switchgear shall consist of deadfront, completely metal-enclosed vertical sections containing load interrupter switches and fuses (where shown) of the number, rating and type noted on the drawings or specified herein.
- B. The following features shall be supplied on every vertical section containing a three-pole, two-position open-closed switch:
1. A minimum 8-inch x 16-inch high-impact viewing window that permits full view of the position of all three switch blades through the closed door. The window shall not be more than 58-inches above the switch pad level to allow ease of inspection
 2. The door shall be interlocked with the switch so that:
 - a. The switch must be opened before the door can be opened.
 - b. The door must be closed before the switch can be closed.

3. A hinged grounded metal barrier that is bolted closed in front of every switch to prevent inadvertent contact with any live part, yet allows for a full-view inspection of the switch blade position
 4. Provision for padlocking the switch in the open or closed position
 5. Green OPEN, Red CLOSED switch position indicators with the words "Open" and "Closed" in English
 6. A hinged cover with rustproof quarter turn nylon latches over the switch operating mechanism to discourage casual tampering.
 7. The switch shall be removable from the structure as a complete operational component
- C. Vertical section construction shall be of the universal frame type using die-formed and bolted parts. All enclosing covers and doors shall be fabricated from steel with thickness equal to or greater than that specified in ANSI/IEEE C37.20.3. No owner removable hardware for covers or doors shall be thread-forming type. To facilitate installation and maintenance of cables and bus in each vertical section, a split removable top cover and *[split removable rear covers with rustproof nylon handles] [padlockable hinged rear door held closed by bolts] shall be provided. A G90 grade galvanized base shall isolate equipment from contact with the concrete pad providing protection from rust. Heavy-duty hot dipped galvanized anchor clips shall be provided to anchor the switchgear to the concrete pad.
- D. Each vertical section containing a switch shall have a single, full-length, flanged front door and shall be equipped with two (2) rotary latch-type padlockable handles. Provision shall be made for operating the switch and storing the removable handle without opening the full length door.
- E. Each load interrupter switch shall have the following features:
1. Three-pole gang-operated mechanism
 2. Manual quick-make, quick-break over-toggle-type mechanism that does not require the use of a chain or a cable for operation, and utilizes a heavy-duty coil spring to provide opening and closing energy
 3. The speed of opening and closing the switch shall be independent of the operator, and it shall be impossible to tease the switch into any intermediate position under normal operation

4. Separate main and break contacts to provide maximum endurance for fault close and load interrupting duty
5. Insulating barriers between each phase and between the outer phases and the enclosure

2.07 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, unless otherwise noted.
- B. Main Bus:
 1. Totally enclosed by metal plates.
- C. Ground Bus:
 1. Material: Same as main bus.

2.08 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.

2.09 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.

2.10 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.

2.11 METERS AND INSTRUMENTS

- A. As shown on drawings and match existing sections. Furnish Current Transformers (CT's) for ammeter.

2.12 EQUIPMENT IDENTIFICATION

- A. Master Nameplate:
 - 1. Deep etched aluminum with manufacturer's name and model number.
 - 2. Riveted to main vertical section.
- B. Section Identification:
 - 1. Match existing section.
- C. Nameplate:
 - 1. Match existing section.

2.13 FACTORY TESTING

- A. Switchgear assembly production tested in accordance with ANSI C37.20.2.

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

F. 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. 1 person-days for installation assistance
2. 1 person-days for pre-startup classroom or site training.
3. 1 person-days for facility startup.

B. See specification 16950 for testing.

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 5/8 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 and Cadweld Exolon.
 - b. Thermoweld.
- B. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.
 - 1. Manufacturers:
 - a. Burndy Corp.
 - b. Thomas and Betts Co.

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.

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.

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. 6 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.
- 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 nonaccessible connections.
 3. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
 4. Use bolted 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 arrester 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 padmounted 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 “Padmounted 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 padmounted transformer shall be manufactured by ABB, Eaton (Cutler_Hammer/Cooper), Square-D, or GE.

PART 2 - PRODUCTS

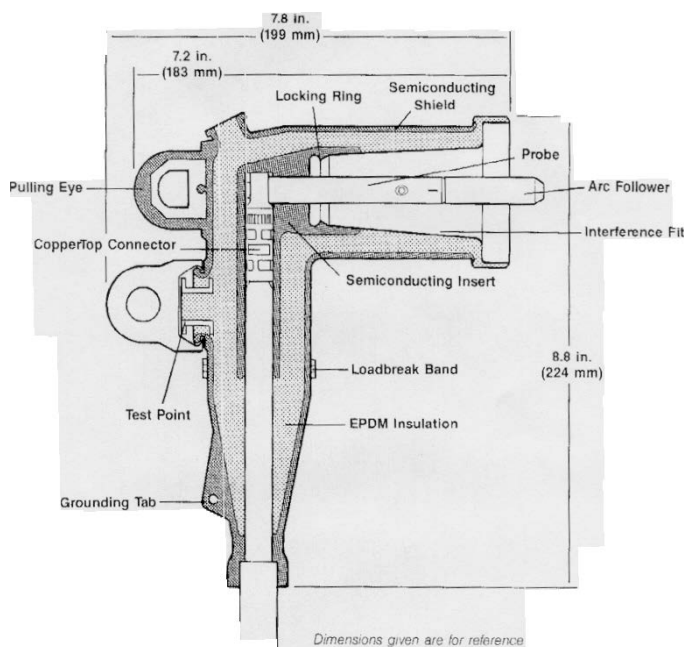
2.01. STANDARD ACCESSORIES

- 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 stainless steel 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 10(±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—

14. 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 padmounted 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 Padmounted

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)	10 kA	16 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.

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 “Padmounted 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 100⁰C 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 furnished upon request by 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 padmounted transformers, 2500 kVA, or below with ratings noted on page 1 or as shown on the drawings.

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. Coordinate with pump supplier and provide pump protection unit (PPU) for each SSRVS as shown on drawings.

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. Eaton (Cutler-Hammer) – Preferred.
 - 2. Square D.
 - 3. or Owner/Engineer approved equal
 - 4. For new SSRVS to be installed in the existing MCC, SSRVS shall be from the MCC manufacturer to maintain the existing UL rating.
- 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 frontal elevation drawings, 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 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

2.06 PUMP PROTECTION UNITS

- A. Where indicated on the drawings, provide a definite purpose microprocessor-based Pump/Motor Protective Unit (PPU) in each starter and/or where indicated on the drawings for protection, control and monitoring of the motors. The PPU shall be Eaton / Cutler-Hammer type MP-3000 relay or approved equal. The PPU shall meet UL 1053, CUL and CSA standards.
- B. The true rms current into the motor shall be constantly monitored, and by means of a protective algorithm, separated into positive and negative sequence components. These components shall be used to determine the heating effects on the stator and rotor of the motor to provide maximum motor protection and utilization. The relay unit shall be capable of being connected by three-wire conductor or fiber optic to a remote Universal Resistance Temperature Detection Module (URTDM) located at the motor to monitor up to six (6) motor winding, four (4) bearing and one (1) auxiliary RTD inputs. The PPU shall integrate the temperature input data from the URTDM with the protective algorithm.
- C. The protective curve algorithm shall be adaptive based on the motor temperature as measured by the URTDM. The protective algorithm shall provide faster trip times for higher temperatures providing maximum motor protection and shall operate with a longer trip time for lower temperatures allowing maximum motor utilization. The PPU shall provide the following protective functions:
 1. Motor running time overcurrent protection (IEEE Device 49/51)
 2. Adjustable instantaneous overcurrent protection (IEEE Device 50) with adjustable start delay in one-cycle increments
 3. Adjustable current unbalance protection (IEEE Device 46 – adjustable in percent unbalance)
 4. Rotor protection
 5. Underload trip with start and run time delays (IEEE Device 37/2)
 6. Jam trip with start and run time delays
 7. Auxiliary overtemperature protection with URTDM

