

D. Handling of Materials:

1. Refer to Section 01600, Material and Equipment, and supplementary requirements below.
2. Handle all HDXLPE tanks and appurtenances as recommended by the manufacturer to avoid damage. Polyethylene tanks that are damaged will not be acceptable. Protect all HDXLPE tank appendages from damage and contamination.
 - a. Comply with manufacturer's recommendations in handling and storing tanks.
 - b. Whenever feasible, shipments shall be made by truck.
 - c. Tanks shall be delivered to the Site on the manufacturer's truck. No common carrier shall be used.
 - d. All tie-down straps shall give provision for thermal expansion and shall be padded where in contact with the equipment.
 - e. Openings shall be protected from damage by covering with suitable plywood or hardboard, securely fastened. Flange adapters shall not be shipped installed. The tanks shall be positively vented at all times.
 - f. Pipe and tubing, fittings and miscellaneous small parts shall be crated or boxed. Additional protection, such as end wrapping, cross bearing, or other interior fastening may be required to assure such individual equipment pieces are not damaged in transit.
 - g. The equipment shall be inspected by the ENGINEER before unloading at the installation site and any resulting damage shall be the carrier's and/or fabricator's responsibility to repair at no cost to COUNTY.
 - h. The tanks and appurtenances shall be unloaded and stored in accordance with the manufacturer's written instructions.

1.5 WARRANTY

- A. All material supplied under these Specifications shall be warranted by the Contractor and the manufacturers for a period of three (3) years. Warranty period shall commence on the date of COUNTY acceptance.
- B. The material shall be warranted to be free from defects in workmanship, design and materials. If any part of the system should fail during the warranty period, it shall be replaced at no expense to the COUNTY.
- C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty or guarantee period. No exception to this provision shall be allowed. The Contractor shall be responsible for obtaining warranties from each of the respective suppliers or manufacturers for all the material specified under these contract specifications.

- D. In the event that the manufacturer is unwilling to provide a three-year warranty commencing at the time of COUNTY acceptance, the Contractor shall obtain from the manufacturer a four (4) year warranty starting at the time of equipment delivery to the job site. This four-year warranty shall not relieve the Contractor of the three-year warranty starting at the time of COUNTY acceptance of the equipment.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Provide one of the following polyethylene tank manufacturers:
1. Snyder Industries, Inc.
 2. Poly Processing Company
 3. Or approved equal.

2.2 SERVICE CONDITIONS

- A. General Design Conditions:
1. Normal Temperature: Ambient, indoor installation, 55 degrees Fahrenheit - 95 degrees Fahrenheit. Chemicals may be delivered at higher or lower temperatures, depending on season.
 2. Maximum Temperature: 100 degrees Fahrenheit.
 3. Normal Internal Loads: Hydrostatic.
 4. External Loads: Appurtenances as shown and specified herein.
 5. Configuration: Double wall, Flat-bottom, vertical, cylindrical with dished tops.
- B. Tanks shall be suitable for:

<u>Tank Identification</u>	<u>Working Capacity, gallons</u>	<u>Chemical</u>	<u>% Conc.</u>	<u>S.G.</u>
T-SH-1	4,400	Sodium Hypochlorite	12.5	1.2

- C. Size: The tank shall have a volumetric capacity as listed above and shall be sized as shown on the Drawings.
- D. Working capacity is defined as full capacity of the tank to the tank shoulder.
- E. **Wall thickness** for a given hoop stress is to be calculated in accordance with ASTM D 1998. Tanks shall be designed using a hoop stress no greater than 600 psi. Wall thickness calculations shall assume that all tank contents have a specific

gravity of not less than 1.9 In NO case shall the tank thickness be less than design requirements per ASTM D 1998.

1. The wall thickness of any cylindrical portion at any fluid level shall be determined by the following equation:

$$T = P \times OD / 2SD \text{ or } 0.433 \times SG \times OD \times H \times OD / 2SD$$

Where: T = wall thickness, in

P = pressure, psi

SG = specific gravity, gm/cc

H = fluid head, ft

OD = outside diameter, ft

SD = hydrostatic design stress, 600 psi

The minimum wall thickness shall be sufficient to support its own weight in an upright position without external support but shall not be less than 0.187" thick.

2.3 MATERIALS OF CONSTRUCTION

A. Polyethylene:

1. The material used shall be virgin polyethylene resin as compounded and certified by the manufacturer. Tanks liners shall be made from linear polyethylene resin as manufactured by Exxon Chemical, or resin of equal physical and chemical properties. Tanks made from crosslinked polyethylene resin shall be as manufactured by Phillips 66, or resin of equal physical and chemical properties.
2. All polyethylene resin material shall contain an ultraviolet (UV) stabilizer as compounded by the resin manufacturer. Pigments may be added, but shall not exceed 0.25% (dry blended) of the total weight.

B. Surface portions of tank, inside and outside, shall be suitable for the specified environment.

C. Color shall be natural color for maximum UV protection.

D. A linear liner that is compatible with the chemical being serviced is required.

1. Liners shall be made with an anti-oxidant, LLDPE (Linear Low Density Polyethylene).

2.4 DETAILS OF CONSTRUCTION

A. Design:

1. The minimum required wall thickness for the cylinder straight shell must be sufficient to support its own weight in an upright position without any external support. Flat areas shall be provided to allow locating large fittings

on the cylinder straight shell. The bottom knuckle radius of flat bottom tanks shall be a minimum of 2 inches.

2. The top head must be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall.
3. Tanks shall have a minimum of 3 lifting lugs integrally molded into the top head. The lifting lugs shall be designed to allow erection of an empty tank.
4. The tank shall be supplied with a wind restraint system designed to allow tank retention in wind and seismic loading situations without tank damage.

B. Construction:

1. Tanks shall be upright, cylindrical, flat bottomed, one-piece seamless construction by rotational molded.
2. The tanks shall be designed for above-ground, vertical installation and shall be capable of containing chemicals at atmospheric pressure.
3. Tanks shall be of the types and sizes shown on the Drawings and specified herein.
4. Lifting Lugs: As required for installation. Capable of withstanding weight of tank with a safety factor of 3 to 1.
5. Use all titanium hardware for mounting and connections of accessories.
6. All gaskets and accessories shall be compatible with the chemical in storage. Dome mounted gaskets shall be EPDM, wall mounted gaskets shall be litharge Viton

C. Fittings:

1. Bolted Double 150 lb. Flange Fittings:
 - a. Provide bolted double flange fittings for fittings below the liquid level.
 - b. The bolted double flange fitting shall be constructed with 2 ea/ 150 lb. flanges, 2 ea. 150 lb. flange gaskets, and the correct number and size of all-thread bolts for the flange specified by the flange manufacturer. The flanges shall be constructed of PVC Type 1, Grade 1. Gaskets shall be a minimum of 1/4" thickness and constructed of 60-70 durometer viton. There shall be a minimum of 4 each all-thread bolts. The bolts may have gasketed flanged metal heads or bolt heads encapsulated in Type II polyethylene material. The encapsulated bolt shall be designed to prevent metal exposure to the liquid in the tank and prevent bolt rotation during installation. The polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4" of the threads closest to the bolt head. The polyethylene shall be a minimum of 1/4" of the threads closest to the bolt head. Each encapsulated bolt shall have a gasket to provide a bolt sealing surface against the inner flange.
 - c. Alternatively double flange sidewall fittings 3" diameter and smaller shall be bolted flange fittings constructed with one 150-lb inner

polyethylene flange, one 150-lb outer Schedule 80 PVC flange, one 150-lb. flange gasket, and the correct number of all-thread bolts that are molded into the inner flange assembly. The inner and outer connection nipples shall be molded into the inner polyethylene flange. The entire assembly shall have only one full-face flange gasket and shall not require separate flange bolt gaskets.

2. Provide compression fittings for all fittings above the liquid level.
3. Transition Fittings: Connections to the primary tank sidewall shall be installed using a bellows style transition fitting to maintain containment integrity of the entire tank system. The bellows design shall allow for system expansion and contraction by providing less residual stress on the primary tank. The transition fitting shall insure 100% chemical containment in the event of primary tank fitting failure and shall incorporate an expansion joint on the primary tank fitting discharge line that is contained within secondary containment system. Transitions fittings that do not contain leaks from the primary tank fitting and expansion joint shall not be allowed.
4. Provide a liner that is compatible with the chemical being serviced.
5. Liners shall be made with an anti-oxidant, LLDPE (Linear Low Density Polyethylene).

2.5 ACCESSORIES

A. Level Indication:

1. Each tank shall be provided with a 3/4-inch diameter clear PVC sight glass, as specified in the Tank Schedule.
2. Each sight glass shall be provided with shutoff valves at the top and bottom. Vented ball valves shall be PVC, true union type.
3. The sight glass shall be installed off the tank drain/pump feed pipe and mounted on the wall in sight of the tank fill station as shown on the drawings.
4. The sight glass shall be provided with a calibrated gallonage tape with level minor and major marks according to the following schedule:

Tank Diameter (ft)	Minor Increment (gal)	Major Increment (gal)
Less than 6 ft	20	100
6 ft to 9 ft	50	250
10 ft or Greater	100	500

5. CONTRACTOR shall provide an ultrasonic level transmitter for each tank with a 4/20 ma output that can be calibrated for each tank depth. The ultrasonic level transmitter shall be constructed of materials compatible with the liquid stored in the tank.

- B. Manways:
 - 1. Provide the size and location as shown on the Drawings.
 - 2. The manway shall be constructed of polyethylene material compatible with the chemical in the tank. The gaskets shall be polyethylene.
- C. Vents:
 - 1. Provide the size and location as shown on the Drawings.
 - 2. Each tank vent line shall be equipped with an plastic insect screen.
- D. Tie Down Systems:
 - 1. Tie down systems must meet wind and seismic requirements per the Florida Building Code.
 - 2. The tie down system shall be resistant to the chemicals stored.
- E. Tank Accessories – Ladders and Handrails:
 - 1. Ladders shall be constructed of FRP or other specified material.
 - 2. All ladders shall be designed to meet applicable OSHA standards. Reference: OSHA 2206; 1910.27; fixed ladders.
 - 3. Ladder and handrail to meet all OSHA requirements and be chemically resistant to the chemical being handled.
 - 4. Ladders and handrails must be mounted to the tank to allow for tank expansion and contraction due to temperature and loading changes. All top ladder mounts shall be connected to integrally molded in attachment lugs that allow for tank movement.
 - 5. Handrail and posts shall be made of 2 inches by 1/4-inch tube, manufactured by the continuous extrusion process.

2.6 SPARE PARTS

- A. Provide spare parts in accordance with manufacturer's recommendations.

2.7 IDENTIFICATION

- A. Label: Permanently attach label to each tank with the following minimum information:
 - 1. Chemical to be stored including:
 - a. Concentration.
 - b. Specific gravity.
 - c. Maximum temperature
 - 2. Tank manufacturer.
 - 3. Date of manufacture.
 - 4. Tank serial number.
 - 5. Tank material.
 - 6. Tank capacity.

7. Tanks shall be furnished with OSHA approved 20-inch by 24-inch Chemical Warning signs with NFPA 704 hazard numbers for the chemical services intended. Chemical signs shall include, as a minimum, the name of the product stored in the tank, precautionary measures, signal word (danger, warning, caution), statement of hazard, precautionary measures, instructions in case of contact, exposure, etc. and NFPA 704 hazard numbers.
8. All packing, packaging, and marking provisions of ASTM Practice D3892 shall apply to this standard.

PART 3 – EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the conditions under which the Work is to be installed and notify the ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.
- B. Inspect tanks prior to installation. If damaged, notify ENGINEER and manufacturer at once.
- C. Do not install damaged tanks until repairs are made in accordance with manufacturers written instructions and approval by ENGINEER.
- D. Inspect concrete pads for proper elevation, dimensions, evenness and anchor bolt locations. Correct if required.

3.2 INSTALLATION

- A. Install tanks in complete conformance with manufacturer's instructions.
- B. Install lining material between the tank bottom and the concrete pad according to the manufacturer's recommendations. Lining material must be compatible with chemical stored in tank.
- C. Coordinate with CONTRACTOR for installation of expansion joints as specified in Section 15112, Chemical Valves and Appurtenances.

3.3 FIELD QUALITY CONTROL

- A. Refer to Section 01751, Starting and Placing Equipment in Operation.

- B. Required Manufacturer Services: Retain a qualified representative of the manufacturer for a minimum period of 8 hours to perform the following services:
 - 1. Equipment Installation:
 - a. Oversee installation of the equipment and accessories specified herein.
 - b. Inspect the completed installation, note deficiencies, and provide certificate of proper installation when deficiencies are corrected.
 - 2. Furnish test forms and procedures for field testing.
- C. Field Testing:
 - 1. Provide all test apparatus required at no extra cost to COUNTY.
 - 2. Follow testing procedures recommended by the manufacturer and approved by the ENGINEER.
 - 3. After installation is complete but before piping connections are made, block all outlets from the exterior and fill each tank with water to the overflow elevation.
 - 4. Each tank must maintain the overflow elevation level with zero-leakage for a 24-hour period.
 - 5. Repair all leaks in accordance with manufacturer's instructions.
- D. Manufacturer's Installation Report:
 - 1. Prepare manufacturer's installation reports and submit within 30 days after completion of field testing and operation instruction. The reports shall be prepared in accordance with the requirements of Section 01730, Operating and Maintenance Data, and shall include the following:
 - a. Field testing reports.
 - b. Description of installation deficiencies not resolved to COUNTY's satisfaction.
 - c. Description of problems or potential problems.

3.4 CLEANING AND REPAIRING

- A. After installation is complete and connections made, pre-approve with COUNTY to clean tank and nozzles with clean water. CONTRACTOR shall verify with tank manufacturer and submit to ENGINEER proper procedures on rinsing to ensure tanks are not damaged during cleaning.

+ + END OF SECTION + +

SECTION 13401

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up and place in satisfactory operation a complete process control system (PCS).
 - 2. The process instrumentation and control Work includes, but is not limited to, the following:
 - a. Panels and panel-mounted instruments and devices.
 - b. Field-mounted instruments and devices.
 - c. Programmable logic controllers (PLC) and software.
 - d. Personal computers and human-machine interface (HMI) software.
 - e. Local area network hardware and software.
 - f. Uninterruptible power supply.
- B. PCS shall monitor, store, display, and log process and equipment operating information; perform various process control functions; and generate various reports.
- C. The Contract Documents describe the required PCS and PCS functions and operational requirements.
- D. Coordination:
 - 1. Process Controls:
 - a. Instrumentation and controls (I&C) Work under this Contract by I&C Subcontractor shall, as part of the Work, be interfaced with the existing SCADA system. Programming of control logic and configuration of the human machine interface (HMI) software is not part of the Work. SCADA system programmer retained by COUNTY is responsible for programming and configuring software. Process control description of process system and its associated equipment will be provided by COUNTY's systems programmer.
 - b. Some panels and equipment are furnished under other Specification Sections under this Contract, and computer system hardware and software are provided by computer system contractor retained by COUNTY. CONTRACTOR shall coordinate with Suppliers of panels and equipment to provide fully functional system complying with the

Contract Documents and that interfaces with the central computer system.

- c. Computer system input/output list identifies inputs and outputs required, and is part of this Section. Use input/output list for coordinating signals between equipment provided under this and other contracts. Include Work for CONTRACTOR-furnished control options not on the input/output list at no additional cost to COUNTY.
2. To centralize responsibility, I&C materials and equipment provided under this Contract shall be furnished by a single Supplier.
3. With CONTRACTOR, Supplier shall assume the responsibility for adequacy and performance of materials and equipment provided under this Section.
4. To the greatest extent possible, provide I&C materials and equipment from a single manufacturer.
5. Supplier's Responsibilities:
 - a. Preparing all process control equipment submittals in accordance with the Contract Documents.
 - b. Proper interfacing of instrumentation and control equipment with field equipment, instruments, devices, and panels, including required interfacing with packaged control systems furnished by other equipment Suppliers, and required interfacing with the Site's electrical system.
 - c. Review and coordination with manufacturers, other Suppliers, and other contracts of Shop Drawings and other CONTRACTOR submittals for equipment, valves, piping, and appurtenances for ensuring proper interfacing of hardware, and locations and installation requirements of inline devices and instrument taps.
 - d. Direct, detailed oversight of installation of instruments, panels, consoles, cabinets, wiring and other components, and related wiring and piping connections.
 - e. Calibrating, source quality control, field quality control, and start-up of the system.
 - f. Responsibility for correction period obligations for the PCS.
 - g. Training operations and maintenance personnel in operation and maintenance (including calibration and troubleshooting) of the PCS.

E. Related Sections:

1. Section 13403, Process Control System Startup and Field Testing.
2. Section 13404, Process Control System Training.
3. Section 13410, Fiber Optic Cable
4. Section 13420, Primary Sensors and Field Instruments
5. Section 13430, Process Control Panels and Enclosures
6. Section 13440, Panel-Mounted Instruments and Devices.
7. Section 13451, Programmable Logic Controllers.
8. Section 13480, Input-Output Point list.
9. Section 13481, Instrument Index

1.2 REFERENCES

- A. Standards referenced in this Section are:
1. ISA 5.4, Instrument Loop Diagrams.
 2. ISA 20, Specification Forms for Process Measurement & Control Instruments, Primary Elements & Control Valves.
 3. NFPA 79, Electrical Standard for Industrial Machinery.

1.3 QUALITY ASSURANCE

- A. Qualifications:
1. Supplier:
 - a. Shall be financially sound with at least five years of continuous experience in designing, implementing, supplying, and supporting process control systems for municipal wastewater treatment facilities comparable to PCS required for the Project, relative to hardware, software, cost, and complexity.
 - b. Shall have record of successful process control system equipment installations. Upon ENGINEER's request, submit record of experience for at least five projects, each with the following information: project name, COUNTY name and contact information, name and contact information for contractor, name and contact information for engineer or architect, approximate and contract value of process control systems Work for which Supplier was responsible,
 - c. Shall have at time of Bid experienced engineering and technical staff capable of designing, supplying, implementing, and supporting the instrument and control system and complying with submittal and training requirements of the Contract Documents.
 - d. Shall be capable of training operations and maintenance personnel in PCS applications, and in operating, programming, and maintaining the control system and equipment.
 - e. Shall have UL-approved panel shop.
 - f. Possess a thorough, working knowledge of wastewater treatment processes and control philosophy in accordance with standard practices of the wastewater treatment industry.
 - g. Possess and maintain a documented program of failure analysis.
 - h. Approved I&C Suppliers:
 - 1) Curry Controls, Inc.
 - 2) Revere Control Systems
 - 3) Commerce Controls
 - 4) DCR Engineering
 - 5) Rocha Controls.