8. Stator protection with URTDM (IEEE Device 49)
 10. Motor bearing overtemperature protection with URTDM (IEEE Device 38)
 11. Load bearing overtemperature protection with URTDM (IEEE Device 38)
- D. The PPU shall have a real-time clock for time tagging of events, operations, and history. The relay shall have quick and easy access to monitored values, view settings, motor history and motor log records.
- E. The PPU shall be capable of accommodating external current transformers with ranges from 10/5 through 4000/5 amperes. Provide three (3) current transformers sized per manufacturer's recommendations based on motor full-load amperes and service factor.
- F. Two user-programmable discrete inputs shall be provided for external control or trip functions. Programmable input functions shall be included for shutdown based on external contacts for incomplete sequence of operation and remote trip, remote reset, differential trip, motor stop, reset disable, zero speed switch or emergency override.
- G. Provide separately mounted Resistance Temperature Detection Module (RTDM), mounted near the motor, to provide up to six (6) stator RTDs, two (2) motor bearing RTDs, and two (2) load-bearing RTDs and one (1) auxiliary RTD. Refer to electrical drawings for SSRVS schematic diagrams.
- H. Alphanumeric display shall read out (in English) complete description of all protective functions, e.g., "instantaneous overcurrent" and all monitored and programmable data such as "percent of full load in amps" and "motor bearing temperature."
- I. PPU shall be installed in the SSRVS section and factory pre-wired, except for field RTU units, for a complete and working system in place.
- J. PPU unit shall have Ethernet TCP/IP communication capability. If the PPU unit factory default communication protocol is not Ethernet TCP/IP, the supplier shall provide communication converter to convert to Ethernet TCP/IP with all required software. SSRVS unit shall have appropriate control transformer or power supply for protocol converter and communication unit and factory pre-wired for a complete and working unit in place.

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 Contractor.
- 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 variable frequency drive system 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 16500

LIGHTING

PART 1 - GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment(1,000 Volts Maximum).
 2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 3. Uniform Building Code (UBC): Section 2329, Earthquake Requirements.
 4. Underwriters Laboratories, Inc. (UL):
 - a. 595, Standard for Safety Marine-Type Electric Lighting Fixtures.
 - b. 844, Standard for Safety Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
 - c. 924, Standard for Safety Emergency Lighting and Power Equipment.

1.02 SUBMITTALS

- A. Shop Drawings:
1. Interior Luminaires:
 - a. Catalog data sheets and pictures.
 - b. Luminaire finish and metal gauge.
 - c. Lens material, pattern, and thickness.
 - d. Candle power distribution curves in two or more planes.
 - e. Candle power chart 0 to 90 degrees.
 - f. Lumen output chart.
 - g. Average maximum brightness data in foot lamberts.
 - h. Coefficients of utilization for zonal cavity calculations.
 - i. Mounting or suspension details.
 - j. Heat exchange and air handling data.
 2. Exterior Luminaires:
 - a. Catalog data sheets and pictures.
 - b. Luminaire finish and metal gauge.
 - c. Lens material, pattern, and thickness.

- d. IES lighting classification and isolux diagram.
 - e. Fastening details to wall or pole.
 - f. Ballast type, location, and method of fastening.
 - g. For light poles, submit wind loading, complete dimensions, and finish.
3. Lamps:
- a. Voltages.
 - b. Colors.
 - c. Approximate life (in hours).
 - d. Approximate initial lumens.
 - e. Lumen maintenance curve.
 - f. Lamp type and base.
 - g. Copy of lamp order, including individual quantities, for Project.
4. Ballasts:
- a. Type.
 - b. Wiring diagram.
 - c. Nominal watts and input watts.
 - d. Input voltage and power factor.
 - e. Starting current, line current, and restrike current values.
 - f. Sound rating.
 - g. Temperature rating.
 - h. Efficiency ratings.
 - i. Low temperature characteristics.
 - j. Emergency ballasts rating and capacity data.
5. Photo-Time Control:
- a. Wiring diagram.
 - b. Contact ratings.
6. Photocells:
- a. Voltage, and power consumption.
 - b. Capacity.
 - c. Contacts and time delay.
 - d. Operating levels.
 - e. Enclosure type and dimensions.
 - f. Temperature range.

1.03 UL COMPLIANCE

- A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

1.04 RELATED SECTION

- A. Section 16510: Lighting Control

PART 2 - PRODUCTS

2.01 LUMINAIRES

- A. Specific requirements relative to execution of Work of this section is located in the Luminaire Schedule on Drawings.
- B. Feed-through type, or separate junction box.
- C. Ballasts: Two-lamp when possible.
- D. Tandem wired for three-lamp, fluorescent fixtures.
- E. Wire Leads: Minimum 18 AWG.
- F. Component Access: Accessible and replaceable without removing luminaire from ceiling.
- G. Soffit Installations:
 - 1. UL Labeled: SUITABLE FOR DAMP LOCATIONS.
 - 2. Ballast: Removable, prewired.
- H. Exterior Installations:
 - 1. UL Labeled: SUITABLE FOR WET LOCATIONS.
 - 2. Ballast: Removable, prewired.
 - 3. When factory-installed photocells are provided, entire assembly shall have UL label.
- I. Emergency Lighting:
 - 1. Power Pack: Self-contained, 120-volt transformer, inverter/charger, sealed nickel cadmium battery, and indicator switch in accordance with UL 924.

2. Lighted, push-to-test indicator.
3. Capable of providing full illumination for 1-1/2 hours in emergency mode.
4. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.
5. Capable of protecting against excess charging and discharging.

2.02 LAMPS

A. LED:

1. Type Efficiency: Energy.
2. Color: See plan.

B. High Intensity Discharge:

1. Type: Metal Halide.
2. Color: Color corrected.

C. Incandescent:

1. Type Efficiency: Energy.
2. Color: Inside frosted.

D. Manufacturers:

1. General Electric.
2. Sylvania.
3. North American Phillips.

2.03 BALLASTS

A. General:

1. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
2. Certified by electrical testing laboratories to conform to Certified Ballast Manufacturer's specifications.

B. LED:

1. LED fixture driver shall be as per the LED light fixture manufacturer's recommendation if not otherwise noted on the drawings.
2. LED driver shall be fixed or dimmable version, as noted on the drawings.

2.04 LIGHTING CONTROL

- A. Photocell for lighting contactor:
 - 1. Automatic ON/OFF switching photo control.
 - 2. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
 - 3. Setting: ON at dusk and OFF at dawn.
 - 4. Time delay feature to prevent false switching.
 - 5. Field adjustable to control operating levels.
 - 6. Manufacturers:
 - a. Tork.
 - b. Paragon.

2.05 POLES

- A. Rating (with Luminaire): All pole installation shall be suitable for 140 mph 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. Material: Extruded aluminum or concrete.