B. Component Supply and Compatibility:

1. PCS components shall be furnished by a single Supplier who shall have responsibility for furnishing a complete and integrated system.
2. Supplier who shall have responsibility for adequacy and performance of all items furnished.
3. Supplier shall prepare, or shall review and approve, all Shop Drawings and other submittals for the PCS.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

a. Field Instruments:

- 1) Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
- 2) Instrument tag number in accordance with the Contract Documents.
- 3) Data sheets and manufacturer's catalog literature. Provide data sheets in accordance with ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets using a format similar to ISA 20.
- 4) Description of construction features.
- 5) Performance and operation data.
- 6) Installation, mounting, and calibration details; instructions and recommendations.
- 7) Service requirements.
- 8) Dimensions of instruments and details of mating flanges and locations of closed tanks, pipe sizes for insertion instruments, and upstream/downstream straight run pipe lengths required.
- 9) Range of each device and calibration information.
- 10) Descriptions of materials of construction and listing of NEMA ratings for equipment.

b. Panels, Consoles, and Cabinets:

- 1) Layout drawings that include:
 - a) Front, rear, and internal panel views to scale.
 - b) Tag number and functional name of components mounted in and on panel, console, or cabinet, as applicable.
 - c) Product information on panel components.
 - d) Nameplate location and legend including text, letter size and colors to be used.
 - e) Location of anchorage connections.
 - f) Location of external wiring and piping connections.
 - g) Mounting and installation details, coordinated with actual application.

- h) Proposed layouts and sizes of operator interface graphic display panels and alarm annunciator panels.
- i) Calculations substantiating panel heating and cooling provisions proposed.
- j) Subpanel layouts and mounting details for items located inside control panels.
- 2) Product information on panel components including:
 - a) Manufacturer's product name and complete model number of devices being provided, including manufacturer's name and address.
 - b) Instrument tag number in accordance with the Contract Documents.
 - c) Data sheets and catalog literature. Submit data sheets as shown in ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets with format similar to ISA 20.
 - d) Description of construction features.
 - e) Performance and operation data.
 - f) Installation, mounting, and calibration details; instructions and recommendations.
 - g) Service requirements
- 3) Wiring and piping diagrams, including the following:
 - a) Name of each panel, console, or cabinet.
 - b) Wire sizes and types.
 - c) Pipe sizes and types.
 - d) Terminal strip and terminal numbers.
 - e) Wire color coding.
 - f) Functional name and manufacturer's designation for components to which wiring and piping are connected.
 - g) Lightning and surge protection grounding.
- 4) Electrical control schematics in accordance with NFPA 79. Control schematics shall be in accordance with convention indicated in Annex D of NFPA 79. Standardized wiring diagrams that do not accurately reflect actual wiring to be furnished are unacceptable. Tables or charts for describing wire numbers are unacceptable.
- 5) Stock list or bill of materials for each panel including tag number, functional name, manufacturer's name, model number and quantity for components mounted in or on the panel or enclosure.
- 6) Detail showing anchorage plan of wire bundles between subpanels and front panel mounted devices.
- c. Field wiring and piping diagrams, include the following:
 - 1) Wire and pipe sizes and types.
 - 2) Terminal numbers at field devices and in panels.
 - 3) Fiber optic termination designations in the field and in panels.

- 4) Color coding.
 - 5) Conduit numbers in which wiring will be located.
 - 6) Locations, functional names, and manufacturer's designations of items to which wiring or piping are connected.
- d. SCADA System:
- 1) Submit the following general information where applicable:
 - a) Detailed block diagram showing system hardware configuration and identifying model numbers of system components.
 - b) Software listings for operating system, applications, and HMI.
 - c) Software language and organization.
 - d) Format, protocol and procedures for data transmission and communications with input/output modules and peripheral devices, including wide area network (WAN) or local area network (LAN).
 - e) HMI interfacing details, licensing structure, and included functions.
 - f) Control and failure modes.
 - g) Online and offline capabilities for programming, system utilities, and diagnostics.
 - h) Input/Output Information:
 - i. Input/output (I/O) point listing with I/O module cross-reference identification.
 - ii. I/O module cross-reference identification based on I/O address list developed by I&C Subcontractor.
 - i) Database listing, including all I/O points.
 - j) Suggested detailed format and configuration of log reports, alarm summaries, printer outputs, displays, and graphics.
 - 2) Hardware:
 - a) Layout drawings showing front, rear, end, and plan views to scale of equipment, I/O components, power supplies, and peripheral devices.
 - b) Equipment ventilation and cooling requirements.
 - c) Interconnection diagrams, including termination details, cable identification list, and cable length.
 - d) Drawings showing equipment layout.
 - e) Installation requirements, instructions, and recommendations.
 - 3) Software:
 - a) Licensing agreement with name of licensee, renewal requirements, release and versions, expiration dates (if any) and upcoming releases scheduled before Project completion. When upcoming releases are expected, provide descriptions, when available, of features that differ from the proposed release.

- b) Provide information of number of run, client, and development licenses as well as I/O point count limit per license.
 - c) Standard technical and instructional documentation covering software for utility, system support, system documentation, display, communications, data logging and storage and diagnostic functions. Submit this information as electronic files.
 - d) Standard technical documentation covering all aspects of the computer system software functions and capabilities, including instruction set description and programming procedures related to monitoring, display, logging, reporting and alarming functions.
 - e) Detailed functional descriptions of application programs explaining control, display, logging and alarming features to be provided and functions to be performed.
- 4) Documentation describing memory type, size and structure and listing size of system memory, I/O and data table memory and size of memory available for control programs.
- 5) System I/O Loop Wiring Diagrams: Prepare Shop Drawings on module-by-module basis and include the following information:
 - a) Rack numbers, module type and slot number, and module terminal point numbers. Include location and identification of intermediate panel and field terminal blocks and terminal numbers to which I/O wiring and power supply wiring is connected. Identify power supply circuits with designation numbers and ratings.
 - b) Wiring types, wire numbers, and color coding.
 - c) Designation of conduits in which field I/O wiring will be installed.
 - d) Location, functional name, tag numbers and manufacturer's module numbers of panel and field devices and instruments to which I/O wiring will be connected.
 - e) Prepare loop wiring diagrams in accordance with ISA 5.4.
- e. Complete point-to-point interconnection wiring diagrams of field wiring associated with the system. Diagrams shall include the following:
 - 1) Field wiring between each equipment item, panel, instruments, and other devices, and wiring to control stations, panelboards, and motor starters. Some of this equipment may be specified in other Divisions. CONTRACTOR is responsible for providing complete point-to-point interconnection wiring diagrams for control and monitoring of that equipment.
 - 2) Numbered terminal block and terminal identification for each wire termination.

- 3) Identification of assigned wire numbers for interconnections. Assign each wire a unique number.
 - 4) Schedule showing the wiring numbers and the conduit number in which the numbered wire is installed.
 - 5) Junction and pull boxes through which wiring will be routed.
 - 6) Identification of equipment in accordance with the Contract Documents.
2. Product Data:
 - a. Product data for field instruments in accordance with requirements for Shop Drawings in this Section.
 - b. Product data for panels, consoles, and cabinets in accordance with requirements for Shop Drawings in this Section.
 - c. Product data for field wiring and piping provided for instrumentation and control service and not included under other Sections or contracts.
 - d. Product data for SCADA system, including software and hardware. Requirements for software product data are included in requirements for Shop Drawings under this Section.
 3. Samples:
 - a. Color charts for finish paint for metallic panels. Provide full range of paint manufacturer's standard and custom colors. Color selection will be by ENGINEER.
 - b. Color charts for fiberglass-reinforced panels. Provide full range of panel manufacturer's standard and custom colors. Color selection will be by ENGINEER.
 4. Factory Acceptance Test Procedure: Submit proposed procedures for factory testing required to comply with the Contract Documents. Test procedure shall include the following:
 - a. Visual inspection of components and assembly.
 - b. Description of hardware operational testing.
 - c. Description of software demonstration.
 - d. Description of testing equipment to be used.
 - e. Sign-off sheets to be used at time of testing.

B. Informational Submittals: Submit the following:

1. Manufacturer's Instructions:
 - a. Shipping, handling, storage, installation, and start-up instructions.
 - b. Templates for anchorage devices for materials and equipment that will be anchored to concrete or masonry.
2. Source Quality Control Submittals:
 - a. Results of factory testing.
3. Special Procedure Submittals:
 - a. Notification to COUNTY and ENGINEER at least 14 days before readiness to begin system checkout at the Site. Schedule system checkout on dates acceptable to COUNTY and ENGINEER.
 - b. Written procedure for system checkout. Submit not less than 90 days prior to starting system checkout.

- c. Ninety days prior to starting system checkout submit written procedure for start-up.
 - 4. Field Quality Control Submittals:
 - a. Submit the following prior to commencing system checkout and start-up.
 - 1) Completed calibration sheets for each installed instrument showing five-point calibration (zero, 25, 50, 75, 100 percent of span), signed by factory-authorized serviceman.
 - b. Field calibration reports
 - c. Field testing reports.
 - 5. Supplier's Reports:
 - a. Installation inspection and check-out report.
 - b. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
- C. Closeout Submittals: Submit the following:
 - 1. Operations and Maintenance Data:
 - a. Submit in accordance with Section 01 78 23, Operation and Maintenance Data.
 - b. Include complete up-to-date system software documentation. Provide hardcopy and electronic copies.
 - 2. Record Documentation:
 - a. Prepare and submit record documents in accordance with Section 01 78 39, Project Record Documents.
 - b. Revise all PCS Shop Drawings to reflect as-built conditions in accordance with the following.
 - 1) Use "as-built" updates of approved Shop Drawings and submittals in operation and maintenance manuals.
 - 2) Half-size black line prints of wiring diagrams applicable to each control panel shall be placed in clear plastic envelopes inside a suitable print pocket or container inside each control panel.
 - 3) Submit drawings of the point-to-point interconnection wiring diagrams updated to reflect final as-built equipment information and as-installed field installation information.
- D. Maintenance Materials Submittals: Submit the following:
 - 1. Spare Parts and Test Equipment
 - a. General:
 - 1) Furnish the spare parts and test equipment in accordance with the Contract Documents, identical to and interchangeable with similar materials and equipment provided for the PCS under the Contract.
 - 2) Provide source quality control for spare parts as part of factory testing prior to shipment of process control system equipment.

- 3) For process sensors and other analog instruments, Supplier shall submit a separate quotation for recommended list of spare parts and test equipment. Separately list and price each item recommended. Spare parts quotation shall include a statement that prices quoted are valid for a period of one year from date of equipment installation and that Supplier understands that COUNTY reserves the right to purchase none, any, or all parts quoted. Upon request, Supplier shall submit documentation that stock of spare parts and test equipment is obtainable within 48 hours of receipt of COUNTY's order.
- b. Furnish the following spare parts:
 - 1) Five of each type of input/output relay for each quantity of forty or fraction thereof provided under the Contract.
 - 2) One of each type of PLC input/output module or card used.
 - 3) One replacement power supply for each type and size provided under the Contract.
 - 4) One-year supply of all expendable or consumable materials.
 - 5) One per quantity of five or fraction thereof of gauges, indicators, and switches provided, complete with diaphragm seals, filled and ready to use.
 - 6) One per quantity of ten or fraction thereof provided, per range of field instruments including insertion type instruments. No spares are required for inline instruments such as magnetic flow meters and flumes or venturis that include flow tubes through which flow is conveyed.
 - 7) Twelve of each type and size of fuse used in instruments.
- c. Furnish the following test equipment:
 - 1) One of each set of special tools required to insert, extract, and connect internal or external connectors, including edge connectors.
 - 2) One portable flow meter calibrator, for magnetic flow meter use only.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prior to packaging, each manufacturer or Supplier shall securely attach tag number and instructions for proper field handling and installation to each instrument.

PART 2 – PRODUCTS

2.1 PCS – GENERAL PROVISIONS FOR PRODUCTS

- A. General:

1. All electrically-powered equipment and devices shall be suitable for operation on 115-volt plus-or-minus 10 percent, 60 Hertz plus-or-minus two Hertz power. If different voltage or closer regulation is required, provide suitable regulator or transformer.
2. Provide appropriate power supplies for all two-wire transmitters, loops for monitoring discrete inputs and necessary outputs. Install power supplies mounted in enclosures, and install in appropriate control room or field panel.
3. Power supplies shall be suitable for minimum of 130 percent of the maximum simultaneous current draw.
4. Provide power on-off switch or air circuit breaker for each item requiring electrical power.
5. Provide isolation transformers, line voltage regulators and power distribution panels for the distributed digital portions of the PCS to eliminate electrical noise and/or transients entering on the primary power line.
6. Unless otherwise shown or indicated in the Contract Documents, control system shall be furnished to use 4 to 20 mA DC analog signals.
7. Provide signal converters and repeaters where required. Analog inputs to distributed control system shall be through appropriate repeaters to provide signal isolation where series-looped with other devices and to allow loop to maintain integrity even when distributed control system is out of service. Power supplies shall be adequate for signal converter and repeater loads.
8. Signals shall be isolated from ground.
9. Signals shall not have a transient DC voltage exceeding 300 volts over one millisecond nor a DC component over 300 volts.
10. PCS and associated input/output wiring will be used in a facility environment where there can be high-energy AC fields, DC control pulses, and varying ground potentials between the sensors/transducers or input contact locations and PCS components. PCS shall be adequate to provide proper protection against interferences from all such possible situations.
11. Instrumentation and PCS components shall be heavy-duty types, suitable for continuous service in a municipal wastewater treatment plant environment. Furnish products that are currently in production at the time products are shipped from the factory. All equipment furnished shall be of modular construction and be capable of field expansion through installation of plug-in circuit cards and additional cabinets as necessary. Logic and control loops shall be fail-safe.
12. Instrumentation and other PCS components shall return automatically to accurate measurement within 15 seconds upon restoration of power after a power failure, and when transferred to standby power supply.
13. Provide surge protection for instruments and all other PCS components that could be damaged by electrical surges.
14. Field-mounted instruments and PCS components shall be suitable for installation in humid and corrosive service conditions. Field-mounted

instrument enclosures, junction boxes, and appurtenances shall comply with NEMA 4X requirements, unless otherwise shown or specified.

15. Relays with interconnections to field devices shall be wired through terminal blocks. Terminals as part of the relay base are unacceptable.
16. Panel mounted instruments, switches, and other devices shall be selected and arranged to present a pleasing coordinated appearance. Front-of-panel-mounted devices shall be of the same manufacturer and model line.
17. All components furnished, including field-mounted and rear-of-panel instruments, shall be tagged with the item number and nomenclature as shown and the instrument index in the Contract Documents or, as applicable, the "data sheets" that are part of the Contract Documents.
18. Ranges and scales specified in the Contract Documents shall be coordinated to suit equipment actually furnished. Range, scale, and set point values specified in other Sections of Division 13 are for initial setting and configuration. Coordinate specified values with actual equipment furnished to implement proper and stable process action as systems are placed in operation.
19. Field-mounted devices shall be treated with an anti-fungus spray.
20. Field-mounted devices shall be protected from exposure to freezing temperatures.

B. Environmental Conditions:

1. PCS and its components shall be designed and constructed for continuous operation under the following temperature and humidity conditions:
 - a. Equipment and Devices Installed in Control Rooms:
 - 1) Ambient Temperature: 60 degrees F to 80 degrees F normal range; and 40 degrees F to 105 degrees F occasional maximum extremes.
 - 2) Relative Humidity: 80 percent, normal; 95 percent maximum.
 - b. Equipment and devices installed at indoor locations (other than control rooms) for digital processing equipment hardware, control panels, and instruments:
 - 1) Ambient Temperature: 40 degrees F to 120 degrees F.
 - 2) Relative Humidity: 98 percent maximum.
 - c. Equipment and Devices Installed Outdoors:
 - 1) Ambient Temperature: -10 degrees F to 120 degrees F.
 - 2) Relative Humidity: 100 percent maximum.

C. Refer to other Sections of Division 13 for product requirements for materials and equipment that are part of the PCS.

PART 3 – EXECUTION

3.1 PCS – GENERAL PROVISIONS FOR EXECUTION

A. Refer to other Sections of Division 13 for execution requirements for the PCS.

++ END OF SECTION ++

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SECTION 13403

PROCESS CONTROL SYSTEM START-UP AND FIELD TESTING

PART 1 - GENERAL

1.1 SYSTEM CHECK-OUT AND START-UP RESPONSIBILITIES

- A. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all equipment and coordinate all activities necessary to perform check-out and start-up of the equipment.
- B. CONTRACTOR shall retain the services of the Supplier to supervise and/or perform check-out and start-up of all system components. As part of these services, the system Supplier shall include for those equipment items not manufactured by him the services of an authorized manufacturers' representative to check the equipment installation and place the equipment in operation. The manufacturers' representative shall be thoroughly knowledgeable about the installation, operation and maintenance of the equipment.

1.2 SYSTEM CHECKOUT AND START-UP

- A. CONTRACTOR, under the supervision of the PCS Supplier, and other instrument suppliers as applicable, shall perform the following:
 - 1. Check and approve the installation of all PCS components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation.
 - 2. Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. When there are future operational functions included in this work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.
- B. CONTRACTOR shall provide all test equipment necessary to perform the testing during system checkout and start-up.
- C. CONTRACTOR and Supplier shall be responsible for initial operation of monitoring and control system and shall make any required changes, adjustment or replacements for operation, monitoring and control of the various processes and equipment necessary to perform the functions intended.

- D. CONTRACTOR shall furnish to the ENGINEER certified calibration reports for field instruments and devices specified in Section 13420, Primary Sensors and Field Instruments, and panel mounted devices specified in Section 13440, Panel-Mounted Instruments and Devices, as soon as calibration is completed.
- E. CONTRACTOR shall furnish ENGINEER an installation inspection report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both CONTRACTOR and the Supplier.

1.3 INTEGRATED SYSTEM FIELD TEST

- A. Following the PMCS checkout and initial operation, CONTRACTOR, under the supervision of the Supplier, shall perform a complete system test to verify that all equipment and programmed software is operating properly as a fully integrated system, and that the intended monitoring and control functions are fully implemented and operational. Any defects or problems found during the test shall be corrected by CONTRACTOR and then retested to demonstrate proper operation.
- B. Following demonstration of all system functions, the PCS including field sensors/transducers and instruments shall be running and fully operational for a continuous 48 hour period. The Operational Availability Demonstration specified below shall not begin until the continuous 48 hour integrated system test has been successfully completed and COUNTY and ENGINEER agree that the Operation Availability Demonstration can begin.

1.4 OPERATIONAL AVAILABILITY DEMONSTRATION

- A. Operational Availability Demonstration (OAD) shall begin following completion of the integrated system field test as specified above and shall continue until a time frame has been achieved wherein the system (both hardware and software) availability meets or exceeds 99.5 percent for 30 consecutive days and no system failures have occurred which result in starting the OAD over again. During the OAD the system shall be available to plant operating personnel for use in normal operation of the plant.
- B. For the purpose of the OAD, the system will be defined as consisting of the following systems and components:
 - 1. SCADA Panel 5.
 - 2. Existing SCADA Panel 4.
- C. The conditions listed below shall constitute system failures which are considered critical to the operability and maintainability of the system. The OAD shall be

terminated if one or more of these conditions occur. Following correction of the problem, a new 30 consecutive day OAD shall begin.