2.06 EMERGENCY BALLAST

- A. In accordance with UL 924.
- B. Nickel cadmium battery, charger, and electronic circuitry in metal case plus ac ballast.
- C. Solid state charging indicator monitoring light and double-pole test switch.
- D. Capable of operating one fluorescent lamps for a period of 90 minutes with output of 1,100 to 1,200 lumens.
- E. Manufacturers:
 - 1. MagneTec Jefferson.
 - 2. Bodine.
 - 3. Radiant.

PART 3 - EXECUTION

3.01 LUMINAIRES

A. General:

1. Install in accordance with manufacturer's recommendations.
2. Provide proper hangers, pendants, and canopies as necessary for complete installation.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building and to concrete pole bases required to safely mount.
4. Install plumb and level.
5. Mounting heights shown for wall mounted or pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.
6. Install each luminaire outlet box with galvanized stud.

B. Pendant Mounted:

1. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
2. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.
3. Provide twin-stem hangers on single luminaires.

C. Pole Mounted:

1. Provide precast concrete base.
2. Provide branch circuit in-line fuses in pole base handhole.

D. Swinging Type:

1. Provide, at each support, safety cable capable of supporting four times the vertical load from the structure to the luminaire.

E. Finished Areas:

1. Install symmetrically with tile pattern.
2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.

4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.
 5. Junction Boxes:
 - a. Flush and Recessed Luminaires: Locate minimum 1 foot from luminaire.
 - b. In concealed locations, install junction boxes to be accessible by removing luminaire.
 6. Wiring and Conduit:
 - a. Provide wiring of temperature rating required by luminaire.
 - b. Provide flexible steel conduit.
 7. Provide plaster frames when required by ceiling construction.
 8. Independent Supports:
 - a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.
 - b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.
 - c. Fasten chain or wire to each end of luminaire.
- F. Unfinished Areas: Locate luminaires to avoid either conflict with other building systems or blockage of luminaire light output.
1. Fixture Suspension: Provide 1/4-inch threaded steel hanger rods. Scissor type hangers not permitted.
 2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

3.02 LAMPS

- A. Provide in each fixture, the number and type for which the fixture is designed, unless otherwise noted.

3.03 BALLASTS

- A. Install in accordance with manufacturer's recommendations.
- B. Utilize all ballast mounting holes to fasten securely within luminaire.
- C. Replace noisy or defective ballasts.

3.04 LIGHTING CONTROL

- A. Outdoor Luminaires: Photocells switch lights ON at dusk and OFF at dawn.

3.05 EMERGENCY BALLAST

- A. Install battery, charger, and electronic circuitry metal case inside fluorescent fixture housing adjacent to ac ballast.
- B. Install monitoring light and double-pole switch adjacent to light fixture.
- C. Wire in accordance with manufacturer's wiring diagrams.

3.06 CLEANING FOLLOWING CONSTRUCTION

- A. Remove all labels and other markings, except UL listing mark.
- B. Wipe luminaires inside and out to remove construction dust.
- C. Clean luminaire plastic lenses with antistatic cleaners only.
- D. Touch up all painted surfaces of luminaires and poles with matching paint ordered from manufacturer.
- E. Replace all defective lamps at time of Substantial Completion.

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 well house at well No.11 and Ground Storage Tank No.3
- 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, where applicable.

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.
- E. Bonded Lightning.
- F. Robbins Lightning.

2.02 GENERAL

- A. Complete system shall bear UL 96 Master Label C, where applicable.
- 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 – 5/8” x 10’ 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 downloads 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 bolted 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 arrester 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 01430, OPERATION 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 24 hours 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. 10-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 functionality 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 10-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 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.

END OF SECTION

APPENDIX A

APPENDIX A

APPENDIX 'D' – ORANGE COUNTY UTILITIES LIST OF APPROVED PRODUCTS

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	Blue 36" Tall	AVG2036 Encl	Pantone 36" Tall	AVG2036 Encl	Green 36" Tall
			GP3232 Base		GP3232 Base		GP3232 Base	
			AVG2041 Encl	Blue 41" Tall	AVG2041 Encl	Pantone 41" Tall	AVG2041 Encl	Green 41" Tall
		GP3232 Base		GP3232 Base		GP3232 Base		
	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	

APPENDIX D

LIST OF APPROVED PRODUCTS - TRANSMISSION SYSTEMS

FEBRUARY 11, 2011

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	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		

APPENDIX D

LIST OF APPROVED PRODUCTS - TRANSMISSION SYSTEMS

FEBRUARY 11, 2011

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	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 Meter	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	
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	

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FEBRUARY 11, 2011

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	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
			Sure Stop 350 Gasket	Gasket	Sure Stop 350 Gasket	Gasket	NA	NA
		McWane Inc. DI Pipe Group	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
			Field Lok 350 Gasket	Gasket	Field Lok 350 Gasket	Gasket	NA	NA
		US Pipe	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		

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Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	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.						
		Certaanteed 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.						
		Certaanteed 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	
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	

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Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	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	

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater		
			Model #	Comments	Model #	Comments	Model #	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	
Line Stops	Line Stops								
	JCM								
	Romac								
	Smith Blair								
Tapping Sleeves and Valves	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		

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Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	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	
	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		Reclaimed Water		Wastewater		
			Model #	Comments	Model #	Comments	Model #	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 minimum 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	
			NA	NA	NA	NA	5600 or 5800 (FLG)	4" & up	
Val-Matic	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 (H2O 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	Fit inside std	NA		2A - 9A Retrofit Valve	Green Sewer
				Box Insert	valve boxes			Box Insert	locking Lid
		Mueller Company	MVB050C thru	Blue Water	MVB050CR thru	Purple Square	MVB050C thru	Green Sewer	
			MVB130C with	Locking Lid	MVB130CR with	Locking Reclaim	MVB130C with	locking Lid	
Extension Stem			Extension Stem	Lid	Extension Stem				
	MVB875 Guide Plate		MVB875 Guide Plate		MVB875 Guide Plate				

APPENDIX D

LIST OF APPROVED PRODUCTS - GRAVITY SYSTEMS

FEBRUARY 11, 2011

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater		
			Model #	Comments	Model #	Comments	Model #	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-Graffiti (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			

APPENDIX D

LIST OF APPROVED PRODUCTS - GRAVITY SYSTEMS

FEBRUARY 11, 2011

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater		
			Model #	Comments	Model #	Comments	Model #	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		

APPENDIX D

LIST OF APPROVED PRODUCTS - GRAVITY SYSTEMS

FEBRUARY 11, 2011

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater		
			Model #	Comments	Model #	Comments	Model #	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		
	Joining Material	Joining 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		

APPENDIX D

LIST OF APPROVED PRODUCTS - PUMP STATION SYSTEMS

FEBRUARY 11, 2011

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	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 shall have Diaphragm Seals. Oil filled.						
Ashcroft		NA	NA	NA	NA	10 1008SL 02L 60#	Gauge Diaphragm Seal	
		25 200SS 02T XYTSE						
Terice		NA	NA	NA	NA	D83LFSS4002LA100 - Gauge		
					M51001SSSS - Diaphragm Seal			
Winter Gauges					D99100 Fill and Mount Charge			
					PFQ770 0-60 PSI			
					D70950 top			
Pumps	Submersible Pumps							
	ABS	NA	NA	NA	NA			
	Flygt	NA	NA	NA	NA			

APPENDIX D

LIST OF APPROVED PRODUCTS - PUMP STATION SYSTEMS

FEBRUARY 11, 2011

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	Comments
Pumps	Floats	Float Regulator (FR) - Duplex and Triplex Pump Stations						
		Atlantic Scientific	NA	NA	NA	NA	Roto-Float	
Pumps	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 Disconnect	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 IEEE C62, 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	
		Joslyn 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	

APPENDIX D

LIST OF APPROVED PRODUCTS - PUMP STATION SYSTEMS

FEBRUARY 11, 2011

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater		
			Model #	Comments	Model #	Comments	Model #	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				

APPENDIX D

LIST OF APPROVED PRODUCTS - PUMP STATION SYSTEMS

FEBRUARY 11, 2011

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

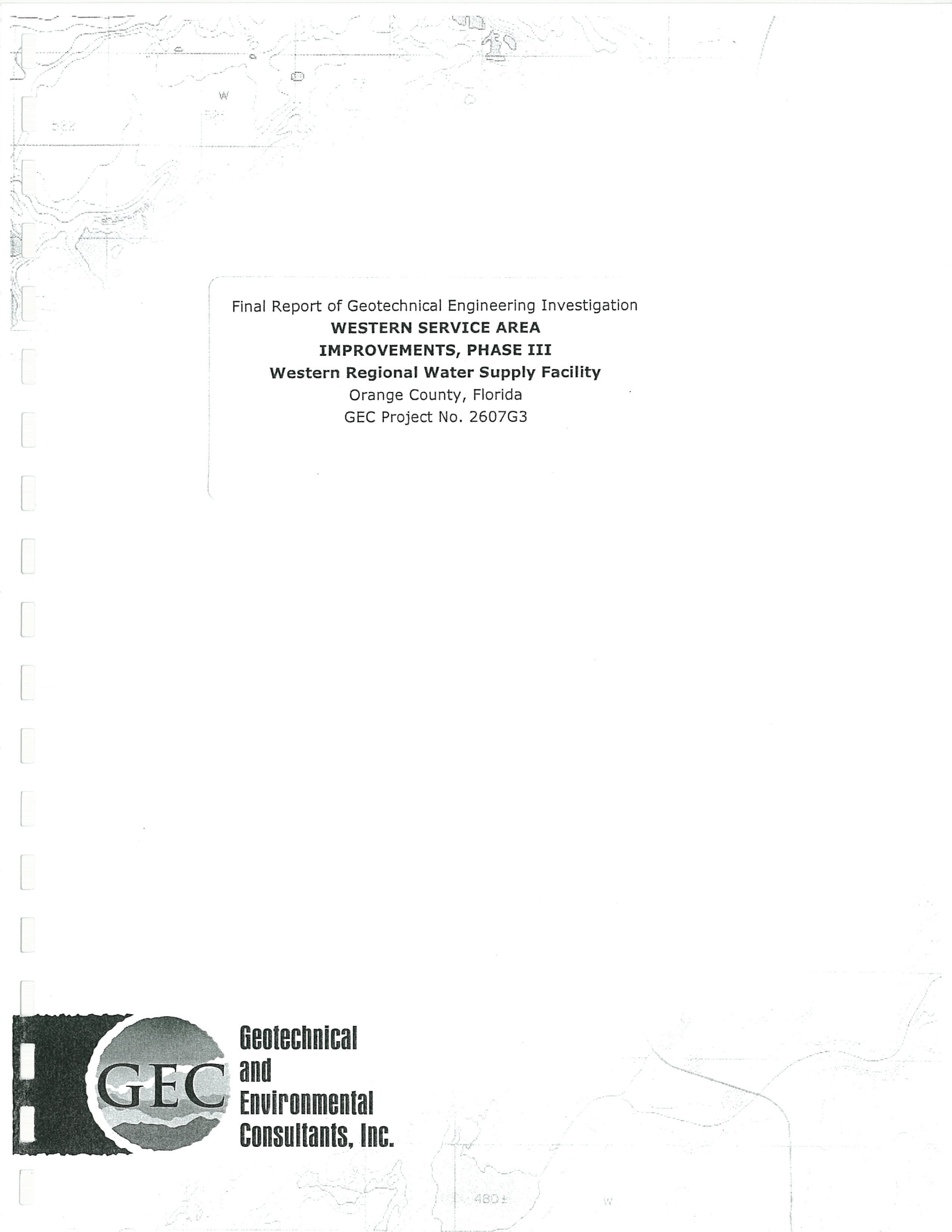
LIST OF APPROVED PRODUCTS - PUMP STATION SYSTEMS

FEBRUARY 11, 2011

Cat.	Desc	Manufacturer	Water		Reclaimed Water		Wastewater	
			Model #	Comments	Model #	Comments	Model #	Comments
Pump Station Control Pane	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