1. Failure to repair a hardware or software problem within 120 consecutive hours from the time of notification of a system failure.
2. Recurrent hardware or software problems: if the same type of problem occurs three times or more.
3. Software problem causing a processor to halt execution.

D. The following conditions shall constitute a system failure in determining the system availability based on the equation specified in Paragraph 1.4.E., below:

1. Failure of SCADA Panel 5.
2. Loss of communications between devices on the communications network.
3. Failure of one or more input/output components.
4. Failures of any type affecting ten or more input/output points simultaneously.
5. Failure of any type affecting one or more regulatory control loops or sequential control strategies thereby causing a loss of the automatic control of the process variable or process sequence operation.
6. Failure of power supply. Where redundant power supplies are provided, failure of one power supply shall not constitute a system failure provided the backup power supply operates properly and maintains supply power. Failure of the backup supply to operate properly and maintain supply power shall constitute a system failure.
7. Failure of three or more primary sensors/transducers or field instruments simultaneously.

E. The system availability shall be calculated based on the following equation:

$$A = \frac{TTO}{TTO + TTR} \times 100 \text{ percent}$$

where, A = system availability in percent

TTO = total time in operation

TTR = total time to repair

F. Time to repair shall be the period between the time that CONTRACTOR is notified of a system failure and the time that the system has been restored to proper operation in terms of hours with an allowance for the following dead times which shall not be counted as part of the time to repair period.

1. Actual travel time for service personnel to get to the Site up to six hours per incident from the time CONTRACTOR is notified of a system failure.
2. Time for receipt of spare parts to the plant site once requested up to 24 hours per incident. No work shall be done on the system while waiting for delivery of spare parts.

3. Dead time shall not be counted as part of the system available period. The dead time shall be logged and the duration of the OAD extended for an amount of time equal to the total dead time.
- G. Completion of a 30 consecutive day period without any restarts of the OAD and with a system availability in excess of 99.5 percent will constitute acceptance of the PMCS by COUNTY.
- H. All parts and maintenance materials required to repair the system prior to completion of the OAD shall be supplied by CONTRACTOR at no additional cost to COUNTY. If parts are obtained from the required plant spare parts inventory, they shall be replaced to provide a full complement of parts as specified.
- I. A Process Control System Malfunction/Repair Reporting Form shall be completed by the plant personnel and ENGINEER to document system failures, to record CONTRACTOR notification, arrival and repair times and CONTRACTOR repair actions. Format of the form shall be developed and agreed upon prior to the start of the OAD.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 13404

PROCESS CONTROL SYSTEM TRAINING

PART 1 - GENERAL

1.1 REQUIREMENTS AND RESPONSIBILITIES

- A. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to perform and coordinate all required training at times acceptable to COUNTY and ENGINEER.
- B. CONTRACTOR shall retain the services of the Supplier to provide operation and maintenance training for all PMCS equipment as specified herein.
- C. For equipment items not manufactured by the Supplier, the Supplier shall provide for on-site training by an authorized representative of the equipment manufacturer as part of the Supplier's services. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.
- D. CONTRACTOR shall be responsible for all costs, including cost of travel, meals and lodging, if required, associated with training, both on-site and at the supplier's facilities, and shall provide all required materials, texts and required supplies.
- E. All training shall be conducted in the normal eight-hour working days until conclusion of the training course.

1.2 SUBMITTALS

- A. Within 90 days of the effective date of the Notice to Proceed, CONTRACTOR shall submit his plan for training. Included in the plan shall be course outlines and schedules for training to be provided at the Supplier's facilities.

1.3 ON-SITE TRAINING

- A. Primary Sensors/Transducers and Field Instruments:
 - 1. Provide on-site operation and maintenance training by Supplier and the equipment manufacturer representatives prior to placing the equipment in continuous operation. The services of equipment manufacturer's representatives shall be provided for a minimum of two hours for each type of instrument provided.
 - 2. Training shall accomplish the following:

- a. Provide instruction covering use and operation of the equipment to perform the intended functions.
 - b. Provide instruction covering procedures for routine, preventive and troubleshooting maintenance including equipment calibration.
 - c. Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall plant monitoring and control system.
- B. Training covering the control equipment:
- 1. The Supplier shall provide two days of operations training covering all system components.
 - 2. Training course shall accomplish the following:
 - a. Provide all instructions necessary to operate and utilize all system components.
 - b. Provide all instruction necessary to monitor and control the system processes from the designated control panel.
 - c. Explain procedures for control of the system during scheduled or rescheduled shutdown and the subsequent start-up.
 - d. Provide instructions for regular caretaking operations.
- C. PLC Training:
- 1. The PCS Supplier shall provide training that covers the PLCs as follows:
 - a. Provide an overview of system hardware and software.
 - b. It shall train people in configuration, operation and programming processors.
 - c. The emphasis shall be placed on how to perform set point changes, minor programming changes, range changes, diagnostics and upkeep of documentation.
 - d. Instruction for hardware and software maintenance, trouble shooting and maintenance planning.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++

SECTION 13410

FIBER OPTIC CABLING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. CONTRACTOR shall provide all labor, materials, equipment and incidentals required to install, and place into successful operation, fiber optic data highway cables and appurtenances for the process and non-process communications systems throughout the plant as specified herein. The system includes, but is not limited to, fiber optic cables, connectors, patch panels, termination kits, enclosures and related appurtenances.
- B. CONTRACTOR shall terminate all fibers in the patch panels and equipment designated on the Contract Drawings. Cable runs between termination points shall be continuous. Provide type and quantity of fiber optic cable to provide and connect the PLCs and HMI computers on an Ethernet ring topology and to provide 200% spare fiber at each node.
- C. The CONTRACTOR shall be responsible to install the equipment specified under this section in accordance with the staging instructions noted on the Contract Drawings.

1.2 RELATED SPECIFICATIONS

- A. Detailed Specifications - Division 16.

1.3 QUALITY ASSURANCE

- A. Installers shall be personally experienced in the installation of optical fiber systems and shall have been regularly engaged in the installation of fiber cable for a minimum of the past five years.
- B. The Installer shall retain the services of a field advisor from the manufacturer for a minimum of 40 hours for the following:
 - 1. Render advice regarding method of cable installation
 - 2. Inspection of equipment for installing cable.
 - 3. Witness representative amount of cable pulling.
 - 4. Witness the installation of at least one splice and termination performed by each cable installer.
 - 5. Witness the after installation test.
 - 6. Certify with an affidavit that the aforementioned particulars are satisfactory and the cable is installed in accordance with cable manufacturer's

recommendations.

- C. Provide all cable in accordance with the listing requirements of Article 770 of the National Electrical Code.

1.4 SUBMITTALS

- A. CONTRACTOR shall submit working drawings, shop drawings and material specifications for the approval of the ENGINEER in accordance with the requirements of the General Conditions, as specified under Section 01332, and as specified herein.
 - 1. Manufacturer's product data sheets and complete construction details including physical characteristics of optical fiber, strength members, and jackets.
 - 2. Overall dimension of cable.
 - 3. Cable pulling plan, which specifies the sequence of work, tasks, materials, and equipment. The information submitted must include splicing and termination data including the following:
 - a. List of materials.
 - b. Method of connecting cables.
 - c. Details of cable preparation.
 - d. Method of applying materials (including quantities).
 - e. Precautionary measures.
 - f. Drawings showing method of splicing including dimensions.
 - g. Written statement from cable manufacturer that splices and terminations submitted are acceptable.
 - h. Written statement from the termination/slice manufacturer that the splices and terminations are suitable for the proposed application.
 - 4. Cable manufacturer's certified test data for attenuation and bandwidth and the maximum pulling strain allowed.
 - 5. Provide an optical link analysis for each fiber optic link. Calculate point-to-point (transmit/receive) optical power loss of each fiber link using proposed installed cable lengths. Include all losses through connectors. Submit calculated values including sketches graphically showing the proposed cable route.
 - 6. Installer and field advisor qualification data including name, employer, experience with fiber installations including a list of completed installations, and the names of five references for installations completed that are similar in scope to this project

1.5 SAMPLES

- A. Provide two foot samples of each type of cable.
- B. Provide a sample of each type of splicing and termination material

1.6 DELIVERY, STORAGE, AND HANDLING

A. Cable Delivery:

1. No cable over one year old shall be acceptable for delivery.
2. Ends of cables shall be kept sealed at all times, except when making splices and terminations. Splice and termination methods approved by the cable manufacturer shall be followed.
3. Include the following data on each reel:
 - a. Facility name and address.
 - b. CONTRACTOR's Name.
 - c. Project Title and Number.
 - d. Date of Manufacture.
 - e. Manufacturer's Name.
 - f. Linear Feet.
 - g. Project specific locations specific cable is to be installed.
 - h. Date of manufacture.

B. Cable Storage: Cable shall be stored at a temperature recommended by the manufacturer for optimum workability.

PART 2 - PRODUCTS

2.1 FIBER OPTIC CABLE BACKBONE CABLE

- A. Provide multimode graded index, tight-buffered, optical glass fiber cores compatible with LED-based transmission systems and suitable for fiber optic Ethernet LAN standards including the point-to-point Fiber Optic Inter-Repeater Link (FOIRL) network, and ANSI standard Fiber Distributed Data Interface (FDDI) networks. Attenuation losses shall be 3.5 dB/km or less at a wavelength of 850 nm and 1.0 dB/km or less at a wavelength of 1300 nm. Minimum bandwidths shall be 160 MHz-Km at 850 nm and 500 MHz at 1300 nm. Do not use cable with plastic fiber core construction. The number of cables and the number of fibers in each cable shall be as specified herein and as shown on the drawings. The cable shall be provided with the necessary number of splitter kits to accommodate the number of terminations shown for each interconnection box on the drawings. Splitter kits shall be suitable units manufactured by the Cable manufacturer. Cable shall be assembled with inner strength members; polyester core separator tape; Aramid yarn or similar strength members; inner PVC jacket with ripcord; and a polyethylene outer jacket with ripcord. Provide a cable outer jacket that is UV inhibited, fungus resistant and flame retardant. Cable to be UL listed as type OFN and suitable for indoor and outdoor. Provide cable unaffected by continuous or intermittent submergence in water, damage from lightning strikes. This cable is to be used for installation in conduits only. Provide continuous inter- and intra building installation, closet to closet, suitable for passing through inside conduit locations directly from outside conduit. Exempt

from NEC 770-50 (50 ft. rule). Resistant to fuel, petro-chemicals and other caustic or noxious materials. Cable shall be UL or ETL OFN per NEC 770-51(D) and NEC 770-53(B) rated. Cable Specifications are as follows:

1. Fiber Size: 62.5 micron /125 micron. (core/cladding)
2. Fiber Count: 6, 8, 18, and 36, fibers, respectively.
3. Nominal Cable Diameter: 0.20, 0.23, 0.28, and 0.62 inches, respectively.
4. Nominal Cable Weight: 18, 24, 34, and 103 pounds per 1000 feet, respectively
5. Crush Resistance: 500 pounds per inch.
6. Maximum Tensile Load: 600 pounds (installation)
7. Maximum Tensile Load: 135 pounds (in-service)
8. Minimum Bend Radius: 20X outside diameter. (installation)
9. Minimum Bend Radius: 10X outside diameter. (in-service)
10. Operating Temperature: -40 to +85 degrees C

B. Product Manufacturer: Provide fiber optic cable of one of the following:

1. Optical Cable Corporation.
2. Corning Cable Systems.
3. Or approved equal.

2.2 FIBER OPTIC TERMINAL CONNECTORS

A. Furnish connectors and components and use specific tools and methods as recommended by the connector manufacturer to form complete and reliable fiber optic cable terminations.

B. Terminal connector shall be type SC, non-polishing, mechanical splice suitable for 62.5 micron multimode fiber optic cable. Terminal shall be constructed of a composite housing, ceramic ferrule and a fiber stub permanently bonded into the ferrule. The other end of the fiber stub shall be precisely cleaved and ready for splicing.

C. The terminal connector performance characteristics shall be as follows:

1. Insertion Loss (typical/maximum): 0.15 / 0.30 dB.
2. Durability Delta (1000 matings): 0.1 dB.
3. Operating Temperature: -40 to +80 degrees C.
4. Cable Retention: 40 pounds.

D. Terminal connectors shall be provided by one of the following manufacturers:

1. Radiant Communications Corp.
2. Corning Cable Systems.
3. Or approved equal.

2.3 FIBER OPTIC JUMPER CABLES

- A. Fiber optic jumper cables shall be three feet in length, 62.5 micron, multimode, and be compatible with the fiber optic backbone cable as specified herein. Jumpers shall be furnished with SC type connector, PVC jacket and be furnished by the fiber optic backbone cable manufacturer. Jumper cables fabricated on site shall not be acceptable.
- B. Provide a quantity of jumper cables equal to the total number of fibers terminated in all patch panels.

2.4 FIBER OPTIC CABLE PATCH PANELS

- A. Wall mounted patch panels shall be enclosed in a NEMA 4X wall mounted cabinet. Fiber optic patch panels designated as a distribution rack shall be mounted in an EIA standard 19-inch width rack enclosure. Patch panels shall be of modular construction and utilize an SC type connector.
- B. Wall mounted fiber optic patch panels shall be suitable for use with 62.5 micron, multimode graded index, tight-buffered fiber optic cable and accommodate a minimum of 48 individual fibers. Panels shall have a metal enclosure, hinged clear polycarbonate jumper door, jumper routing guides, strain relief points and lockable door. Appropriate quantities of SC type connector modules shall be furnished.
- C. Rack mounted fiber optic patch panels shall be suitable for use with 62.5 micron, multimode graded index, tight-buffered fiber optic cable and accommodate a minimum of 144 individual fibers. Appropriate quantities of SC type connector modules shall be furnished.
- D. Provide fiber optic cable patch panels to meet the following requirements:
 - 1. Furnish panels with the following accessories:
 - a. Splice trays
 - b. Cable strain relief
 - c. Bend radius protectors
 - d. Routing guides
 - e. Grommetted cable entries
 - f. T adapters and adapter plates
 - g. Sufficient working space for removal of connectors
 - h. Identification label
 - i. All cable management hardware required to accomplish the installation
 - 2. Installation of accessories in a separate enclosure inside the NEMA 4X enclosure shall be permissible.
 - 3. Furnish each cabinet with a key lock and four (4) keys. All cabinets provided are to be keyed alike so that a single key opens all cabinets.

4. Furnish cabinets with internal space to store, organize, and strain relieve incoming and outgoing cables.
 5. Ground lug for cable support member and routing supports to maintain allowable cable bend radius.
- E. Product and Manufacturers: Provide one of the following:
1. Radiant Communications Corporation.
 2. Corning Cable Systems.
 3. Or approved equal.

2.5 ENCLOSURES

- A. Type: 316 stainless steel, 14-gauge enclosure, rated NEMA 4X, solid center post with heavy stiffener. Stainless steel captivated door screws, oil resistant gasket with two 12 gauge steel panels mounted on collar studs.
- B. Enclosure shall house patch panels and fiber optic cables as shown on the Contract Drawings. Enclosure shall be wall and rack mount type and of adequate size to house all the components.
- C. Individual front door for each enclosure with engraved nameplate identifying equipment.
- D. Padlocking arrangement permitting locking the doors with at least 2 padlocks.
- E. Minimum size shall be 30" width, 30" high, and 12" deep.
- F. A clearance of approximately 6" inside the enclosure around the patch panels shall be provided.
- G. Product and Manufacturers: Provide one of the following:
 1. Hoffman Engineering Endura Line.
 2. Hubbell.
 3. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fiber optic cables shall be installed in conduit types as defined in Division 16. Where existing spare conduits can be reused, inspect conduits prior to pulling cables. Rod and swab out conduits and ducts prior to installing cables. For areas where existing conduit cannot be reused and excavation is required, install fiber optic cable in concrete encased duct banks.

- B. Pull cables prior to attachment of connectors. Terminate all fibers at each patch panel. Install jumper cables at each patch panel as required, or as directed by the COUNTY's CONSULTANT.
- C. Pull cables using an indirect attachment method such as a "Kellems Grip" which distributes the pulling forces over the outer portion of the cable. Pulls directly on the fiber core shall not be allowed.
- D. Do not exceed maximum pulling strength limits of the cable during installation. Monitor cable pull tensions at all times during the installation of the cable using a remote sensing puller, strain gauge or running line tensiometer. If electronic tension monitoring equipment is used, it shall be calibrated or checked for calibration on a daily basis or prior to any cable pull.
- E. To reduce cable friction and minimize pulling forces during installation, use a polymer based, water soluble lubricant when pulling cable.
- F. Do not exceed the minimum bend radius of the cable. Tight loops, kinks, knots or tight bends shall not be allowed during installation.
- G. For conduit installation, the minimum bending radius shall be 8 inches. Use sweeping elbows at all transitions from horizontal to vertical conduit runs.
- H. Provide adequate lengths of cable such that all runs, from termination-to-termination are without splices. Cable splices shall be avoided to the greatest extent possible. Where splice are required they shall be done with the approval of the COUNTY's CONSULTANT and in accordance with the manufactures recommendations.
- I. Provide handholds and pull boxes as required by the cable manufacturer or at a minimum of every two hundred feet or at the third 90-degree conduit bend.
- J. Within manholes, route and support fiber optic cable along the inside wall.
- K. Install patch panels as needed to permit ease of troubleshooting but not to exceed point-to-point DB loss specified herein.

3.2 IDENTIFICATION

- A. Label each termination point.
- B. Tag each cable in junction boxes, pull boxes, manholes and handholds. Tags shall indicate the cable number, date installed, type of cable, and manufacturer. Attach tags to cable with non-ferrous metal wire.

- C. Provide patch panel schedule for each patch panel showing fiber optic cable number and termination points.

3.3 CHECKOUT AND TESTING

- A. Test fiber optic cables before and after field installation. Tests shall be witnessed by the ENGINEER.
 - 1. Upon receipt of the fiber optic cable reels, test each fiber separately with an Optical Time Domain Reflectometer (OTDR) to verify fiber length, attenuation and continuity.
 - 2. After the cable has been installed, visually inspect each fiber termination for out-of-round conditions and surface defects such as cracks and microchips using a 200X inspection microscope.
 - 3. After connectors have been attached at both ends, test each fiber with an OTDR. Tests shall be bi-directional.
 - 4. Test all fibers including spares. Test shall include, but not be limited to the following:
 - a. Check candlepower transmitted through each fiber in the data highway fiber optic cable. If the light transmitted through the cable does not meet the requirements, then check all connectors on the fiber cable for proper installation. Replace all bad connections.
 - b. The test shall be performed on a point to point basis from the head end device to the end device and shall include any jumper cables to connect the end devices.
 - c. If a section of the fiber optic cable is not transmitting light to the requirements, then replace that section of the cable.
- B. Furnish certification documents for each test and record the following data. Include printouts from the OTDR with the certification documents.
 - 1. Installer's company name and address.
 - 2. Installer's name.
 - 3. Date of certification.
 - 4. Attenuation of each fiber link.
 - 5. Length of each fiber optic link measured.
 - 6. Equipment used to certify the fiber optic link.
 - 7. Name of person(s) recording the test data.
- C. Power meters shall have calibrations traceable to National Institute of Standards and Technology (NIST) standards.
- D. The maximum total loss including connectors and cable attenuation for each fiber optic link shall not exceed 7.5 dB.