APPENDIX B
GEOTECHNICAL REPORT



Final Report of Geotechnical Engineering Investigation

WESTERN SERVICE AREA

IMPROVEMENTS, PHASE III

Western Regional Water Supply Facility

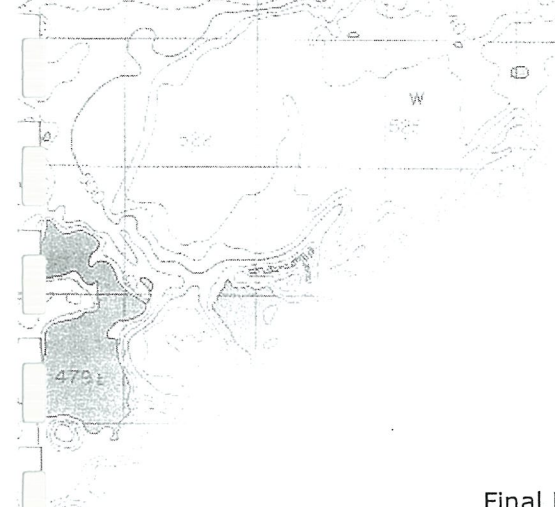
Orange County, Florida

GEC Project No. 2607G3



GEC

**Geotechnical
and
Environmental
Consultants, Inc.**



Final Report of Geotechnical Engineering Investigation


WESTERN SERVICE AREA

IMPROVEMENTS, PHASE III

Western Regional Water Supply Facility

Orange County, Florida

GEC Project No. 2607G3





**Geotechnical
and
Environmental
Consultants, Inc.**

At the very foundation of our community

March 28, 2008

Tetra Tech, HAI
201 East Pine Street, Suite 1000
Orlando, Florida 32801

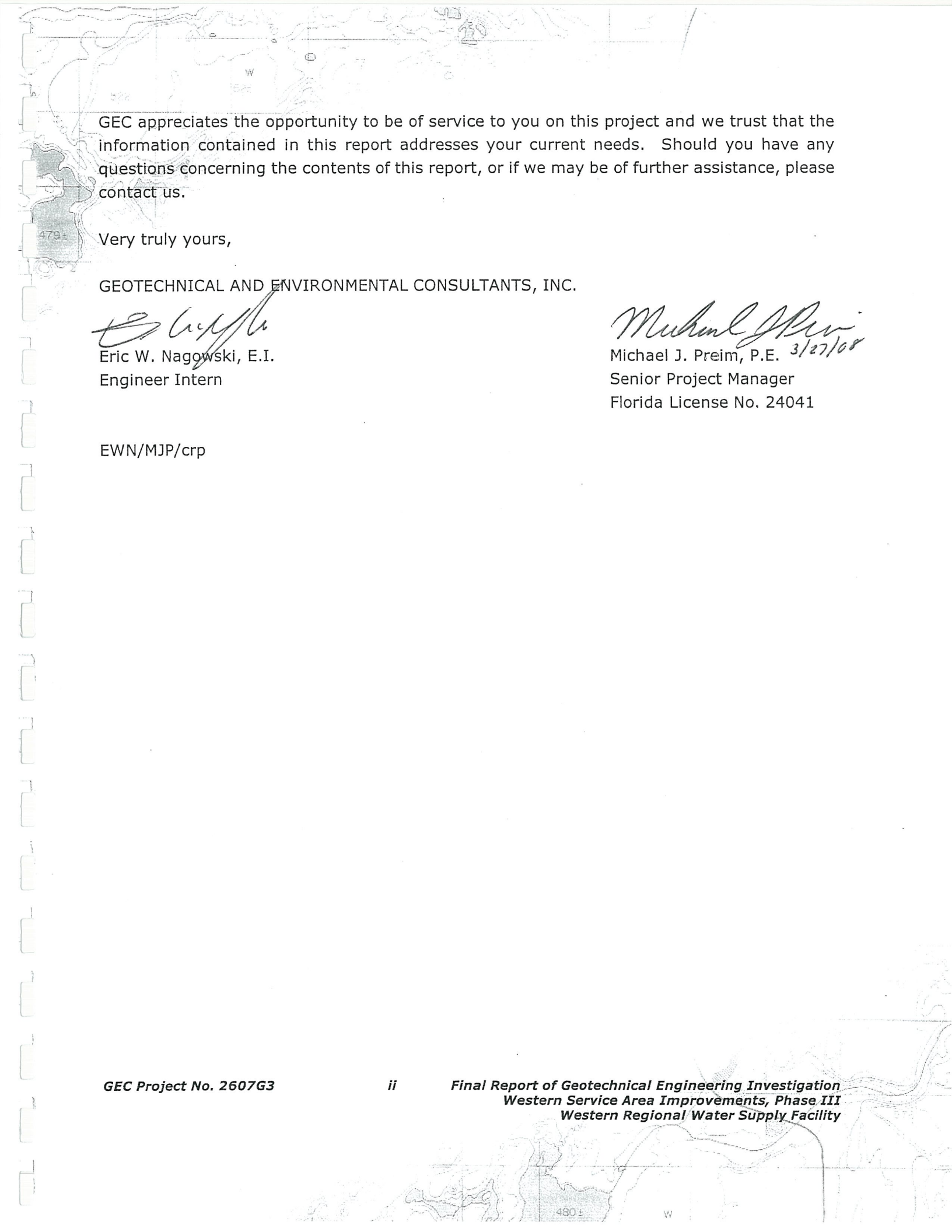
Attention: Mr. Jarrett Kinslow, P.E.

Subject: Final Report of Geotechnical Engineering Investigation
WESTERN SERVICE AREA IMPROVEMENTS, PHASE III
Western Regional Water Supply Facility
Orange County, Florida
GEC Project No. 2607G3

Dear Mr. Kinslow:

Geotechnical and Environmental Consultants, Inc. (GEC) is pleased to present this Final Report of Geotechnical Engineering Investigation for the above-referenced project. An interim report was submitted to you on March 12, 2008. This final report is modified to include geotechnical recommendations for design and construction of the 2 MG ground storage tank included in the project. This study was performed in general accordance with our Proposal No. 4508G dated February 6, 2007.

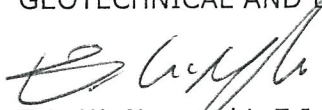
The purposes of this study were to explore subsurface conditions at the subject site and to use the information obtained to develop geotechnical engineering recommendations regarding site preparation and the design of structure foundations, pavements, and re-evaluation/modifications to an existing stormwater pond for the expansion of the above referenced facility. This final report describes our exploration procedures, exhibits the data obtained, and presents our geotechnical engineering recommendations for the proposed structures, pavements and the stormwater pond.

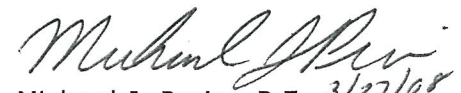


GEC appreciates the opportunity to be of service to you on this project and we trust that the information contained in this report addresses your current needs. Should you have any questions concerning the contents of this report, or if we may be of further assistance, please contact us.

Very truly yours,

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS, INC.


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Figure 2: Boring Location Plan

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Field Permeability Results

Consolidation Test Report

Settlement Analysis

1.0 SITE AND PROJECT DESCRIPTION

The project site is located at the existing Western Regional Water Supply Facility on Lakeville Road in Apopka, Florida. The existing water supply facility is to be expanded. Based on the plans provided to GEC, improvements to the facility will include:

- ◆ A single story operations building supported on a shallow foundation.
- ◆ A 2 MG ground water storage tank. The tank bottom will be approximately 1.5 to 2 feet below the finished exterior grade on a foundation consisting of a base slab and ring footing.
- ◆ Three well pump buildings supported on shallow foundations.
- ◆ A single story bulk sodium hypochlorite storage and feed facility supported on shallow foundations.
- ◆ Repairs to the existing GST trench drain.
- ◆ Miscellaneous new yard piping.
- ◆ Modifications to the existing dry pond.

...recommendations for the repair of the GST trench drain were previously provided by GEC...

In addition to the above improvements, approximately 850 lineal feet of new roadway will be constructed with 3 new parking areas. The new parking areas are located adjacent to the new buildings. It should be noted that recommendations for the repair of the GST trench drain were previously provided by GEC under separate cover dated January 30, 2008.

Based on the United States Geological Survey (USGS) Forest City, Florida Quadrangle map, the elevations across the subject site range from approximately +115 feet NGVD to approximately +125 feet NGVD. The subject site is shown on an excerpt from the USGS Quadrangle map on **Figure 1** in the **Appendix**.

2.0 NRCS SOIL SURVEY REVIEW

The Natural Resources Conservation Service (NRCS) Soil Survey for Orange County, Florida was reviewed to obtain near surface soils and groundwater information in the vicinity of the subject site. The NRCS soils near the project site are summarized in the following Table 1:

Table 1
NRCS Soil Survey Classification

Map Symbol	Soil Name	Depth to Seasonal High Water Table (ft)
4	Candler fine sand 0 to 5 percent slopes	>6.0
5	Candler fine sand 5 to 12 percent slopes	>6.0

An excerpt of the NRCS Soil Survey map showing the approximate site vicinity is presented on **Figure 1** in the **Appendix**. *Information contained in the NRCS Soil Survey is very general and may be outdated.* It may not, therefore, be reflective of actual soil and groundwater conditions, particularly if recent development in the site vicinity has modified soil conditions or surface/subsurface drainage. The information obtained from the soil borings provides a better characterization of actual site conditions.

3.0 SUBSURFACE EXPLORATION

GEC explored subsurface conditions at the proposed structure, pavement, and pond locations by performing:

- ◆ 2 SPT borings to a depth of 15 feet in the operations building location.
- ◆ 2 SPT borings to a depth of 120 feet each in the proposed ground storage tank location.
- ◆ 3 SPT borings to a depth of 10 feet each at the proposed well pump building locations (1 per location).
- ◆ 2 SPT borings to a depth of 15 feet each in the proposed bulk storage and feed facility.
- ◆ 3 auger borings to a depth of 15 feet each in the existing pond location.
- ◆ 10 hand auger borings to a depth of 5 feet each in the proposed pavement and new yard piping locations.
- ◆ 1 field permeability test within the limits of the existing pond.

The approximate boring locations are shown on **Figure 2** in the **Appendix**. Boring locations were not surveyed, but established by taping distances from existing features shown on a plan provided by Tetra Tech, therefore, they should be considered approximate. On-site assistance clearing buried utilities was provided by a Water Treatment Plant employee when the boring locations were established.

Although the boring locations are therefore given only approximately, the methods used to locate the borings are, in GEC's opinion, sufficient to meet the intent of our study. If greater accuracy is desired, a registered Professional Land Surveyor should be retained to survey the boring locations.

3.1 SPT Borings

SPT borings were drilled in general accordance with ASTM Procedure D-1586. At some locations a hand auger boring was performed to a depth of 6 feet at the SPT location to prevent damaging buried utilities that may not have been previously located. GEC's field crew then obtained SPT samples continuously in the borings to a depth of 10 ft and at 5 ft depth intervals thereafter. A GEC engineering technician supervised the drilling operation, and examined and visually classified each sample in the field. He then packaged representative portions of each sample for transport to our laboratory for further examination.

3.2 Machine Auger Borings

Machine auger borings were performed in general accordance with ASTM Procedure D-4700. Machine auger borings were made by hydraulically turning a 4-inch wide continuous flight, solid-stem, auger into the ground in 5-foot increments until the desired boring termination depth was achieved. The auger flights were retrieved, without further rotation, in 5-foot increments and examined by our technician prior to collection of representative soil samples. The samples were placed in sealed jars and transported to GEC's laboratory for further examination and limited laboratory testing.

3.3 Hand Auger Borings

Our engineering technician performed standard barrel hand auger borings, ASTM D-4700, by manually turning a 3-inch diameter, 6-inch long sampler into the soil until it was full. He then retrieved the sampler and visually examined and classified the soil. This procedure was repeated until the desired termination depth was achieved. Our technician collected representative samples for further visual examination and classification in our laboratory.

3.4 Groundwater Measurement

A GEC engineering technician measured the depth to groundwater in the boreholes at the time of drilling and again after approximately 24 hours. After the groundwater levels were recorded, boreholes 30 feet or less in depth were backfilled with soil cuttings to prevailing ground surface. Boreholes deeper than 30 feet were grout-sealed to the existing grade with a mixture of bentonite clay and portland cement.

4.0 LABORATORY SOIL TESTING

Selected soil samples retrieved from the borings were tested in general accordance with Florida Standard Testing Methods (FM). Florida Standard Testing Methods are adaptations of recognized standard methods, e.g., ASTM and AASTHO, which have been modified to accommodate Florida's geological conditions. The GEC laboratory is reviewed annually by the Construction Materials Engineering Council, Inc. (CMEC) to verify compliance with FM. Our laboratory testing program is summarized in Table 2 below:

Table 2
Laboratory Testing Program Summary

Type of Test	Number of Tests
Percent Fines (FM 1-T 88)	16
Natural Moisture Content (FM 1-T 265)	4
Atterberg Limits (FM 1-T89/90)	4

In addition, a consolidation test was performed on a relatively undisturbed sample from boring B-1 at a depth of about 41 feet. The results of our laboratory tests are shown adjacent to the soil borings on **Figures 3 through 7** and in the **Appendix**. The results of the consolidation test are included in the **Appendix**.

5.0 DESCRIPTION OF SUBSURFACE CONDITIONS

We based our soil classifications and descriptions on visual examination and the laboratory test results...

Subsurface conditions encountered in the SPT and auger borings are shown on **Figures 3 through 7** in the **Appendix**. The boring logs describe the soil layers using the Unified Soil Classification System (USCS) symbol (e.g. SP-SM) and ASTM soil descriptions (e.g. sand with silt). We based our soil classifications and descriptions on visual examination and the laboratory test results presented in this report.

The boring logs and related information included in this report are indicators of subsurface conditions only at the specific boring location at the time of our field exploration.

Subsurface conditions, including groundwater levels, at other locations of the subject site may differ from conditions we encountered at the boring locations. Moreover, conditions at the boring locations can change over time. Groundwater levels fluctuate seasonally, and soil conditions can be altered by earthmoving operations.

The depths and thicknesses of the subsurface strata indicated on the boring logs were interpolated between samples obtained at different depths in the borings. The actual transition between soil layers may be different than indicated. *These stratification lines were used for our analytical purposes. Earthwork quantity estimates based on the boring results will differ from the actual quantities measured in the field.*

5.1 Soil Strata

In general, the SPT borings performed encountered the following generalized soil profile:

Average Layer Depth (ft)	Soil Description	Observed "N" Values
0 to 30*	Loose to medium dense fine sand (SP) fine sand with silt (SP-SM) and silty fine sand (SM)	4 to 15
30 to 37	Very loose to loose silty fine sand (SM)	2 to 6
37 to 52	Inter-mixed layers of very loose silty fine sand (SM), soft sandy clay (CL) and soft clay with sand (CH)	2 to 3
50 to 57	Loose shell with sand and silty sand with abundant shell (SM)	7 to 10
57 to 70	Loose to medium dense silty fine sand (SM)	9 to 12
70 to 120	Very dense silty fine sand (SM) with phosphate and cemented sands	86/11" to 50/0"

* Please note, borings B-3 to B-9 were terminated at depths between 10 and 15 feet below the existing grade.

In general, the borings performed at proposed pavement and piping locations encountered fine sand from the existing grade to a depth of 5 feet.

Borings AB-1 through AB-3 performed in the existing pond encountered fine sand (SP) from the existing grade to a depth of 10 feet. From 10 feet to the boring termination depth of 15 feet, fine sand with silt (SP-SM) was encountered.

5.2 Groundwater Levels

Groundwater was not encountered to a depth of 15 feet below ground surface in the structural borings. Seasonal high groundwater levels at the structure locations are anticipated to be at depths greater than 6 feet below the existing grade.

Groundwater was encountered in the pond borings AB-1 through AB-3. These borings were performed at the bottom of the existing dry pond. Groundwater was encountered between 7.4 and 7.5 feet below the existing pond bottom. Based on topographic information provided to GEC by Tetra Tech, the pond bottom is near elevations +110.5' to +110.3' at the boring locations. The encountered groundwater is at approximate elevations +103.1' to +102.8'. Seasonal high groundwater levels are estimated to be near elevations +105.6 to +105.3 at borings AB-1 through AB-3. Encountered groundwater levels and estimated seasonal high groundwater levels are shown on Figures 3 through 7 in the Appendix.