3.4 SPARE PARTS AND TEST EQUIPMENT

- A. CONTRACTOR shall furnish and deliver the spare parts and test equipment as

outlined below, all of which shall be identical and interchangeable with similar parts furnished under this specification.

- B. Spare parts shall be packed in containers suitable for long term storage, bear labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. The following shall constitute the minimum required spare parts:
 - 1. Three (3) fiber termination kits.
 - 2. Fifty (50) fiber patching cables.
- D. The following shall constitute the minimum required test equipment:
 - 1. One (1) fiber optic test kit, calibrated to the appropriate wavelength and with suitable connectors for the fiber type provided.

++ END OF SECTION ++

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SECTION 13420

PRIMARY SENSORS AND FIELD INSTRUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation all primary sensors and field instruments shown and specified herein.
2. Contract Documents illustrate and specify functional and general construction requirements of the sensors and field instruments and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable, and integrated system.
3. CONTRACTOR shall be responsible for installing in-line flow elements (magnetic flow meter flow tubes, insert flow tubes, propeller flow meters) and for providing taps in the process piping systems for installation of other flow, pressure, and temperature sensing instrumentation.

B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all components and systems.

C. Related Sections:

1. Section 13401, Process Control System General Provisions.
2. Section 13403, Process Control System Startup and Field Testing.
3. Section 13404, Process Control System Training.
4. Section 13430, Process Control Panels and Enclosures
5. Section 13440, Panel-Mounted Instruments and Devices.
6. Section 13480, Input-Output Point list.
7. Section 13481, Instrument Index

1.2 QUALITY ASSURANCE

A. Comply with the requirements of Section 13401, Process Control System General Provisions.

B. Acceptable Manufacturers:

1. Furnish primary process measurement devices by the named manufacturers or equal equipment by other manufacturers.
2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.
3. Obtain all sensors and field instruments of a given type from the same manufacturer.
4. The primary sensors and field devices shall be interchangeable with similar function existing primary sensors and field devices to minimize spare parts inventory.

C. Manufacturers' Responsibilities and Services:

1. Design and manufacture the primary process measurement devices in accordance with the applicable general design requirements specified in Section 13401, Process Control System General Provisions, and the detailed Specifications herein.
2. Field supervision, inspection, start-up and training in accordance with the requirements of Section 13403, Process Control System Startup and Field Testing, and Section 13404, Process Control System Training.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Comply with the requirements specified in Section 13401, Process Control System General Provisions.
- B. Primary process measurement devices shall not be delivered to the Site until all product information and system Shop Drawings for the sensors and instruments have been approved by the ENGINEER.

1.4 SUBMITTALS

- A. Comply with the requirements specified in Section 13401, Process Control System General Provisions.

1.5 CHEMICAL SERVICE

- A. Where a primary element is designated for chemical service, all wetted components and appurtenances for that primary element shall be resistant to corrosion by that chemical. Chemicals referred to commonly as "caustic", "sodium hypochlorite", "hydrochloric acid", "ferric chloride", and "methanol" shall mean the following:
 1. "SODIUM HYPOCHLORITE": Sodium Hypochlorite (NaOCl), 12.5 percent solution, Specific Gravity = 1.2.

1.6 MATERIALS OF CONSTRUCTION FOR WETTABLE PARTS

- A. Provide compatible materials of construction for primary sensors and field instrument (wetted) parts that come in contact with the process fluids listed in the Instrument Index.

1.7 IDENTIFICATION TAGS

- A. Performance Requirements:
 - 1. Tag numbers of sensors and field instruments shall be as shown and as specified. For items not shown or specifically tagged, the item tag number shall be established by the system supplier. All instruments, whether field or panel mounted, shall have an identification tag.
 - 2. Information to be permanently engraved onto the tag shall include the identifying tag number, manufacturer, model number, service, and range.
 - 3. The tags shall be fastened to the device with self-tapping stainless steel screws. Where fastening with screws cannot be accomplished the tags shall be permanently attached to the device by a circlet of stranded stainless steel wire rope and clamp.
 - 4. All sensors and field instruments mounted on or within control panels and enclosures shall have the identification tag installed so that the engravings are easily visible to service personnel. Panel mounted devices shall have the tag attached to the rear of the device.
- B. Construction Features:
 - 1. Tags shall be engraved with 3/16-inch letters and constructed as follows.
 - a. 3/32-inch thick laminated phenolic for engraving composed of core, laminated on both sides with a matte (non-glare) finish cover sheet.
 - b. Core to be black; cover sheet to be white.
 - c. Mounting holes to be centered on width and 1/4-inch from each end.

1.8 FILLING LIQUID

- A. Use silicone except for process fluids containing chlorine. When the process fluid contains chlorine, the filling liquid shall be Halocarbon 63 or Fluorolube 63.

PART 2 - PRODUCTS

- 2.1 Process Taps, Sensing Lines and Accessories.
- 2.2 Level Transmitter - Ultrasonic Type.
- 2.3 Level Switch - Float Type.
- 2.4 Level Switch – Multipoint Float Type.
- 2.5 Level Switch - Conductance Type.

- 2.6 Level Sight Gauge.
- 2.7 Pressure Switches.
- 2.8 Pressure Gauge - Bourdon Tube.
- 2.9 Diaphragm Seal.
- 2.10 Rotameter.
- 2.11 Residual Chlorine Analyzer.
- 2.12 Flow Switch
- 2.13 Spare Parts and Test Equipment.

2.1 PROCESS TAPS, SENSING LINES AND ACCESSORIES

A. Pressure Tap Sensing Lines and Accessories for Pressure Gauges and Pressure Switches:

1. For Process Sensing Taps in Ductile Iron, Steel and Stainless Steel Piping Systems:
 - a. Material and Fittings: Type 304 stainless steel pipe (ASTM A 312) and threaded fittings and adapters (ASTM A 403).
 - b. Sizes: 1/2-inch minimum for main sensing piping and 1/4-inch gauge and switch connections.
 - c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the Exposed Piping Schedule in Section 15052, Exposed Pipe Installation.
 - d. Accessories:
 - 1) For applications not requiring diaphragm seals, provide separate 1/2-inch Type 316 stainless steel threaded ball valve for each gauge and switch.
 - 2) For applications requiring diaphragm seals, provide a separate 1/2-inch threaded Type 316 stainless steel ball valve for seal process side shutoff.
2. For Process Sensing Taps in Copper and Thermoplastic Piping Systems:
 - a. Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system. PVC pipe and fittings shall be provided in accordance with the requirements of Section 15068, Thermoplastic Pipe.
 - b. Sizes: 1/2-inch minimum for main process sensing piping and 1/4-inch for gauge and switch connections.
 - c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in Section 15052, Exposed Pipe Installation.
 - d. Accessories:
 - 1) For copper piping system taps with or without seals, provide a separate 1/2-inch minimum threaded brass or bronze ball valve for each gauge and switch.

- 2) For PVC piping systems with or without diaphragm seals, provide a separate 1/2-inch threaded ball valve for process sensing line shutoff.

2.2 LEVEL TRANSMITTER - ULTRASONIC TYPE

- A. Type: Microprocessor based, non-contacting, ultrasonic type continuous liquid level measuring system consisting of a transducer, remote transmitter, and interconnecting cable which produces an output signal linear with level.
- B. Performance Requirements:
 1. Accuracy: 0.25 percent of maximum range with temperature compensation.
 2. Resolution: 0.1 percent of range or 2 mm, whichever is greater.
 3. Range: As specified in the Instrument Index.
 4. Damping: Adjustable damping rate.
 5. Ambient Temperature:
 - a. Electronics: -5 degrees F to 122 degrees F.
 - b. Transducer: -40 degrees F to 200 degrees F.
 6. Output: Two isolated 4 to 20 mA DC into 0 to 750 ohms.
 7. Relay Output: Six SPDT level alarm contacts rated 5A at 250 VAC, with LED indication of relay status.
 8. Power: 120 VAC, 60 Hz.
 9. Filter: Electronic filter to smooth the small variations in the level signal that result from surface waves or minor disturbances.
- C. Construction Features:
 1. Transmitter :
 - a. Microprocessor based control circuitry.
 - b. Keypad for system programming and configuration. Programming and configuration values shall be stored in EEPROM memory that does not require battery back-up.
 - c. NEMA 4X polycarbonate enclosure. Provide Type 316 stainless steel hardware for remote (wall) mounting at the location shown on the Electrical Drawings.
 - d. Display: 100 mm x 40 mm multi-field backlit LCD.
 - e. Units of Measure: Feet, or as specified in the Instrument Index.
 - f. Front panel indication of loss of echo.
 - g. Adjustable blanking distance.
 2. Transducer:
 - a. Kynar housing.
 - b. Integral temperature sensor for temperature compensation.
 - c. Piezoelectric barium titanite crystal.
 - d. Twelve degree beam angle for ranges less than 33 feet. Five degree beam angle for ranges greater than 33 feet.

- e. Provide flange mounting or threaded pipe mounting as shown.
- f. Provide coaxial communication cable from transducer to the remote transmitter; length as required.

D. Accessories:

- 1. NEMA 4X rated 120 VAC power on-off selector switch as specified in Article 2.2, above.

E. Products and Manufacturers: Provide one of the following:

- 1. Siemens Milltronics, Hydro Ranger with XPS-10 transducer.
- 2. Endress+Hauser, Prosonic T.
- 3. Or equal.

2.3 LEVEL SWITCH - FLOAT TYPE

A. Type: Direct acting, pear shaped, eccentric weighted, displacement type liquid level sensor.

B. Construction Features:

- 1. Float Body: Hollow hermetically sealed, rigidly molded of polypropylene containing mechanical switch and eccentric metal weight.
- 2. Mechanical Switch: SPDT switch rated 16 amps resistive at 120 VAC and five amps resistive at 30 VDC.
- 3. Weight: Weight to cause sensor to hang straight down from cable when not immersed and only allow float to pivot when immersed in liquid.
- 4. Electrical Cable:
 - a. Heavy duty, three conductor, flexible and submersible cable, sheathed in PVC and connected to float and switch with watertight seal.
 - b. Length furnished to be sufficient to extend to junction box.

C. Products and Manufacturers: Provide one of the following:

- 1. Flygt, Model ENM-10.
- 2. Or equal.

2.4 LEVEL SWITCHES - MULTIPOINT FLOAT TYPE

A. Type: Multiple float switches mounted to a common rod.

B. Construction Features:

- 1. Rod, Float, and Mounting Materials: PVC.
- 2. Mounting: Three-inch, 150 pound flange.
- 3. Float Rod Length: As specified in the Instrument Index.
- 4. Number of Floats: As shown and specified in the Instrument Index.
- 5. Float Switch Activation Level: As specified in the Instrument Index.

6. Magnetic Reed Switch: Hermetically sealed SPDT switch rated 20 VA, individually isolated for each float switch.
 7. Operating Temperature: 40 to 140 degrees F.
- C. Products and Manufacturers: Provide one of the following:
1. GEMS, LSP-800 Series.
 2. Or equal.

2.5 LEVEL SWITCH - CONDUCTANCE TYPE

- A. Type: Complete level sensing system utilizing conductance type measuring techniques to energize and de-energize independent control relays when the monitored medium reaches the corresponding level electrode elevation.
- B. Performance Requirements:
1. Level Setpoints: 5.
 2. Total Number of Electrodes: 5.
- C. Construction Features:
1. Electrodes:
 - a. Type: Insulated, 1/4-inch diameter solid rod with bare end tip; cut to required length in field.
 - b. Insulation: PVC.
 - c. Rod Material: Type 316 stainless steel.
 2. Electrode Holders:
 - a. Type and Material: Flanged PVC; size as specified in Instrument Index.
 3. Control Relays:
 - a. Type: Solid state with low fixed sensitivity resistance of 10K ohms. Sensitivity shall be field changeable to adjust for process fluid conductivity by means of external resistor replacement and relay shall be field convertible for direct or inverse operation.
 - b. Power Supply: 120 VAC (-20, +10 percent), 60 Hz.
 - c. Power Required: Nine volt-ampere, six watts.
 - d. Sensing Circuit: Eight VAC and less than 30 mADC short circuit.
 - e. Contacts: Silver cadmium oxide.
 - f. Load Contact Arrangement: Three separate and isolated sets of Form C (SPDT) contacts; one set wetted for local use, two sets dry for remote monitoring or external load control.
 - g. Contact Ratings: Ten amps at 120 VAC, 240 VAC and 28 VDC.
 - h. Temperature Range Limitations: -40 degrees F to 180 degrees F.
 - i. Enclosure: NEMA 4X for field mounted locations; NEMA 1 for interior panel mounted installations.

- j. Quantity: One control relay per control or alarm electrode. Ground common electrode to each relay.

D. Products and Manufacturers: Provide one of the following:

- 1. B/W Controls:
 - a. Electrodes: Model 6013 Series.
 - b. Electrode Holders: 6012 Series, Type KF.
 - c. Control Relays: Series 52.
- 2. Or equal.

2.6 LEVEL SIGHT GAUGE

- A. Type: Magnetic level gauge consisting of a float chamber, a float, and an external indication device. The float shall move up and down inside the chamber as the process level changes. Contained inside the sealed float shall be a magnet assembly. An indicator tube and scale assembly shall be attached to the outside of the float chamber. Inside the transparent indicator tube shall be a magnetized indicator. The indicator shall be magnetically coupled with the float and move up and down inside the indicator tube as the float moves up and down with the rising and falling of the process level. The indicator shall be brightly colored to allow an operator to easily read the level.

B. General Requirements:

- 1. Material: All wetted parts to be compatible with the process fluid as indicated in the Instrument Index. Indicator tube to be glass or polycarbonate.
- 2. Float Type: Float type to be determined by process fluid specific gravity, pressure and temperature.
- 3. Scale: Range as shown with 1/2-inch scale division.
- 4. Indicator: Brightly colored for long distance viewing.
- 5. Process Connections: Side couplings or flanges, or top and bottom flanges as shown. Provide drain and vent connections to allow the chamber to be periodically cleaned.
- 6. Level Switches:
 - a. Type: Reed or tilt type non-invasive switch magnetically activated by the level gauge float directly through the chamber wall of the gauge.
 - b. Contacts: SPDT rated 120 VAC, three amps.
 - c. Action: Activated on rising or falling level and/or N.C. or N.O. operation with fixed deadband to eliminate chattering.
- 7. Housing: General purpose; explosion proof required for Class I, Division 1 or 2, Group D classified areas.

C. Manufacturers: Provide products of one of the following:

- 1. Babbitt International.

2. Krohne.
3. Solartron.
4. Or equal.

2.7 PRESSURE SWITCHES

- A. Type: Switch assembly with diaphragm/piston pressure sensor.
- B. Function: Sense gauge or absolute pressure and open or close a contact when the pressure reaches the specified trip point.
- C. Performance Requirements:
 1. Operating Range: As specified in the Instrument Index.
 2. Setpoint: As specified in the Instrument Index.
 3. Setpoint Repeatability: \pm One percent of range.
 4. Output: Snap action switch, SPDT rated not less than ten amp resistive at 120 VAC and 1/2 amp resistive at 125 VDC.
 5. Switch and Reset Action: Adjustable deadband.
 6. Adjustable Deadband Range and Setting: As specified in the Instrument Index.
 7. Ambient Temperature Limits: -4 degrees F to 140 degrees F.
- D. Construction Features:
 1. Pressure Transducer Housing and Diaphragm Materials: Coordinate with the process piping materials.
 - a. Water Service with Copper Pipe: Brass housing with Buna-N diaphragm.
 - b. Other Services: Housing and diaphragm to be compatible with the process fluid as indicated in the Instrument Index.
 2. Set and Reset Point Adjustments: Adjustable external adjusting nuts and pressure setting scales in psi.
 3. Process Connection: 1/4-inch NPT.
 4. Housing: Copper-free die cast aluminum, NEMA 4. NEMA 7 construction required for hazardous locations.
 5. External Mounting Lugs.
 6. Adjusting Nuts Metal Cover with Gasket.
 7. Electrical Connection: 3/4-inch NPT.
- E. Products and Manufacturers: Provide one of the following:
 1. Automatic Switch Company, Tri-point SA Series.
 2. Or equal.

2.8 PRESSURE GAUGE – BOURDON TUBE

- A. Type: Bourdon Tube Pressure Element Type, Liquid Filled Gauge (for pressure ranges of 15 psi and greater and vacuum ranges to 30-inches Hg):
- B. Performance Requirements:
 - 1. Range: As specified in the Instrument Index.
 - 2. Accuracy: ± 0.5 percent of span (ANSI B40.1 Grade 2A).
- C. Construction Features:
 - 1. Case:
 - a. Solid front design constructed of glass filled polyester.
 - b. Color: Black.
 - 2. Size: 4-1/2-inch.
 - 3. Ring: Threaded, glass filled polyester.
 - 4. Window: Glass.
 - 5. Dial: White with black markings.
 - 6. Filling Liquid: See Article 1.8.
 - 7. Overpressure protection: Full blowout back.
 - 8. Bourdon Tube and Socket:
 - a. Type 316 stainless steel.
 - b. Heliarc welded, unless otherwise specified.
 - 9. Movement:
 - a. Type 300 series stainless steel.
 - b. Rotary geared with Teflon S coating, or cam and roller type.
 - c. Built-in overload and underload movement stops.
 - 10. Connection: 1/4-inch male NPT, bottom.
 - 11. Mounting: Stem Mount.
 - 12. Calibration:
 - a. Adjustable pointer.
 - b. Externally accessible zero adjustment.
- D. Accessories:
 - 1. Pressure Snubber: Sintered stainless steel snubber threaded into gauge socket or in external stainless steel housing with 1/4-inch NPT male and female connections.
 - 2. Process Isolation: Provide ball valves for process isolation in accordance with the requirements of Article 2.1, above.
- E. Products and Manufacturers: Provide one of the following:
 - 1. Ashcroft, Duragage 1279 Series.
 - 2. Helicoid, Series 900.
 - 3. Wika EN 837.
 - 4. Or equal.