Groundwater levels can vary seasonally and with changes in subsurface conditions between boring locations. Alterations in surface and/or subsurface drainage brought about by site development and the operation of rapid infiltration basins can also affect groundwater levels. *Therefore, groundwater depths measured at different times or at different locations on the site can be expected to vary from those measured by GEC during this investigation.*

6.0 ANALYSIS AND DESIGN RECOMMENDATIONS

The analyses and recommendations contained in this report are based in part on the data obtained from a limited number of soil samples and groundwater measurements obtained from widely-spaced borings. The sampling methods used indicate subsurface conditions only at the specific boring locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Borings cannot be relied upon to accurately reflect the variations that usually exist between boring locations and these variations may not become evident until construction. If variations from the subsurface conditions described in this report do become evident during construction or if the project characteristics described in this report change, GEC should be retained to reevaluate this report's conclusions and recommendations in light of such changes.

6.1 Water Storage Tank

We understand that the tank will be supported on a shallow foundation consisting of a ring footing for support of the tank and a slab-on-grade for support of the water load. The maximum service bearing pressure from the water storage tank is approximately 1500 psf over the footprint. We estimated the settlement from a circular loaded area with a diameter of 115

feet for the tank with a bearing pressure of 1500 psf. We assumed the embedment depth of the tank would be about 2.0 feet below existing ground. The evaluation was based on the data obtained from our soil borings.

SAF-I, was used to evaluate soil settlement under the tank. GEC assumed the tank footprint will be prepared in accordance with the recommendations presented in the **Site Preparation** and **Fill Selection, Placement and Compaction** sections of this report. The total settlement for the tank is anticipated to be about 2.6 inches and an estimated long term differential settlement across the foundation of less than about $\frac{3}{4}$ inch is anticipated.

The total settlement for the tank is anticipated to be about 2.6 inches...

Approximately 1.75 to 2.0 inches of this settlement is estimated to be the result of "immediate" elastic settlement of the sandy soils in the profile. The "long term" consolidation of the cohesive soils encountered is expected to be approximately 0.5 to 0.8 inches.

...we recommend the use of flexible piping connections whenever possible to allow for post-construction settlement as a precaution should some minor additional settlement occur.

Even though the anticipated settlement is relatively low, we recommend that an initial tank filling (hydrotest) be performed to the maximum water storage height, and permanent pipe connections to the tank should not be made until after the hydrotest. Tank settlements should be monitored during the test and filling discontinued if excessive total or differential settlements are measured. We also recommend the use of permanent flexible piping connections to allow for post-construction settlement as a precaution should minor additional settlement occur.

6.2 Other Structure Foundations

On the basis of the data obtained for this study, the site appears suitable for support of the proposed structures, other than the proposed storage tank, upon a system of conventional shallow spread or continuous strip footings and/or thickened edge monolithic slabs. This conclusion is contingent upon the design engineer's and contractor's adherence to the following recommendations:

- ◆ Prepare the structure areas in accordance with the recommendations in the **General Site Preparation** and **Fill Selection, Placement and Compaction** sections of this report.

- ◆ Prepare footing subgrade soils in accordance with the recommendations presented in the **Foundation Subgrade Preparation** section of this report.

Use a maximum gross soil bearing pressure of 2,500 pounds per square foot in foundation design.

- ◆ Use a maximum gross soil bearing pressure of 2,500 pounds per square foot in foundation design.
- ◆ Use minimum footing dimensions of 24 inches for shallow spread footings, 18 inches for thickened edges of monolithic slabs, and 18 inches for shallow strip and/or ring footings even though the maximum net soil bearing pressure may not be fully developed in all cases.
- ◆ Design foundations so that footings bear at least 18 inches below finished exterior grades (12 inches for thickened edges on monolithic slabs).
- ◆ Support structure floor slabs constructed on-grade on a compacted sand base.
- ◆ Overexcavate excessively loose or disturbed soils encountered in the base slab areas and replace with sands selected and compacted in accordance with the **Fill Selection, Placement and Compaction** section of this report.

6.3 Pavements

Our study results indicate that the site can be made suitable for support of conventional flexible pavement sections. Flexible pavements can incorporate either limerock or soil-cement base material. These conclusions are contingent upon preparation of proposed pavement areas in accordance with GEC's recommendations in the **General Site Preparation; Fill Selection, Placement and Compaction;** and **Pavement Subgrade Preparation** sections of this report.

The following recommended flexible pavement sections are typical of similar projects in this area and are not based on any traffic loading information or formal pavement design, since such information is not available:

- ◆ For light duty usage, such as automobile parking stalls, we recommend the following minimum pavement section:
 - ▶ 1.5 inches Type S-1 or S-3 Asphalt Surface Course.
 - ▶ 6 inches of limerock or 8 inches of soil-cement base course.

- ▶ 12 inches of stabilized subgrade (LBR=40) if limerock is used.
- ◆ For heavy duty usage, such as interior parking lot driveways and perimeter roads, we recommend the following minimum pavement section:
 - ▶ 2 inches of Type S-1 or S-3 Asphalt Surface Course.
 - ▶ 8 inches of limerock or 10 inches of soil-cement base course.
 - ▶ 12 inches of stabilized subgrade (LBR=40) if limerock is used.

We recommend that final pavement grades provide a minimum of 1 foot of vertical separation between the bottom of the stabilized subgrade and seasonal high groundwater levels. If this minimum separation is provided, a limerock base could be used in the pavement section. If this separation cannot be provided, we recommend that a soil-cement or asphaltic base course be used and underdrains be installed to lower groundwater levels.

6.4 Stormwater Ponds

Based on the soil and groundwater conditions encountered at the site, the proposed expansion/re-evaluation of the dry pond located on the south side of the plant appears feasible. The soils encountered in the pond locations appear suitable for use as structural fill beneath pavements and structures.

One falling head permeability test was performed in the existing pond location at boring AB-2 between a depth of 2 to 4 feet below the existing grade. The permeability test resulted in a rate of approximately 19.8 feet per day.

7.0 CONSTRUCTION ISSUES

The following sections of this report include comments on issues related to the geotechnical aspects of the proposed construction. *These recommendations are not intended to dictate construction methods or sequences.* Instead, they are furnished as an aid to design professionals and to identify important construction issues related to foundation and earthwork plans and specifications. These recommendations may also be useful to personnel who observe construction activity.

Prospective contractors for this project should evaluate potential construction problems on the basis of their review of the contract documents, their own knowledge and experience in the local area, and on the basis of similar projects in other localities, taking into account their own proposed methods and procedures.

7.1 General Site Preparation

Our recommendations regarding routine site preparation of the structure areas can be summarized as follows:

- ◆ Remove all concrete, asphalt, vegetation, organic topsoil, major root systems, buried utilities, and other deleterious materials from beneath and to a minimum of 5 feet beyond the proposed structure and pavement limits. Standard clearing, grubbing, and topsoil stripping procedures should be appropriate for most of this site.
 - ◆ Perform temporary dewatering as required to achieve proper site preparation, fill placement and compaction.
 - ◆ Allow a Geotechnical Engineer to inspect the site after it has been stripped to verify adequate topsoil and vegetation removal and also to observe subsequent proofrolling.
 - ◆ In structure areas where fill is required, proofroll the stripped ground surface using a large vibratory roller (Dynapac CA-25 or equivalent). Proofroll cut areas after excavation to proposed grade to allow adequate compaction of the exposed subsoil.
- Structures may be adversely affected by vibratory rolling operations.
- ◆ ***Exercise extreme caution when operating vibratory equipment near existing structures.*** Operate roller in the static mode if excessive vibrations are experienced by any near-by structures or if the soil subgrade becomes unstable (e.g., "yields" or "pumps"). Structures may be adversely affected by vibratory rolling operations. Provisions should be made to monitor any adjacent buildings for excessive vibrations.
 - ◆ Proofroll the structure and pavement areas with a minimum of 10 overlapping passes in each of two perpendicular directions. For the tank at this site, a minimum of 20 overlapping passes in each of two perpendicular directions should be performed. Allow a Geotechnical Engineer, or his representative, to observe proofrolling operations. The purposes of the proofrolling will be to detect unstable soils that yield when subjected to compaction and to densify the near-surface loose sands for support of shallow foundations and soil supported floor and/or tank slabs.
 - ◆ Remove material that yields excessively during proofrolling and replace with fill selected and compacted as described in the next section of this report. The Geotechnical Engineer, based on his observations, should recommend the nature and extent of any

remedial work. If the soil subgrade is saturated, or if fill is at a moisture content over "optimum", then instability may occur and the contractor will be required to implement remedial measures to dry the soil to a water content to allow successful placement and compaction of the fill.