2.9 DIAPHRAGM SEAL

A. General:

1. Furnish diaphragm seals for pressure gauges and switches at locations shown and as specified.
2. The complete diaphragm seal assembly, including gage, switch or transmitter, shall be factory assembled, filled and calibrated to the ranges and switch setpoints specified prior to shipment.
3. System Supplier Manufacturer shall be responsible for assuring that fill volumes and sensitivities of the supplied seals and diaphragms are suitable to provide the required gage, switch or transmitter accuracy over the specified measurement range or at switch setpoints.
4. Location and orientation of the gauges, switches and seal assemblies shall be coordinated with the actual piping and equipment installations so that gages and indicators shall be easily read and accessed for maintenance by plant personnel.
5. Where field mounting and orientation conflicts arise due to incomplete coordination with field changes in the process piping and equipment installation, assemblies shall be relocated, re-oriented, re-assembled and re-calibrated as directed by the ENGINEER.

B. Construction Features:

1. Instrument Connection: 1/4-inch NPT.
2. Process Connection: 1/2-inch NPT.
3. Flushing Connection: 1/4-inch NPT.
4. Top Housing Materials: Type 316 stainless steel.
5. Process Side Housing Materials:
 - a. Type 316L stainless steel for metallic piping.
 - b. PVC or CPVC to match non-metallic piping.
6. Bolting Materials: Type 316 stainless steel.
7. Diaphragm, O-Rings, and Gasket Materials:

<u>Process Fluid</u>	<u>Diaphragm</u>	<u>O-Ring</u>	<u>Gasket</u>
Wastewater/Sludge	316 SS	Buna-N	Buna-S
Sodium Hypochlorite	Teflon	Teflon	Teflon

7. Filling Liquid: See Article 1.8.
8. Working Pressure Rating: Equal to or greater than the attached gage or switch operating pressure.

C. Accessories:

1. Provide fill/bleed screw to permit filling of instrument and diaphragm seal.

2. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid or change in calibration.

D. Products and Manufacturers: Provide one of the following:

1. Helicoid, Type 100 HAC.
2. Or equal.

2.10 ROTAMETER

A. Type: Low-Flow Variable-area Flow meter:

1. Provide fine control needle valve and check valve.
2. Range and Scale: Direct reading in ccm, gph or scfh as listed in the Instrument Index.
3. Accuracy: \pm Two percent of maximum capacity; \pm ten percent of full scale for extra low capacity meters.
4. Construction:
 - a. Frame: Type 302 stainless steel.
 - b. End Fittings: Type 316 stainless steel.
 - c. Tube: Borosilicate Glass.
 - d. Float: Type 316 stainless steel, black glass or tantalum as required.
 - e. O-rings: Buna-N or Viton.
 - f. Tube Retainer: Kynar.
 - g. Tube Shield: Polycarbonate.
 - h. Check and Needle Valves: Type 316 stainless steel.
 - i. Adapters and Plugs: Type 316 stainless steel.
5. Products and Manufacturers: Provide one of the following:
 - a. Wallace and Tiernan Low Flow Meters.
 - b. Or equal.

2.11 RESIDUAL CHLORINE ANALYZER

A. General: Unit shall use amperometric analysis to analyze and indicate total chlorine residual in a sample piped to the unit.

B. Required Features:

1. Type: Amperometric.
2. Accuracy: \pm Two percent of calibrated span.
3. Sensitivity: 0.001 mg/L or one percent of full scale, whichever is greater.
4. Repeatability: 0.001 mg/L or one percent of full scale range, whichever is greater.
5. Stability: \pm One percent of full scale for one month.
6. Response Speed: 90 percent of change within 60 seconds after sample entry.

7. Output Signal: Isolated 4 to 20 mADC.
8. Piping Connections: 3/4-inch female NPT sample line, 1 1/4-inch female NPT drain connection.
9. Temperature: 35 to 125 degrees F. Provide automatic compensation for sample temperature.
10. Enclosure: ABS cabinet, NEMA 4X.
11. Power: 120 VAC \pm 10 percent.
12. Display: Four digit LED and a 16 character display.
13. Operator Keypad Menu:
 - a. mg/L total residual.
 - b. Cell current in microamps.
 - c. Sample temperature in degrees F or C.
 - d. Feed rate in ml/hr.
 - e. High and low alarm setpoints.
 - f. Backflush cycles per day.
 - g. Output signal in mADC.
 - h. Access code status.
14. Accessories:
 - a. Include sufficient quantities of reagents and expendables for one year of operation.
 - b. NEMA 4X rated power on-off selector switch along with discrete input signal to start/stop the analyzer from the SCADA system.

C. Products and Manufacturers: Provide one of the following:

1. Capital Controls Series 1870E
2. Series CL17, as manufactured by Hach.
3. Micro/2000, as manufactured by Wallace & Tiernan.

2.12 FLOW INDICATING SWITCH

A. The flow indicating switch shall use thermal dispersion technology suitable for the applications shown. For seal water service, coordinate with requirements of equipment being furnished.

B. Required Features:

1. NEMA 4X housing and control box.
2. Type 316 stainless steel internal moving parts.
3. Line size and connection ends as shown on drawings.
4. Dual switches, each SPDT, minimum rating five amp at 120 VAC.
5. Field adjustable switch setting.
6. Switch accuracy and deadband shall be five percent of full range.

C. Manufacturers: Provide products of one of the following:

1. Model No. TD1/TD2, Magnetrol International Inc.,

2. Or equal.

2.13 SPARE PARTS AND TEST EQUIPMENT

- A. Furnish and deliver the spare parts and test equipment as outlined below, identical to and interchangeable with similar parts furnished under this Section.
- B. Spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. The following shall constitute the minimum spare parts:
 1. Five of each type input-output relay for each 40 or less furnished for this Contract.
 2. One replacement power supply for each type and size furnished for this Contract.
 3. A one-year supply of all expendable materials.
 4. One per five of gauges, indicators and/or switches used in field complete with diaphragm seals, filled and ready for use.
 5. One dozen of each type and size of fuse used in instruments.
- D. The following shall constitute the minimum test and calibration equipment.
 1. All tooling required to insert, extract and connect any internal or external connector, including edge connectors.
 2. All special calibration equipment required for system calibration.
- E. All spare parts shall have been operated and tested in the factory as part of factory testing prior to shipment of the control system.
- F. For process sensors and all other analog instruments, the supplier shall submit a separate quotation for a recommended list of spare parts and test equipment. Each item recommended shall be listed and priced separately. The spare parts quotation shall contain a statement that the prices quoted are firm for a period of one year from the installation date of the equipment, and that the supplier understand that the COUNTY reserves the right to purchase none, any, or all of the parts quoted. The supplier is required to show that a stock of spare parts and test-equipment is obtainable within a 48-hour period.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. CONTRACTOR shall require the system supplier to furnish the services of qualified factory-trained servicemen to assist in the installation of the instrumentation and control system equipment.
- B. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents. Transmitters and instruments, which require access for periodic calibration or maintenance, shall be mounted so they are accessible while standing on the floor. Care shall be taken in the installation to ensure sufficient space is provided between instruments and other equipment or piping to allow for easy removal and servicing.
- C. All items shall be mounted and anchored using stainless steel hardware, unless otherwise noted.
- D. All field instruments shall be rigidly secured to walls, stands or brackets as required by the manufacturer and as shown.
- E. Conform to all applicable provisions of the NEMA standards, NEC and local, State and Federal codes when installing the equipment and interconnecting wiring.

3.2 START-UP, CALIBRATION, TESTING, AND TRAINING

- A. Comply with the requirements of Section 13401, Process Control System General Provisions, Section 13403, Process Control System Startup and Field Testing, and Section 13404, Process Control System Training.

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SECTION 13430

PROCESS CONTROL PANELS AND HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, start-up and place into satisfactory operation all process control panels and enclosures.

B. Related Sections:

1. Section 02220, Excavation Backfill and Grading for Structures.
2. Section 03300, Cast-In-Place Concrete.
3. Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.
4. Section 13401, Process Control System General Provisions.
5. Section 13403, Process Control System Startup and Field Testing.
6. Section 13404, Process Control System Training.
7. Section 13420, Primary Sensors and Field Instruments.
8. Section 13440, Panel-Mounted Instruments and Devices.
9. Section 13480, Input-Output Point list.

1.2 QUALITY ASSURANCE

A. Standards, Codes and Regulations:

1. Construction of panels and the installation and interconnection of all equipment and devices mounted within shall comply with applicable provisions of the following standards, codes and regulations:
 - a. National Fire Protection Association 79, Annex "D" Standards, (NFPA).
 - b. National Electrical Code, (NEC).
 - c. National Electrical Manufacturer's Association Standards, (NEMA).
 - d. American Society for Testing and Materials, (ASTM).
 - e. Operational Safety and Health Administration Regulations, (OSHA).
 - f. Underwriters' Laboratory, Inc., (UL).
 - g. State and Local code requirements.
 - h. Where any conflict arises between codes or standards, the more stringent requirement shall apply.
2. All materials and equipment shall be new and all panels shall be built in an Underwriters' Laboratory, Inc. (UL) approved panel shop and bear the UL label.

- B. General Design Requirements:
 - 1. Comply with the requirements of Section 13401, Process Control System General Provisions.
 - 2. Comply with the control descriptions of Section 13491, Process Control Descriptions.
- C. Factory Assembly and Testing:
 - 1. Comply with the requirements of Section 13402, Process Control System Factory Testing.

1.3 SUBMITTALS

- A. Comply with the requirements of Section 13401, Process Control System General Provisions.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Comply with the requirements of Section 13401, Process Control System General Provisions.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION REQUIREMENTS

- A. Provide all electrical and/or pneumatic components and devices, support hardware, fasteners, interconnecting wiring and/or piping required to make the control panels and/or enclosures complete and operational.
- B. Panels and Enclosures shall be UL 508A and devices therein shall be UL508 listed.
- C. Locate and install all devices and components so that connections can be easily made and that there is ample room for servicing each item.
- D. Components for installation on panel exterior shall be located generally as shown. Layouts shall be submitted for review in accordance with Section 40 61 13, Process Control System General Provisions.
- E. Where permitted by location and layout as shown, panels and enclosures shall have full height rear access doors. Where rear doors are not possible, panels shall have full or half height front access doors.
- F. Adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.

- G. Provide sub-panels for installation of all relays and other internally mounted components.
- H. All wiring to panel connections from field instruments, devices, and other panels shall be terminated at master numbered terminal strips, unless otherwise specified.
- I. Provide copper grounding studs for all panel equipment.
- J. Provide the following convenience accessories inside of each control panel:
 - 1. One 120 VAC, 20A duplex, grounding type receptacle.
 - 2. One or more 120 VAC fluorescent light fixtures with 40 watt lamp and protective plastic shield to span across the width of the panel but not less than two-thirds the width of the panel, as a minimum.
 - 3. One 120 VAC, 20A, snap switch, to turn on the light, mounted in an outlet box with a cover and located so that it is easily accessible from access door.
 - 4. Service light with switch and duplex receptacle shall have its own circuit breaker and separate power feed.
- K. The bottom 12-inches of free standing panels shall be free of all devices, including terminal strips, to provide ease of installation and testing.
- L. No device shall be mounted less than 36-inches above the operating floor level, unless otherwise specified.

2.2 IDENTIFICATION

- A. Provide laminated plastic nameplates for identification of panels and components mounted thereon as follows:
 - 1. Nameplates shall be of 3/32-inch thick laminated phenolic type with white matte finish surface and black letter engraving.
 - 2. Panel identification nameplates to have 1/2-inch high letter engravings.
 - 3. Panel mounted component (e.g., control devices, indicating lights, selector switches, etc.) identification nameplates to have 1/4-inch high letter engravings.
 - 4. Nameplates shall be attached to the panel face with two stainless steel self-tapping screws.
 - 5. Nameplate engravings shall include the instrument or equipment tag number and descriptive title as shown and specified.
- B. Tag all internally mounted instruments in accordance with the following requirements:
 - 1. Tag numbers shall be as listed in the Instrument Index.

2. The identifying tag number shall be permanently etched or embossed onto a stainless steel tag which shall be fastened to the device housing with stainless steel rivets or self tapping screws of appropriate size.
 3. Where neither of the above fastenings can be accomplished, tags shall be permanently attached to the device by a circllet of 1/16-inch diameter stainless steel wire rope.
 4. Identification tag shall be installed so that the numbers are easily visible to service personnel.
 5. Front of panel mounted instruments shall have the tag attached to rear of device.
- C. Tagging of the following items shall be accomplished with the use of adhesive plastic Brady USA, Inc. labels, or equal.
1. Tag all electrical devices (e.g., relays, timers, power supplies) mounted within control panels and enclosures.
 2. Tag all pneumatic lines.
 3. Numerically tag all terminal blocks.
 4. Color code and numerically tag wiring at each end.

2.3 PANELS AND ENCLOSURES

- A. General:
1. Panels and enclosures shall meet the NEMA requirements for the type specified.
 2. Sizes shown are estimates. CONTRACTOR shall furnish panels and enclosures amply sized to house all equipment, instruments, front panel mounted devices, power supplies, power distribution panels, wiring, tubing and other components installed within, as required.
- B. Construction Features:
1. Control panels located inside environmentally controlled (conditioned spaces)room areas shall be NEMA 12 rated.
 - a. Fabricate enclosures using minimum 14-gage steel for wall or frame mounted enclosures and minimum 12-gage for free standing enclosures. Steel shall be free of pitting and surface blemishes.
 - b. Continuously weld all exterior seams and grind smooth. Also, surface grind complete removal of corrosion, burrs, sharp edges and mill scale.
 - c. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
 - d. Panel shall be flat within 1/16-inch over a 24-inch by 24-inch area, or flat within 1/8-inch for a larger surface. Flatness shall be checked by using a 72-inch long straight edge. Out-of-flatness shall be gradual, in one

- direction only, and shall not consist of obvious depressions or a series of wavy sections.
- e. Use pan type construction for doors. Door widths shall not exceed 36-inches.
 - f. Mount doors with full-length heavy-duty piano hinge with stainless steel hinge pins.
 - g. Provide oil resistant gasket completely around each door or opening.
 - h. Provide handle-operated, oil-tight, key-lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.
 - i. Use stainless steel fasteners throughout.
 - j. Provide interior mounting panels and shelves constructed of minimum 12-gage steel with a white enamel finish.
 - k. Provide steel print pocket with white enamel finish.
 - l. Provide enclosure mounting supports as required for floor, frame, or wall mounting.
 - m. Provide all holes and cutouts for installation of conduit and equipment. Cable and piping to enter the enclosure through the bottom, unless otherwise noted. All conduit and piping openings and all conduits entering cabinet shall be sealed watertight.
 - n. Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Zinc phosphatize for corrosion protection.
 - o. One coat of primer shall be applied to all interior and exterior surfaces immediately after corrosion protection has been applied. Exterior surfaces shall then be given sufficient coats of primer surfacer, applied with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.
 - p. All interior surfaces shall be painted with two coats of semi-gloss white polyurethane enamel.
 - q. All exterior surfaces shall be painted with a minimum of three finish coats of semi-gloss white polyurethane enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections).
 - r. Primer and finish paint shall be compatible and shall be a low VOC, high solids polyurethane enamel, Hi-Solids Polyurethane B65 W300 Series as manufactured by Sherwin-Williams, Inc. or equal. Provide one extra quart of Primer and finish paint.
2. Control panels located in field (outdoor and/or in non-conditioned spaces) shall be NEMA 4X rated.
- a. Panels shall be Type 316L stainless steel construction with a minimum thickness of 12-gage for all surfaces (except those areas requiring reinforcement) having a smooth brushed finish.
 - b. Stainless steel screw clamp assemblies on three sides of each door.
 - c. Rolled lip around three sides of door and along top of enclosure opening.
 - d. Hasp and staple for padlocking.

- e. Provide a, gasketed lockable hinged door to encompass all non-NEMA 4 front of panel instruments.
 - f. Provide 3-inch high channel base assembly, with solid bottom, drilled to mate the panel to its floor pad.
 - g. Floor Pad: Refer to Part 3 of this Section.
 - h. Provide interior back panel for mounting of panel components and for easy removal of component system. Panel to be steel, powder coated black.
3. Where the application applies and with the approval of ENGINEER, wall mounted enclosures may be provided. The enclosure shall comply with Paragraph B.1., B.2. or B.3., except for the following:
 - a. Locations shall be as shown on or as specified under other Sections.
 - b. Panels may be all fiberglass, polycarbonate or ABS.
 - c. Doors shall be full height.
 - d. Corrosion resistant polyester quick release latches shall be provided.
 - e. No extra holes or knockouts shall be provided. No light or convenience outlet need be provided.
 4. For panels located outdoors, provide sunshields and white epoxy coating on panel exterior, this includes stainless steel. Coordinate proper etching primer for epoxy adhesion. Refer to Instrumentation details shown on the drawings for additional requirements. Sunshields shall be designed to withstand regional wind loads. Sunshield design shall be submitted for approval.
- C. Electrical Systems:
1. Control of Environment:
 - a. Outdoor Panels (or Panels located in non-conditioned spaces):
 - 1) Provide adequately sized automatically controlled 120 VAC strip heaters to maintain temperature inside each enclosure above 40°F to maximum of 95°F when the outside temperature is -20°F through 40° F.
 - 2) Provide automatically controlled closed loop ventilation fans if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclosure. Housing shall be constructed of 316 SS materials.
 - 3) Provide thermostats to automatically control heating and cooling requirements without need of manual operation of a heating/cooling transfer switch.
 - 4) Provide documentation if any of the above is deemed unnecessary.
 - b. Indoor Panels (or Panels located in Conditioned spaces):
 - 1) Provide adequately sized, automatically controlled 120 VAC strip heaters to maintain temperature 10°F above ambient for condensation prevention inside panels.

- 2) Provide automatically controlled closed loop ventilation fans to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclosure.
 - 3) Provide documentation if any of the above is deemed unnecessary.
2. Power Source and Internal Power Distribution:
 - a. General: Control panel power supply source, type, voltage, number of circuits and circuit ratings shall be as shown.
 - b. Panels shall be provided with an internal 120 VAC power distribution panel with number of circuits and separate circuit breakers sized as required to distribute power to the panel components. Distribution panel shall contain two spare breakers, minimum.
3. Wiring:
 - a. Internal wiring shall be Type MTW and THW stranded copper wire with thermoplastic insulation rated for 600 V at 90°C for single conductors, color coded and labeled with wire identification.
 - b. For DC panel signal wiring, use No. 18 minimum AWG shielded.
 - c. For DC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 16 minimum AWG. For wiring carrying more than 15 A, use sizes required by NEC standards.
 - d. Separate and shield low voltage signal wiring from power and control wiring by a minimum of 6-inches.
 - e. Group or bundle parallel runs of wire using covered troughs. Maximum bundle size to be 1-inch. Troughs shall have 40 percent spare capacity.
 - f. Install wire troughs along horizontal or vertical routes to present a neat appearance. Angled runs are not acceptable.
 - g. Adequately support and restrain all wiring runs to prevent sagging or other movement.
 - h. Terminate all field wiring (no more than one wire per termination) using screw/clamp type terminals, insulated, crimp-on connectors (soldered type not acceptable) at 600 V rated barrier type terminal strips and permanently affixed numeric identifiers beside each connection. Identifiers to be self-stick plastic tape strips with permanent type, machine printed numbers. For DC field signal wiring, terminal strips shall be capable of handling No. 12 wiring (minimum). Provide Phoenix Contact, Entrelec or Allen Bradley.
 - i. All wiring shall be installed such that if wires are removed from any one device, power will not be disrupted to any other device.
 - j. All alarms generated external to the panel, spare alarm, and repeat contacts shall be wired out to terminal blocks.
 - k. For internal component-to-component wiring only, compression type terminal blocks are acceptable.
 - l. Provide spare terminals equal in number to 20 percent of the terminals used for each type of wiring (e.g., DC signal and AC power).
 - m. Provide a separate terminal for grounding each shielded cable.

- n. Use separate 5/16-inch diameter copper grounding studs for instrument signal cable shields and AC power.
 - o. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.
 - p. When DC power and/or low voltage AC power is required, provide and install the necessary power supplies and transformers in the panel.
 - q. Provide circuit breakers to protect each circuit, with no more than one instruments on a single circuit.
 - r. Provide complete wiring diagram showing "as-built" circuitry. Diagram shall be enclosed in transparent plastic and placed in easily accessible pocket built into panel door.
4. Surge Protection:
- a. General: Surge protection shall be provided to protect the electronic instrumentation system from surges propagating along the signal and power supply lines.
 - b. Provide Surge Protection as outlined in section 2.9 Surge Protection and UPS Requirements attached as Appendix. F - Seminole County Water & Wastewater Treatment Facilities I&C Design Guidelines Document as an added supplement to this specification for specific County standards.
 - c. Products and Manufacturers: Provide one of the following:
 - 1) Pheonix Contact
 - 2) Citel
 - 3) Edco
 - 4) No approved Equal.
5. Residual Chlorine Analyzer Relay Panel (RCARP):
- a. General Description: A sample pump and chlorine residual analyzer shall be controlled from the residual chlorine analyzer relay panel. Refer to electrical drawings for control schematic diagram. Refer to process instrumentation drawings for I/o signals.
 - b. Operation of sample pump and residual chlorine analyzer shall be controlled through hardwired switches on the relay panel in either the HAND-OFF-AUTO (HOA) position. These switches shall be mounted on the relay panel.
 - 1) HAND: With switch in this position manual start of the sample pump and residual chlorine analyzer will be performed.
 - 2) AUTO: With switch in this position, the sample pump shall start and stop based on the discrete output signal from the SCADA Panel No.4. If any of the three switches located on the influent line of the lake gravity disk filters 1, 2 and 3 indicate flow, a discrete output from the SCADA panel no. 4 shall energize to start the sample pump.
A flow switch is located on the discharge line of the sample pump and shall be hard wired to the relay panel. The chlorine residual analyzer shall be powered to start based on the activation/de-

- activation of the flow switch hard-wired to the relay panel.
- 3) OFF: With switch in this position both sample pump and residual chlorine analyzer, power shall be disabled.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment in conformance with NEC.
- B. Unless otherwise noted, install indoor NEMA 4X panels on 4-inch concrete pad. Extend pad 4-inches beyond outside dimensions of base, all sides. Lay grout after panel sills have been securely fastened down.
- C. Unless otherwise noted, install outdoor NEMA 4X panels on a reinforced concrete pedestal:
 - 1. Minimum Thickness: Eight-inches with No. 4 steel reinforcing bars at 12-inches on centers, each way.
 - 2. Minimum Size: Twelve-inches larger than outer dimensions of base, all sides.
 - 3. Provide excavation and backfill work in conformance with Section 02220, Excavation Backfill and Grading for Structures.
 - 4. Provide concrete work in conformance with Section 03300, Cast-In-Place Concrete.
- D. Install anchor bolts and anchor in accordance with Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.
- E. Install and interconnect all equipment, devices, electrical hardware, instrumentation and controls and process controller components into and out of and among the enclosures as indicated on the Drawings.

3.2 TESTING AND ADJUSTMENTS

- A. Perform system testing and make any adjustments necessary in accordance with this Section, Section 13401, Process Control System General Provisions, Section 13402, Process Control System Factory Testing, and Section 13403, Process Control System Start-up and Field Testing.
- B. Perform power supply, voltage adjustments to tolerances required by the appurtenant equipment.

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SECTION 13440

PROCESS CONTROL PANEL INSTRUMENTS AND DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation panel instruments and devices.
 - 2. Contract Documents illustrate and specify functional and general construction requirements of the panel components and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. CONTRACTOR shall provide all piping, wiring, accessories and labor required for a complete, workable and integrated system.
- B. Coordination: Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

1.2 QUALITY ASSURANCE

- A. Comply with the requirements of Section 13401, Process Control System General Provisions.
- B. Acceptable Manufacturers:
 - 1. Furnish instruments and devices by the named manufacturers or equal equipment by other manufacturers.
 - 2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.
 - 3. Obtain all instruments or devices of a given type from the same manufacturer.
- C. Manufacturers' Responsibilities and Services:
 - 1. Design and manufacture the instruments and devices in accordance with the applicable general design requirements specified in Section 13401, Process Control System General Provisions, and the detailed Specifications herein.
 - 2. Field supervision, inspection, start-up and training in accordance with the requirements of Section 13403, Process Control System Startup and Field Testing, and Section 13404, Process Control System Training.

1.3 SUBMITTALS

- A. Comply with the requirements of Section 13401, Process Control System General Provisions.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Comply with the requirements specified in Section 13401, Process Control System General Provisions.
- B. Instruments and devices shall not be assembled in the panels until all product information and system Shop Drawings for respective components have been approved.

1.5 IDENTIFICATION TAGS

- A. All panel instruments and devices shall have an identification tag meeting the following requirements:
 - 1. Tag numbers shall be as listed in the Instrument Index.
 - 2. Identifying tag number shall be permanently etched or embossed onto a stainless steel tag which shall be fastened to the device housing with stainless steel rivets or self tapping screws of appropriate size.
 - 3. Where neither of the above fastenings can be accomplished, tags shall be permanently attached to the device by a circlet of 1/16-inch diameter stainless steel wire rope.
 - 4. All instruments and devices mounted within panels shall have the stainless steel identification tag installed so that the numbers are easily visible to service personnel. Front of panel mounted components shall have the tag attached to the rear of the device.
 - 5. Front of panel mounted components shall have nameplates, which comply with the requirements specified in Section 13430, Process Controls Panels and Enclosures.

PART 2 - PRODUCTS

Article Instrument Title

- 2.1 Power Supplies.
- 2.2 Selector Switches, Pushbuttons and Indicating Lights.
- 2.3 Digital Indicator.
- 2.4 Elapsed-Time Meter (Hour meter).
- 2.5 Control Relay.
- 2.6 Time Delay Relay.

- 2.7 Current Alarm Relay.
- 2.8 Spare Parts and Test Equipment.

2.1 POWER SUPPLIES

- A. General: Single unit and multiple unit power supplies, located in control room panels, remote terminal units and field panels as required.
- B. Multiple Unit Required Features:
 - 1. Solid state circuitry.
 - 2. Standard 19-inch RETMA (EIA) rail mounting.
 - 3. Input Power: 120 VAC \pm 10 percent, 60 Hz.
 - 4. Output Power: 24 VDC or as required.
 - 5. Polarity: Floating output.
 - 6. Ambient Temperature: -10°C to +71°C.
 - 7. Response Time: <20 μ S.
 - 8. Include over-voltage protection, output current limiting protection, provisions for paralleling power supplies and front panel mounted indicating fuses.
 - 9. If the power supplies are connected in parallel, provide isolation diodes in series with the positive lead of each of the parallel connected power supplies.
 - 10. Connections:
 - a. Twist-lock AC power connector.
 - b. DC power terminal strip.
- C. Products and Manufacturers: Provide one of the following:
 - 1. Phoenix Contact
 - 2. SOLA
 - 3. Or equal.

2.2 SELECTOR SWITCHES, PUSHBUTTONS AND INDICATING LIGHTS

- A. General:
 - 1. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.
 - 2. Type:
 - a. Heavy duty, oil tight.
 - 3. Provide legend plate for indication of switch, pushbutton or light function (e.g., "OPEN-CLOSED", "HAND-OFF-AUTO").
 - 4. Mounting: Flush mounted on control panel front, unless otherwise noted.
 - 5. NEMA rated to match panel in which mounted.
- B. Selector Switches:
 - 1. Type: Provide selector switches with number of positions as required to perform intended functions as shown and specified.

2. Contacts:
 - a. Provide number and arrangement of contacts as required to perform intended functions specified, but not less than one single pole, double throw contact.
 - b. Type: Double break, silver contacts with movable contact blade providing scrubbing action.
 - c. Rating: Compatible with AC or DC current with devices simultaneously operated by the switch contacts, but not less than 10 A resistive at 120 VAC or DC continuous.
 3. Switch Operator: Standard black knob.
- C. Pushbuttons (Standard or Illuminated):
1. Type: Provide momentary lighted and/or unlighted, single and/or dual type pushbuttons as required to perform intended functions specified and shown.
 2. Contacts: Comply with the requirements specified for selector switches.
- D. Indicating Lights:
1. Type: Compact, integral transformer type.
 2. Lamps: Six volt, long life (20,000 hours minimum).
- E. Button and Lens Colors:
1. Green for indication of open, on, running.
 2. Red for indication of closed, off (ready), stopped.
 3. Amber for indication of equipment malfunction, process trouble and alarms (e.g., "HIGH LEVEL", "LOW LEVEL", etc.).
 4. Blue for indication of electrical control power on.
- F. Products and Manufacturers: Provide one of the following:
1. Cutler-Hammer, Type E30.
 2. Allen Bradley, Series 800.
 3. Or equal.

2.3 DIGITAL INDICATOR

- A. General: The digital indicator shall accept an analog input and convert it to scaled numerical characters for digital display and also provide up to two alarm outputs.
- B. Required Features:
1. Display Height: 0.56-inch.
 2. Display Capacity: Four digits with decimal point position jumper selectable.
 3. Display Type: Seven segment, red LED.
 4. Accuracy: ± 0.05 percent.
 5. Analog Input: 4 to 20 mADC.
 6. Excitation Output: 15 VDC for powering transmitter.

7. Analog Output: Proportional 4 to 20 mADC.
8. Alarm Output: Dual with two 2 A relays.
9. Temperature Range: 0°C to 60°C.
10. Power: 120 VAC, + 10 to -15 percent, five watts.
11. Enclosure: NEMA 4 splash proof.

C. Products and Manufacturers: Provide one of the following:

1. Newport Electronics, Model Q9000E.
2. Precision Digital, Model PD690.
3. Or equal.

2.4 ELAPSED TIME METER (HOUR METER)

A. General: Unit shall be a powered, non-resettable time indicator, with easy to read analog figures.

B. Required Features:

1. Power: 120 VAC.
2. Accuracy: Within one percent.
3. Capacity: Up to 99,999.9 hours (automatic recycle at zero); one-tenth hour resolution.
4. Operating Temperature: -40°C to +68°C.
5. Sealed against dirt and moisture.
6. Tamperproof.
7. Shock resistant.
8. Panel mountable.
9. Nameplate below display shall read "TOTAL HOURS".

C. Products and Manufacturers: Provide one of the following:

1. Dynapar/Veeder-Root, 7795 Series.
2. Cutler-Hammer, E42DIR Series.
3. Or equal.

2.5 CONTROL RELAY

A. Type: General purpose, plug-in type rated for continuous duty.

B. Construction Features:

1. Coil Voltages: 24 VDC or 120 VAC, as required.
2. Contacts:
 - a. Silver cadmium oxide rated not less than 5 A resistive at 120 VAC or 24 VDC continuous.

- b. For switching low energy circuits (less than 200 mA) fine silver, gold flashed contacts rated not less than 3 A resistive at 120 VAC or 28 VDC continuous shall be provided.
 - 3. Relays to have clear plastic dust cover.
 - 4. Relays to have pilot light to show energized coil.
 - 5. Relays to be UL recognized.
- C. Products and Manufacturers: Provide one of the following:
- 1. Square D Company, Type R and/or Type K.
 - 2. IDEC, RU Series.
 - 3. Or equal.

2.6 TIME DELAY RELAY

- A. Type: Dial adjustable, plug-in type time delay relay providing delay-on-make, delay-on-break or interval operation.
- B. Construction Features:
- 1. MOS digital circuit with transformer coupled power.
 - 2. Switch selectable ranges as follows:
 - a. One second.
 - b. Ten seconds.
 - c. One minute.
 - d. Ten minutes.
 - e. One hour.
 - f. Ten hours.
 - 3. Minimum Setting: Three percent of range, except 50 ms for one-second range.
 - 4. Setting Knob Accuracy: Ten percent.
 - 5. Contacts:
 - a. Type: DPDT.
 - b. Rating: 5 A resistive at 120 VAC, 5 A at 24 VDC.
 - 6. Housing: Plug-in design with dust and moisture resistant molded plastic case.
 - 7. Power Input: 120 VAC or 24 VDC as required.
 - 8. Operating Temperature: 0°C to 55°C.
 - 9. Unit shall have LED to show timing status.
 - 10. Relays to be UL recognized.
- C. Products and Manufacturers: Provide one of the following:
- 1. Automatic Timing and Controls Company, Series 328D.
 - 2. IDEC, Series GE1A.
 - 3. Or equal.

2.7 CURRENT ALARM RELAY

- A. Type: Direct current, electronic setpoint control relay which accepts 4 to 20 mA DC input signal and provides dry circuit contact output based on trip point setting.
- B. Performance Requirements:
 - 1. Repeatability: Trip point repeats within ± 0.2 percent of span.
 - 2. Trip Adjustment: 0 to 100 percent of span.
 - 3. Adjustable Deadband: 1 to 15 percent of span.
- C. Construction Features:
 - 1. Trip Adjustment: Multi-turn front panel adjustment.
 - 2. Contacts: DPDT relays, rated 5 A at 120 VAC or 24 VDC non-inductive.
 - 3. Enclosure: Standard housing designed for internal panel mounting.
 - 4. Power Supply: 120 VAC, 60 Hz or 24 VDC, as required.
- D. Products and Manufacturers: Provide one of the following:
 - 1. Ronan, X54 Series.
 - 2. Action Pak, Model AP 1080.
 - 3. Or equal.

2.8 SPARE PARTS AND TEST EQUIPMENT

- A. CONTRACTOR shall furnish and deliver the spare parts and test equipment as outlined below, all of which shall be identical and interchangeable with similar parts furnished under this Section.
- B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. The following shall constitute the minimum spare parts:
 - 1. Five of each type of input-output relay for each 40 or less furnished for this Contract.
 - 2. One replacement power supply for each type and size furnished for this Contract.
 - 3. A one-year supply of all expendable materials.
 - 4. One per ten (two, if fewer than twenty) of each type of panel mounted instrument including lights, pushbuttons and PLC equipment.
 - 5. One dozen of each type and size of fuse used in panels and instruments.
- D. All spare parts shall have been operated and tested in the factory as part of factory testing prior to shipment of the control system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install each item in accordance with manufacturers recommendations and in accordance with the Contract Documents.
- B. All items shall be mounted and anchored in compliance with Section 13430, Panels and Enclosures.

3.2 START-UP, CALIBRATION, TESTING AND TRAINING

- A. Comply with the requirements of Section 13403, Process Control System Startup and Field Testing, and Section 13404, Process Control System Training.

++ END OF SECTION ++

SECTION 13451

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install a fully functional Programmable Logic Controller (PLC) system.
2. The hardware and architecture of the system shall be that of a PLC. A Distributed Control System (DCS), hybrid PLC based system, or a PLC and components no longer supported or being removed from support within two years by PLC manufacturer shall not be acceptable.
3. The hardware required for the PLC is shown on the PLC block diagram and is comprised of the following types of major monitoring processing and control equipment units:
 - a. Fiber Optic Data Highway Communication System.
 - b. Programmable logical controller(s) with local I/O subsystem.
 - c. Network communication devices.
 - d. Power Supplies.
 - e. I/O Chassis and Cabling.

B. Related Sections:

1. Section 13430, Process Control Panels and Enclosures.

1.2 TERMS

A. The terms listed below are used throughout this Section and are defined as such:

1. Human Machine Interface (HMI): Operator Interface to control system. Allows operator intervention and monitoring of all systems and subsystems connected to the PLC system; usually a desktop computer or industrial hardened computer.
2. Programmable Logic Controller (PLC): The controlling device used to control and monitor hardware connected to it by way of networks or I/O cards. May be identified under different names such as small logic controller, mini or micro.
3. Backplane: Usually will indicate the I/O chassis that the power supply, PLC and I/O cards, and network cards reside in.
4. I/O Cards: Can be either analog or discrete cards that interface between field devices and PLC.
5. Network Hub: Data concentrator where one or more networks are integrated.

6. Server: Computer having one or more CPU's used for a specific task such as data depository, web management. Usually connected to the plant network.
7. Peripheral Devices: Includes, but not limited to, printer(s), display devices and standalone intelligent devices, such as remote HMI stations.
8. PLC System: Includes all parts listed above.

1.3 QUALITY ASSURANCE

- A. CONTRACTOR shall engage the services of the PCS Supplier to provide all equipment listed in this Section. The System manufacturer shall demonstrate a minimum of five years experience providing PLC systems and be able to show evidence of at least five installations of equal or greater size to the one being specified.

1.4 MAINTENANCE

- A. The PLC vendor shall provide recommended preventive maintenance tasks, schedules and instructions for hardware supplied. The PM documentation must be clear, applicable to hardware provided, concise and accurate.

1.5 TROUBLESHOOTING

- A. The PLC vendor shall provide trouble-shooting procedures for hardware supplied. The procedures shall be accurate, easy to understand and follow, current, and comprehensive in scope. If links to vendor website or technical support is necessary the vendor shall provide up-to-date phone numbers and links. The vendor shall supply this documentation prior to awarding of Contract.

PART 2 - PRODUCTS

2.1 STAND ALONE EQUIPMENT OR PROCESS UNITS (<256 I/O)

- A. The PLC configuration indicated is diagrammatic. The PLC system shall include as a minimum power supply, network connections, I/O cards, CPU and a HMI as shown and as required to achieve the specified functionality.
- B. The final system configuration shall utilize the System Manufacturer's standard hardware and software to meet the functional requirements of these Specifications.
- C. All equipment furnished under this Contract shall be provided to meet the functional requirements of these Specifications plus a 20 percent growth in project requirements, (e.g., graphic displays, alarms, additional instrumentation and equipment). All equipment shall be provided under this Contract, such that the entire 20 percent

project growth can be implemented into the PLC, without any additional hardware cost to the COUNTY.