- ◆ Due to deep groundwater at this site, subgrade soils may be dry of the optimum moisture content for proper compaction. The contractor should be prepared to add moisture to soils in a controlled manner in order to obtain optimum moisture contents for proper compaction.
- ◆ Continue proofrolling until the soil at a depth of 12 and 24 inches below the compaction surface has attained a minimum of 95% of the soil's modified Proctor maximum dry density as determined by ASTM Specification D-1557.
- ◆ Allow an Engineering Technician, working under the direction of a Geotechnical Engineer registered in the State of Florida, to perform in-place density tests to verify the required degree of compaction has been achieved.

7.2 Fill Selection, Placement and Compaction

After the contractor proofrolls the site in accordance with the above recommendations, the contractor should place and compact fill required to bring the site to final grade. We recommend that all fill be selected, placed and compacted as follows:

- ◆ Use fill material comprised of non-plastic sands with less than about 10% fines content. The fill should not contain any significant amount of organic substances (less than 3% by weight) and should be substantially free from roots or other organic or deleterious materials.
- ◆ Our borings encountered sands with varying silt content (SP, SP-SM) in the upper 15 feet of the subsurface profile which appear suitable for use as fill. Sands excavated above the water table may have to be wetted to attain the moisture content needed to achieve the required degree of compaction.
- ◆ Place fill in level lifts no thicker than 12 inches. Thinner lifts may be needed to achieve compaction in the silty sands.
- ◆ Caution should be used when operating vibratory compaction equipment in the vicinity of and adjacent to existing structures. Vibratory compaction equipment should be operated in static mode when within about 100 feet of existing structures or if excessive vibrations are detected in adjacent structures. Structures near all compaction sites should be carefully monitored for excessive vibrations during compaction operations.

- ◆ Compact fill to a minimum of 95% of the soil's modified Proctor maximum dry density as determined by ASTM Specification D-1557 for each lift of fill placed.

7.3 Foundation Subgrade Preparation

We recommend the following steps be taken during footing excavation and subgrade preparation:

- ◆ Excavate footings in accordance with the recommendations presented in the **Temporary Excavations** section of this report.
- ◆ Compact footing subgrade soils to a depth of 12 inches below footing bearing elevations to a minimum of 95% of the soil's modified Proctor maximum dry density as determined by ASTM Specification D-1557.
- ◆ Perform in-place density tests to verify footing subgrade compaction.
- ◆ Allow a Geotechnical Engineer, or his representative, to observe footing excavation conditions prior to placement of reinforcing steel or concrete.
- ◆ On the basis of the Geotechnical Engineer's observations, remove any unsuitable material encountered in the footing excavations and replace with sand selected and compacted in accordance with the **Fill Selection, Placement and Compaction** section of this report.

7.4 Pavement Subgrade Preparation

Our general recommendations for the pavement subgrade are as follows:

- ◆ Prepare pavement areas in accordance with the **General Site Preparation** and **Fill Selection, Placement and Compaction** sections of this report.
- ◆ Compact the 12-inch subgrade beneath the base to a minimum of 98% of ASTM D-1557 maximum density.
- ◆ Stabilize the subgrade beneath a limerock base to a minimum Limerock Bearing Ratio (LBR) of 40.
- ◆ In our opinion, stabilization is not required beneath a soil-cement base or rigid (concrete) pavement. However, the lack of subgrade stabilization should be considered in the pavement design.

7.5 Temporary Excavations

The contractor should also be responsible for the means, methods, techniques, sequences, and operations of the construction.

Temporary excavations will be required for installation of piping and utilities for most of the proposed improvements. The owner and the contractor should be familiar with local, State and Federal safety regulations, including current Occupational Safety and Health Administration (OSHA) excavation and trench safety standards. Construction site safety is the responsibility of the contractor. The contractor should also be responsible for the means, methods, techniques, sequences, and operations of the construction.

The contractor should be aware that slope height, slope inclination, and excavation depths (including utility trench excavations) should not exceed those specified in local, State, or Federal safety regulations; e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926. *OSHA regulations are strictly enforced and, if not followed, the owner, contractor, earthwork subcontractor or utility subcontractor could be liable for substantial penalties.*

If braced excavations, trench shields, or sheet piling are required to stabilize excavations, all shields, shoring and bracing systems or sheet piling should be designed and reviewed by an experienced professional engineer registered in the state of Florida. Adjacent traffic loads and induced vibrations should be included in the design of these systems.

The shallow soil encountered in the borings performed by GEC at this site are primarily sand with varying amounts of silt. We anticipate that OSHA will classify these materials as Type C. OSHA recommends a maximum temporary slope inclination of 1.5 horizontal to 1 vertical for this soil type. Soils encountered in the construction excavations may vary significantly across the site. Our soil classifications are based on the materials encountered in widely-spaced borings. The contractor should verify that similar conditions exist throughout the proposed excavation area. If different subsurface conditions are encountered at the time of construction, GEC should be contacted immediately to evaluate the conditions encountered.

8.0 QUALITY ASSURANCE

We recommend establishing a comprehensive quality assurance program to verify that all site preparation and foundation construction is conducted in accordance with the appropriate plans and specifications. Materials testing and inspection services should be provided by Geotechnical and Environmental Consultants, Inc. due to our familiarity with the site conditions and the intent of our recommendations.

As a minimum, an on-site engineering technician should monitor all stripping and grubbing to verify that all deleterious materials have been removed. In-situ density tests should be conducted during earthwork 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.

9.0 USE OF THIS REPORT

GEC has prepared this report for the exclusive use of our client, Tetra Tech and for specific application to our client's project. GEC will not be held responsible for any third party's interpretation or use of this report's subsurface data or engineering analysis without our written authorization.

The sole purpose of the borings made by GEC at this site was to obtain indications of subsurface conditions as part of a geotechnical exploration program. GEC has not evaluated the site for the potential presence of contaminated soil or groundwater, nor have we subjected any soil samples to analysis for contaminants.

GEC has strived to provide the services described in this report in a manner consistent with that level of care and skill ordinarily exercised by members of our profession currently practicing in Central Florida. No other representation is made or implied in this document.

The conclusions or recommendations of this report should be disregarded if the nature, design, or location of the facilities is changed. If such changes are contemplated, GEC should be retained to review the new plans to assess the applicability of this report in light of proposed changes.

FIGURES

**USGS QUADRANGLE AND
SOIL SURVEY MAPS**