- D. The PLC system shall be capable of being integrated into a larger plant wide PLC system, or DCS system using non-proprietary network communication protocol.
- E. The PLC system should have as a minimum the following features and capabilities:
 - 1. The CPU shall be a 32-bit microprocessor with onboard dynamic random access memory (DRAM) and flash memory for read/write functions and storage of configured data without battery backup. The microprocessor shall operate:
 - a. With a minimum clock speed of 25 MHZ.
 - b. With a minimum of 10K user application storage space.
 - c. Diagnostic LED's or indicating lights that, at a minimum, identifies processor status as (e.g., running, faulted or forced), communication status, and power on.
 - d. Internal Clock.
 - e. Include Arithmetic and PID function blocks.
 - f. Ladder logic programming features.
 - g. Online and offline programming capabilities.
 - h. Accept DC and AC analog, RTD, and digital input and output signals.
 - i. Provide timer, counter, shift register, and move control functionality.
 - j. Programming of PLC will be done using a personal computer attached to the front of the PLC or through a network node.
 - 2. I/O Modules:
 - a. All I/O modules shall meet Surge Withstand Capability Standard ANSI/IEEE C37.90.1-1989. All I/O modules shall be Radio Frequency Protected, providing 140 dB common mode and 80 dB, 60 Hz normal mode noise rejection, and conform to SAMA-PMC 33.1. Analog cards shall have individual A/D and D/A converters on a per point basis with all inputs and outputs being optically or galvanic ally isolated. Input/Output module performance specifications are specified below:
 - b. Current Inputs (4 to 20 mADC):
 - 1) Input Range: 0 to 20.4 mADC.
 - 2) Rated Mean Accuracy: +0.05 percent of span.
 - 3) Isolation: 600 VAC.
 - 4) Transmitter Power: 24 volts at 20 mA.
 - 5) Resistance: 390 ohm, maximum.
 - 6) Conversion Time: 0.1, 0.2, 0.5, 1.0 seconds (software configurable).
 - 7) Linearity Error: Between 0.0125 and 0.005 percent of range time conversion dependent.
 - 8) Resolution: 12, 13, 14, and 15 bits, time conversion dependent.
 - 9) Field Termination: No. 12 AWG, maximum.
 - c. Current Outputs:
 - 1) Output Range: 0 to 20.4 mADC.

- 2) Output Load: 735 ohms.
 - 3) Compliance Voltage: 18.6 volts nominal at 20 mA at field terminals.
 - 4) Rate Mean Accuracy: +0.05 percent span.
 - 5) Linearity Error: +0.025 percent of span.
 - 6) Resolution: 12 bits.
 - 7) Isolation: 600 Vac.
 - 8) Field Termination: No. 12 AWG, maximum.
 - 9) Bypass Jack: Built into the termination connector.
 - 10) Accepts external 20 mA source.
- d. Contact Input (Voltage Monitor 120 VAC). All contact input cards shall contain filtering to eliminate contact bounce. The filters shall reject input signal levels, which are not stable over a configurable time period.
- 1) Input ON-state Voltage: 79 to 132 Vac.
 - 2) Input OFF-state Voltage: 0 to 20 Vac.
 - 3) Input Current: 2.2 mA at 20 to 132 Vac.
 - 4) Isolation: 600 Vac.
 - 5) Filter Time: Configurable (4, 6, 16 or 32 Ms).
 - 6) Source Resistance Limits:
 - a) ON-state: 1K ohm (max) at 79 VAC.
 - b) OFF-state: 100K ohm (min) at 132 VAC.
 - 7) Field Termination: No. 12 AWG, minimum.
- e. Contact Output (Switch):
- 1) Voltage: 79 to 132 Vac, field furnished.
 - 2) Current: Two amps, maximum.
 - 3) Off-State Leakage: Five mA, maximum.
 - 4) Isolation: 600 Vac.
 - 5) Field Termination: No. 12 AWG, maximum.

2.2 CONTROL NETWORK

- A. General: Furnish and install a high-security, dual, redundant process control network. The network shall be arranged such that future nodes can be added at any point(s) along the network without overloading the system or requiring re-routing of the highway cable being installed under this contract.
- B. Required Features:
1. The network shall be based on open standards and shall provide a redundant backbone that shall be implemented using ANSI X3T12 requirements.
 2. The network shall be a high-throughput network based on Fiber/Copper Distributed Data Interface (FDDI/CDDI) per ANSI X3T12 or via Fast Ethernet. The Distributed Control Units shall be interconnected and reside on the process control network.
 3. The redundant network shall not rely on proprietary hardware or software.

4. Devices residing on the network shall utilize standard Network Interface Cards (NICs). The network devices shall individually connect to either FDDI/CDDI concentrators or Ethernet switches and hubs through appropriate media.
5. The net effective communications rate shall be nearly 100 MB per second, sufficient to support the transmission of at least 100,000 periodic data point values each second. System data shall be automatically available to all devices on the network at all times. An analog or digital variable shall be input, output, calculated or sent to any device on the network within 100 milliseconds.
6. CONTRACTOR shall provide cable meeting all transmission requirements for the system supplied. Since communication protocols vary from supplier to supplier, achieving the minimum transmission rate specified does not relieve CONTRACTOR from conforming to all specific performance requirements.
7. The Operator shall be able to verify from the central location, the presence, type and well-being of all devices on the network. All devices on the network shall be capable of switching between the two highway terminations. The switching shall be automatic, so that in the event of a line break, there shall be no degradation in system performance. The equipment shall recognize that a line break has occurred and shall provide an appropriate alarm output.
8. The failure of any single component anywhere on the highway network shall not prevent or degrade system performance. The network shall allow expansion while remaining on-line.
9. The communications protocol shall be based on the TCP/IP communications standard. If FDDI/CDDI is utilized, it shall be implemented in accordance with ANSI X3T12 such to utilize both synchronous and asynchronous modes.
10. Extensive error checking shall be provided to verify that accepted messages contain the same data that was sent from the original source and to verify that noise or hardware failure has not incorporated erroneous data in the received message.
11. The communication channel shall operate without failure in presence of 2.5 KV, 1 MHZ damped sinusoidal signal (IEEE surge withstanding capabilities specification) applied differentially or to either data line with respect to ground.
12. The communication channel shall withstand without damage 120V RMS at 60 Hz applied differentially or to either data line with respect to ground.
13. All data highway cabling shall be provided under this Section.
14. All communication with remote input/output enclosures shall be accomplished via a redundant I/O network. The redundant network shall be over a redundant fiber optic data highway using the manufacturer's standard configuration for fiber optic communications and providing reliability and fault tolerant redundancy throughout. It shall be possible to disconnect and expand one data highway without shutting down the system or losing communications with remote I/O.
15. The I/O communication network shall offer a degree of security, providing complete protection against single-bit, double-bit, and odd-bit number errors. In addition, the I/O communication network shall be immune to failures to the

extent that no single failure in any one module can cause both segments of the redundant communication network to become inoperable. All required cabling for I/O both local and remote shall be furnished and installed under this Section.

2.3 PLC PROGRAMMING SOFTWARE

- A. Software shall support the development of the PLC ladder logic derived from process control strategies as specified in Section 13491, Process Control Descriptions. Software shall utilize traditional relay logic as well as modular, function block type of control elements, which are familiar to control engineers, instrumentation technicians and electricians. The function blocks shall be; computational blocks for performing arithmetic, operational blocks for performing such functions as move and convert values, file to file operations, communication blocks for communicating with other PLC's and system resources, special algorithm blocks for advanced control procedures such as shift register, and PID functions. The PID shall use traditional strategies such as proportional, integral derivative (PID) controllers, feed forward, cascaded controllers, etc. shall be provided. Tuning constants shall be easily set from operator consoles. For each analog loop, software to allow provision of status of the manual backup control to be monitored and an alarm generated when switch is not in automatic mode.
- B. For each sequence or logic control loop, a disagreement alarm shall be triggered when a command (start-stop, etc.) is initiated and confirmation is not received.
- C. Supplier shall provide and configure internal diagnostics alarms for the PLC hardware. Alarms shall be suitable to verify proper and to alert operators when alarm conditions occurs. This includes, but is not limited to annunciation blown fuse indication for all I/O, watchdogs for communications failure with any system processor or I/O address, and communications failure with existing third party equipment.
- D. PLC software shall allow for editing of comments and other PLC documentation using traditional editors such as Notepad.
- E. PLC software shall include as easy to use file and printing management module.
- F. The PLC software shall include a report generation module for system information use. The reporting module should allow for user-configured reports.
- G. The PLC software shall use intuitive, menu-driver environment and base package platform. These easy-to-use Graphical User Interface (GUI) packages shall perform configuration and maintenance operations.

- H. The PLC software shall be compatible with Windows 2000 or latest version, Windows XP, and LINUX operating systems.

PART 3 - EXECUTION

3.1 ENVIRONMENTAL CONDITIONS

- A. The complete monitoring and control system and associated input/output wiring will be used in a wastewater treatment facility environment where there will be high energy AC fields, DC control pulses, and varying ground potentials between the transducers or input contact locations and the system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.
- B. The PLC components shall be designed and constructed for satisfactory operation and long, low maintenance service under the following environmental conditions:
1. Temperature range: 32 to 122°F continuous.
 2. Relative humidity: 5 through 95 percent (non-condensing).
- C. The Control rooms will normally be air-conditioned to achieve environmental conditions outlined above. No positive control of relative humidity is provided or contemplated. However, in the event of a failure of the air conditioning system, the entire monitoring and control system shall be capable of operating continuously and satisfactorily with ambient temperatures between 32 and 104°F and with relative humidity to 95 percent (non-condensing).

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SECTION 13480

INPUT/OUTPUT POINT LIST

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. This Section describes the input/output (I/O) point list, which follows this Section and requirements for configuring the control system database.
- B. Related Sections:
 - 1. Section 13451, PLC/HMI Hardware and Software.
- C. The I/O list information is attached as an appendix (13480A) at the end of this section.

1.2 SUBMITTALS

- A. For each I/O attribute listed in the I/O list that cannot be used exactly as listed, submit an explanation of the reason for the deviation and propose a method to modify the I/O list information. Do not proceed with any configuration until a method of resolving deviations is accepted by the ENGINEER.
- B. Include the control system I/O database information in the PLC specific submittals for Section 13451, PLC/HMI Hardware and Software.

1.3 I/O POINT LIST DESCRIPTION

- A. The I/O point list contains the information necessary to configure the PLC I/O interface hardware and to indicate range conversion or signal functions.
- B. "TAG" is an alphanumeric character string. For example, the point ROCP_F123I_A, the following apply:
 - 1. The first four characters (ROCP) refers to the PLC/Remote I/O panel (MSCP = Membrane Skid Control Panel).
 - 2. The third character is the functional identifier and follows ANSI/ISA-S5.1. In the example, the "F" represents flow.
 - 3. The three-digit number (0123) identifies the loop or field device.
 - 4. The next alpha character (I) is the function identifier. In the example, the "I" represents an analog input.

5. The final numeric character (1) is used, as required, as a suffix to differentiate multiple points in the same loop.
- C. "DESCRIPTION" is an alphanumeric character string up to 60 positions in length. Points described as "SPARE" denote pre-wired I/O.
- D. "SIGNAL TYPE" is one of the following:
 1. AI designates an analog input.
 2. DI designates a discrete input.
 3. AO designates an analog output.
 4. DO designates a momentary, maintained or latched discrete output.
 5. DAI designates a soft analog input over data highway.
 6. DDI designates a soft discrete input over data highway.
 7. DAO designates a soft analog output over data highway.
 8. DDO designates a soft discrete output over data highway.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 I/O CONFIGURATION

- A. Implement the control system database fields in a consistent manner by using the following procedures:
 1. Use abbreviations and acronyms already established in the Contract Documents. In particular, use the information in the I/O Point List.
 2. Use only abbreviation or acronym for a word or group of words, respectively.
 3. Use the same subject and word order within data fields.
 4. Use the same term (either phrase, word or acronym) to denote the same meaning. Do not use multiple terms for a single meaning.
 5. Use the point names, descriptions, logic state descriptions, ranges and units of measurement exactly the same wherever the point is referenced.
 6. Show point names and descriptions for all point references on documentation.
 7. Spell correctly.
 8. Maintain lists of acronyms and abbreviations used.

3.2 I/O HARDWARE CONFIGURATION

- A. Partition the I/O among cards within an I/O enclosure to provide control loop integrity.
 1. Put all inputs of the same I/O type associated with a device (e.g. pump,

- blower, clarifier or other piece of equipment) on the same card.
2. Put all inputs of the same I/O type for devices arranged in process trains (e.g. a pump, its inlet valve and its outlet valve, or a pump and its associated macerator) on the same card or cards if more than one card is required to accommodate the points.
 3. Put all outputs of the same I/O type associated with a device or group of devices in a process train on the same card or cards if more than one card is required to accommodate the points.
 4. Where the preceding requirements specified in this paragraph would cause more than 20 percent spare points on a card, points for a device or process train may be split between two consecutive cards.
 5. Make unused terminals resulting from partitioning the I/O into pre-wired spares. Provide pre-wired spare points with all cabling, control relays, surge protection and termination blocks internal to the PLC Panel as done for other I/O points.

3.3 POINT DATA FIELDS

- A. I/O point data fields may be subject to review and modification by the ENGINEER during the Shop Drawing review phase. Incorporate changes directed by the ENGINEER completely into the entire system, at no additional cost to OWNER, subject to the following limitations:
 1. Limit the total number of modifications to 20 percent of the total number of I/O points.
 2. Each unique change will count as one modification. For example, modifying the description, range, and engineering unit on an analog input count as three modifications.
 3. Analog input alarm limit definition will not be counted as a modification.

3.4 INPUT/OUTPUT TAGGING

- A. Each tag number shall be written as follows AA_I_####Y_# where:
 1. AAA = PLC Identifier
 2. I = ISA Identification.
 3. ### = 3 Digit Loop Number.
 4. Y = Function Identifier.
 5. # = Suffix (to distinguish between similar variables).
- B. PLC Identifier:
 1. ROCP = Reverse Osmosis Control Panel
 2. EPLCCP = Existing PLC Control Panel
 3. CPSCP = Concentrate Pump Station Control Panel

C. ISA Identification:

1. A = Miscellaneous Analytical.
2. B = Burner, Combustion.
3. C = Conductivity.
4. D = Density.
5. E = Voltage.
6. F = Flow.
7. G = Intrusion.
8. H = Hand.
9. I = Current.
10. J = Power.
11. K = Time.
12. L = Level.
13. M = Motor.
14. N = Nitrogen/Ammonia Analyzer.
15. O = Oxygen.
16. P = Pressure.
17. Q = Quantity.
18. R = Radioactivity.
19. S = Speed, Frequency.
20. T = Temperature.
21. U = Common Alarm.
22. V = Vibration.
23. W = Torque (Weight or Force).
24. X = Hazardous Gas.
25. Y = Event, State or Presence (Switch Position).
26. Z = Position, Dimension.

D. Function Identifier:

1. A = Available / In Auto (input)
2. B = Backward Rotation (input)
3. C = Full Closed (input)
4. D = Full Open (input)
5. E = Close/Energize (output)
6. H = High (input)
7. I = Input (Analog)
8. L = Low (input)
9. N = Open (output) or Control Mode (input)
10. O = Output (Analog)
11. R = Running (input)
12. S = Start (output)
13. T = Stop (output)
14. U = Malfunction (input)
15. V = Slow (output)

16. W = Slow (input)
17. X = Selector Switch (input)

E. Examples:

1. MTC_Z_120N = Membrane Train C, Valve 120 Position, Open Command.
2. PTC_F_100I = Feed Water (Pre Treatment/Chemical Systems Remote I/O Panel), Flow Transmitter 100, Analog Input Value.
3. FRP_L_701L = Membrane Cleaning Tank (Finished Water Remote I/O Panel), Level Switch 701, Low Alarm (Discrete Input).

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INPUT/OUTPUT POINT LIST

SL No.	P&ID Loop No.	Description/Location	Type	Input from	Output To	Remarks/Drawing No.
1	YIL-100	Lake Gravity Disk Filter No.1 In Backwash	DI	DFCP No.1	SP5	I-2
2	KQI-101	Lake Gravity Disk Filter No.1 Drive Motor No.1 Run Time	DI	DFCP No.1	SP5	I-2
3	YIL-101	Lake Gravity Disk Filter No.1 Drive Motor No.1 Run Status	DI	DFCP No.1	SP5	I-2
4	YIL-101	Lake Gravity Disk Filter No.1 Drive Motor No.1 In Auto	DI	DFCP No.1	SP5	I-2
5	UA-101	Lake Gravity Disk Filter No.1 Drive Motor No.1 Over Load	DI	DFCP No.1	SP5	I-2
6	UA-101A	Lake Gravity Disk Filter No.1 Drive Motor No.1 Fail	DI	DFCP No.1	SP5	I-2
7	KQI-102	Lake Gravity Disk Filter No.1 Drive Motor No.2 Run Time	DI	DFCP No.1	SP5	I-2
8	YIL-102	Lake Gravity Disk Filter No.1 Drive Motor No.2 Run Status	DI	DFCP No.1	SP5	I-2
9	YIL-102	Lake Gravity Disk Filter No.1 Drive Motor No.2 In Auto	DI	DFCP No.1	SP5	I-2
10	UA-102	Lake Gravity Disk Filter No.1 Drive Motor No.2 Over Load	DI	DFCP No.1	SP5	I-2
11	UA-102a	Lake Gravity Disk Filter No.1 Drive Motor No.2 Fail	DI	DFCP No.1	SP5	I-2
12	LAHH-107	Lake Gravity Disk Filter No.1 Level High High	DI	DFCP No.1	SP5	I-2
13	UA-110	Lake Gravity Disk Filter No.1 Common Alarm	DI	DFCP No.1	SP5	I-2
14	YIL-200	Lake Gravity Disk Filter No.2 In Backwash	DI	DFCP No.2	SP5	I-2 (TYP.)
15	KQI-201	Lake Gravity Disk Filter No.2 Drive Motor No.1 Run Time	DI	DFCP No.2	SP5	I-2 (TYP.)
16	YIL-201	Lake Gravity Disk Filter No.2 Drive Motor No.1 Run Status	DI	DFCP No.2	SP5	I-2 (TYP.)
17	YIL-201	Lake Gravity Disk Filter No.2 Drive Motor No.1 In Auto	DI	DFCP No.2	SP5	I-2 (TYP.)
18	UA-201	Lake Gravity Disk Filter No.2 Drive Motor No.1 Over Load	DI	DFCP No.2	SP5	I-2 (TYP.)
19	UA-201A	Lake Gravity Disk Filter No.2 Drive Motor No.1 Fail	DI	DFCP No.2	SP5	I-2 (TYP.)
20	KQI-202	Lake Gravity Disk Filter No.2 Drive Motor No.2 Run Time	DI	DFCP No.2	SP5	I-2 (TYP.)
21	YIL-202	Lake Gravity Disk Filter No.2 Drive Motor No.2 Run Status	DI	DFCP No.2	SP5	I-2 (TYP.)
22	YIL-202	Lake Gravity Disk Filter No.2 Drive Motor No.2 In Auto	DI	DFCP No.2	SP5	I-2 (TYP.)
23	UA-202	Lake Gravity Disk Filter No.2 Drive Motor No.2 Over Load	DI	DFCP No.2	SP5	I-2 (TYP.)
24	UA-202A	Lake Gravity Disk Filter No.2 Drive Motor No.2 Fail	DI	DFCP No.2	SP5	I-2 (TYP.)
25	LAHH-207	Lake Gravity Disk Filter No.2 Level High High	DI	DFCP No.2	SP5	I-2 (TYP.)
26	UA-210	Lake Gravity Disk Filter No.2 Common Alarm	DI	DFCP No.2	SP5	I-2 (TYP.)
27	YIL-300	Lake Gravity Disk Filter No.3 In Backwash	DI	DFCP No.3	SP5	I-2 (TYP.)
28	KQI-301	Lake Gravity Disk Filter No.3 Drive Motor No.1 Run Time	DI	DFCP No.3	SP5	I-2 (TYP.)

INPUT/OUTPUT POINT LIST

SLNo.	P&ID Loop No.	Description/Location	Type	Input from	Output To	Remarks/Drawing No.
29	YIL-301	Lake Gravity Disk Filter No.3 Drive Motor No.1 Run Status	DI	DFCP No.3	SP5	I-2 (TYP.)
30	YIL-301	Lake Gravity Disk Filter No.3 Drive Motor No.1 In Auto	DI	DFCP No.3	SP5	I-2 (TYP.)
31	UA-301	Lake Gravity Disk Filter No.3 Drive Motor No.1 Over Load	DI	DFCP No.3	SP5	I-2 (TYP.)
32	UA-301A	Lake Gravity Disk Filter No.3 Drive Motor No.1 Fail	DI	DFCP No.3	SP5	I-2 (TYP.)
33	KQL-302	Lake Gravity Disk Filter No.3 Drive Motor No.2 Run Time	DI	DFCP No.3	SP5	I-2 (TYP.)
34	YIL-302	Lake Gravity Disk Filter No.3 Drive Motor No.2 Run Status	DI	DFCP No.3	SP5	I-2 (TYP.)
35	YIL-302	Lake Gravity Disk Filter No.3 Drive Motor No.2 In Auto	DI	DFCP No.3	SP5	I-2 (TYP.)
36	UA-302	Lake Gravity Disk Filter No.3 Drive Motor No.2 Over Load	DI	DFCP No.3	SP5	I-2 (TYP.)
37	UA-302A	Lake Gravity Disk Filter No.3 Drive Motor No.2 Fail	DI	DFCP No.3	SP5	I-2 (TYP.)
38	LAHH-307	Lake Gravity Disk Filter No.3 Level High High	DI	DFCP No.3	SP5	I-2 (TYP.)
39	UA-310	Lake Gravity Disk Filter No.3 Common Alarm	DI	DFCP No.3	SP5	I-2 (TYP.)
40	LAHH-115	Wetwell Level High High	DI	BPCP	SP5	I-2
41	KQL-116	Backwash Pump No.1 Run Time	DI	BPCP	SP5	I-2
42	YIL-116	Backwash Pump No.1 Run Status	DI	BPCP	SP5	I-2
43	YIL-116	Backwash Pump No.1 In Auto	DI	BPCP	SP5	I-2
44	UA-116	Backwash Pump No.1 Over Load	DI	BPCP	SP5	I-2
45	TAH-117	Backwash Pump No.1 Motor Over Temp	DI	BPCP	SP5	I-2
46	MAH-118	Backwash Pump No.1 Seal Fail	DI	BPCP	SP5	I-2
47	TAH-119	Backwash Pump No.1 Motor Over Temp	DI	BPCP	SP5	I-2
48	MAH-120	Backwash Pump No.2 Seal Fail	DI	BPCP	SP5	I-2 (TYP.)
49	KQL-121	Backwash Pump No.2 Run Time	DI	BPCP	SP5	I-2 (TYP.)
50	YIL-121	Backwash Pump No.2 Run Status	DI	BPCP	SP5	I-2 (TYP.)
51	YIL-121	Backwash Pump No.2 In Auto	DI	BPCP	SP5	I-2 (TYP.)
52	UA-121	Backwash Pump No.2 Over Load	DI	BPCP	SP5	I-2 (TYP.)
75	FS-111	Lake Gravity Filter No.1 Influent Flow Switch - Active	DI	FSH-111	SP4	I-2
76	FS-211	Lake Gravity Filter No.2 Influent Flow Switch - Active	DI	FSH-211	SP4	I-2
77	FS-311	Lake Gravity Filter No.3 Influent Flow Switch - Active	DI	FSH-111	SP4	I-2
56	SP-140	Sample Pump - Chlorine Residual (Total) - START/STOP	DO	SP4	RCARP	I-2

INPUT/OUTPUT POINT LIST

SL.No.	P&ID Loop.No.	Description/Location	Type	Input from	Output To	Remarks/Drawing No.
50	YIL-148	Residual Chlorine (Total) - Run Status	DI	RCARP	SP4	I-2
58	AI-150	Lake Gravity Filter Common Effluent Chlorine Residual (Total)	AI	AIT-150	SP4	I-3
59	AI-150	Lake Gravity Filter Common Effluent Chlorine Residual (Total)	AO	SP4	SHTB	I-3
60	LI-204	Sodium Hypochlorite Storage Tank No.4 Level	AI	LI-204	SP4	I-3
61	LAH-204	Sodium Hypochlorite Storage Tank No.4 Level High	SOFT	LI-204	SP4	I-3
62	LAL-204	Sodium Hypochlorite Storage Tank No.4 Level Low	SOFT	LI-204	SP4	I-3
63	HS-210	Sodium Hypochlorite Metering Pump No.1 START/STOP	DO	SHTB	SP4	I-3
64	KQI-210	Sodium Hypochlorite Metering Pump No.1 Run Time	DI	SHTB	SP4	I-3
65	YIL-210	Sodium Hypochlorite Metering Pump No.1 Run Status	DI	SHTB	SP4	I-3
66	YL-210	Sodium Hypochlorite Metering Pump No.1 In Auto	DI	SHTB	SP4	I-3
67	UA-210	Sodium Hypochlorite Metering Pump No.1 Fail	DI	SHTB	SP4	I-3
68	SC-210	Sodium Hypochlorite Metering Pump No.1 Speed Control	AO	SHTB	SP4	I-3
69	HS-220	Sodium Hypochlorite Metering Pump No.2 START/STOP	DO	SHTB	SP4	I-3 (TYP.)
70	KQI-220	Sodium Hypochlorite Metering Pump No.2 Run Time	DI	SHTB	SP4	I-3 (TYP.)
71	YIL-220	Sodium Hypochlorite Metering Pump No.2 Run Status	DI	SHTB	SP4	I-3 (TYP.)
72	YL-220	Sodium Hypochlorite Metering Pump No.2 In Auto	DI	SHTB	SP4	I-3 (TYP.)
73	UA-220	Sodium Hypochlorite Metering Pump No.2 Fail	DI	SHTB	SP4	I-3 (TYP.)
74	SC-220	Sodium Hypochlorite Metering Pump No.2 Speed Control	AO	SHTB	SP4	I-3 (TYP.)
75	FS-111	Lake Gravity Filter No.1 Influent Flow Switch - Active	DI	FSH-111	SP4	I-2
76	FS-211	Lake Gravity Filter No.2 Influent Flow Switch - Active	DI	FSH-211	SP4	I-2
77	FS-311	Lake Gravity Filter No.3 Influent Flow Switch - Active	DI	FSH-111	SP4	I-2
78	HS-107	MOV # 107 (Open/Close/off/Auto)	DO	SPI	MOV-107	I-4
79	UA-107	MOV # 107 Fail	DI	MOV-107	SPI	I-4
80	ZI-107	MOV # 107 Position Indicator	AI	MOV-107	SPI	I-4
81	ZC-107	MOV # 107 Position Control	AO	SPI	MOV-107	I-4
82	ZIL-107	MOV # 107 Not In Remote	DI	MOV-107	SPI	I-4
83	ZIO-107	MOV # 107 Open Indication	DI	MOV-107	SPI	I-4
84	ZIC-107	MOV # 107 Close Indication	DI	MOV-107	SPI	I-4

INPUT/OUTPUT POINT LIST

Sl.No.	P&ID Loop.No.	Description/Location	Type	Input from	Output To	Remarks/Drawing No.
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SECTION 13481

INSTRUMENT AND CONTROL SYSTEM INSTRUMENT INDEX

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust, commission and place into satisfactory operation all primary sensors and field instruments and panel instruments and devices furnished under this Section.
2. An Instrument Index for the Instrumentation and Control System is included at the end of the Section.
3. Contract Documents illustrate and specify functional and general construction requirements of the sensors and field instruments and panel instruments and devices and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.

B. Coordination:

1. Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

C. Related Sections:

1. Division 11, Equipment.
2. Division 13, Special Construction.
3. Division 16, Electrical.

1.2 QUALITY ASSURANCE

- ###### A. Comply with the requirements of Section 13401, General Requirements.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

- ###### A. Comply with the requirements specified in Section 13401, General Requirements.

1.4 SUBMITTALS

- A. Comply with the requirements specified in Section 13401, General Requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

INSTRUMENT INDEX

Sl.No	Tag	Description/Location	Range/Setpoint	Spec. Ref.	Remarks/Drawing No.
1	FSH-111	Lake Gravity Filter No.1 Influent Flow Switch	-	13420, 2.12	Drawing I-2
2	FSH-211	Lake Gravity Filter No.1 Influent Flow Switch	-	13420, 2.12	Drawing I-2
3	FSH-311	Lake Gravity Filter No.1 Influent Flow Switch	-	13420, 2.12	Drawing I-2
4	LSLL-112	Backwash Reject Lift Station - Low Level Switch	Spec. 11322	13420, 2.3	Drawing I-2
5	LS-113	Backwash Reject Lift Station - Level Switch	Spec. 11322	13420, 2.3	Drawing I-2
6	LS-114	Backwash Reject Lift Station - Level Switch	Spec. 11322	13420, 2.3	Drawing I-2
7	LSHH-115	Backwash Reject Lift Station - High High Level Switch	Spec. 11322	13420, 2.3	Drawing I-2
8	PI-121	Backwash Pump No.1 Discharge Pressure Gauge	0-50 PSI	13420, 2.8	Drawing I-2
9	PI-123	Backwash Pump No.2 Discharge Pressure Gauge	0-50 PSI	13420, 2.8	Drawing I-2
10	AE/AIT-150	Common Filter Effluent Chlorine Residual Analyzer	0-5 mg/l	13420, 2.8	Drawing I-2
11	LE-204	SHC Storage Tank No.4 Level Element	0-20 FT	13420, 2.2	Drawing I-3
12	LIT-204	SHC Storage Tank No.4 Level Transmitter	0-20 FT	13420, 2.2	Drawing I-3

++ END OF SECTION ++

SECTION 15051

SECTION 15051

BURIED PIPING INSTALLATION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all buried piping, fittings, and specials. The Work includes the following:
 - a. All types and sizes of buried piping, except where buried piping installations are specified under other Sections.
 - b. Unless otherwise shown or specified, this Section includes all buried piping Work required, beginning at the outside face of structures or structure foundations, including piping beneath structures, and extending away from structures.
 - c. Work on or affecting existing buried piping.
 - d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, cathodic protection, and other Work required for a complete, buried piping installation.
 - e. Supports, restraints, and thrust blocks.
 - f. Pipe encasements, with the exception of piping embedded in concrete within a structure or foundation specified under Section 15052, Exposed Piping Installation.
 - g. Field quality control, including testing.
 - h. Cleaning and disinfecting.
 - i. Incorporation of valves, meters, and special items shown or specified into piping systems in accordance with the Contract Documents and as required.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before buried piping Work.
2. Coordinate with appropriate piping Sections of Division 15, Mechanical.

C. Related Sections:

1. Section 02221, Trenching, Bedding, and Backfill for Pipe
2. Section 02223, Excavation Below Grade and Crushed Stone or Shell Refill.
3. Section 03300, Cast-In-Place Concrete.

4. Section 09900, Coatings.
5. Division 15, Mechanical.

1.2 REFERENCES

- A. Standards referenced in this Section are:
1. ASME B31.3, Process Piping.
 2. ASTM D2321, Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
 3. ASTM D2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
 4. ANSI/AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
 5. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 6. ANSI/AWWA C206, Field Welding of Steel Water Pipe.
 7. ANSI/AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
 8. ANSI/AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
 9. ANSI/AWWA C651, Disinfecting Water Mains.
 10. AWWA M11, Steel Water Pipe - A Guide for Design and Installation.
 11. AWWA M23, PVC Pipe - Design and Installation.
 12. AWWA M41, Ductile-Iron Pipe and Fittings.
 13. ASCE 37, Design and Construction of Sanitary and Storm Sewers.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Comply with requirements and recommendations of authorities having jurisdiction over the Work, including.
 - a. NFPA Standard No. 24 for ("outside protection" to fire protection systems.
 - b. UL, FM and other jurisdictional authorities.
 - c. NSF 61 for surfaces in contact with water supply systems.
 - d. Local regulatory agencies.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. Laying schedules for piping with restrained joints.
 - b. Details of piping, specials, joints, harnessing, and connections to piping, structures, equipment, and appurtenances.

2. Product Data: Manufacturer's literature and specifications, as applicable, for products specified in this Section.
 3. Testing Procedures: Submit proposed testing procedures, methods, apparatus, and sequencing. Obtain ENGINEER's approval prior to commencing testing.
- B. Informational Submittals: Submit the following:
1. Certifications: Certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.
 2. Field Quality Control Submittals: Results of each specified field quality control test.
- C. Closeout Submittals: Submit the following:
1. Record Documentation:
 - a. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work. Submittal shall show actual location of all piping Work and appurtenances at same scale as the Drawings.
 - b. Show piping with elevations referenced to Project datum and dimensions from permanent structures. For each horizontal bend in piping, include dimensions to at least three permanent structures, when possible. For straight runs of piping provide offset dimensions as required to document piping location.
 - c. Include profile drawings with buried piping record documents when the Contract Documents include piping profile drawings.
 - d. Conform to Section 01720, Project Record Documents.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site and replace with acceptable material.
- B. Storage:
1. Store materials to allow convenient access for inspection and identification. Store materials above ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
 2. Pipe and fittings other than PVC and CPVC may be stored outdoors without cover. Cover PVC and CPVC pipe and fittings stored outdoors.

C. Handling:

1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
2. Avoid unnecessary handling of pipe.
3. Keep pipe interiors free from dirt and foreign matter.
4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Piping materials are specified in the Buried Piping Schedule at end of this Section. Piping materials shall conform to Specifications for each type of pipe and piping appurtenances in applicable Sections of Division 15, Mechanical.

B. General:

1. Pipe Markings:

- a. Factory-mark each length of pipe and each fitting with designation conforming to those on approved laying schedules.
- b. Manufacturer shall cast or paint on each length of pipe and each fitting pipe material, diameter, and pressure or thickness class.

C. Polyethylene Encasement:

1. Polyethylene may be supplied in tubes or sheets.
2. Polyethylene encasement materials shall be in accordance with ANSI/AWWA C105.

D. Cathodic Protection:

1. Bonding Cables: Bonding cable and test lead wires shall be not less than No. 6 AWG, Type CP copper cathodic protection cable, with low density, high molecular weight polyethylene insulation.
2. Test Lead Stations: Provide test lead stations where shown and indicated in the Contract Documents. Standard connection boxes for test lead stations shall be plastic terminal boxes, 18 inches long and five-inch inside diameter, with locking cast iron lid with "CP TEST" cast into cover. Inside terminal box shall be terminal block with seven terminals. Terminal box shall be manufactured by C.P. Test Services "NM-7" or equal.

2.2 BURIED PIPING IDENTIFICATION

- A. Polyethylene Underground Warning Tape for Metallic Pipelines:
1. Tracer tape shall be of inert, acid- and alkali-resistant, polyethylene, four mils thick, six inches wide, suitable for direct burial. Tape shall be capable of stretching to twice its original length.
 2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other service as appropriate, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW", with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet.
 3. Manufacturer: Provide products of one of the following:
 - a. Brady Corporation.
 - b. Seton Identification Products.
 - c. Marking Services, Inc.
 - d. Or approved equal.
- B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
1. Tape shall be of inert, acid- and alkali-resistant, polyethylene, five mils thick, six inches wide, with aluminum backing, and have 15,000 psi tensile strength and 80 percent elongation capability. Tape shall be suitable for direct burial.
 2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other appropriate service, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW" with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet.
 3. Manufacturer: Provide products of one of the following:
 - a. Brady Corporation.
 - b. Seton Identification Products.
 - c. Marking Services, Inc.
 - d. Or approved equal.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. General:
1. Install piping as shown, specified, and as recommended by pipe and fittings manufacturer.
 2. In event of conflict between manufacturer's recommendations and the Contract Documents, request interpretation from ENGINEER before proceeding.

3. COUNTY will observe excavations and bedding prior to laying pipe by CONTRACTOR. Notify COUNTY in advance of excavating, bedding, pipe laying, and backfilling operations.
4. Minimum cover over buried piping shall be 3 feet, unless otherwise shown or approved by ENGINEER.
5. Earthwork is specified in Section 02221, Trenching, Bedding, and Backfill for Pipe.
6. Excavation in excess of that required or shown, and that is not authorized by ENGINEER shall be filled at CONTRACTOR's expense with granular material furnished, placed, and compacted in accordance with Section 02223, Excavation Below Grade and Crushed Stone or Shell Refill.
7. Comply with NFPA 24 for "Outside Protection", where applicable to water piping systems used for fire protection.

B. Manufacturer's Installation Specialist:

1. Provide services of competent installation specialist of pipe manufacturer when pipe installation commences for:
 - a. Concrete pipe.
 - b. Welded Steel or Stainless Steel piping.
2. Retain installation specialist at the Site for minimum of one day (eight hours per day at the Site) or until competency of pipe installation crew has been satisfactorily demonstrated.

C. Separation of Sewers and Potable Water Piping:

1. Horizontal Separation:
 - a. Where possible, existing and proposed potable water mains and service lines, and sanitary, combined, and storm sewers shall be separated horizontally by clear distance of at least ten feet.
2. Vertical Separation:
 - a. Provide minimum vertical distance of 12 inches between outside of potable water main and outside of sewer when sewer crosses over potable water main.
 - b. Center a section of potable water main pipe at least 18 feet long over sewer so that sewer joints are equidistant from potable water main joints.
 - c. Provide adequate structural support where potable water main crosses under sewer. At minimum, provide compacted select backfill for ten feet on each side of crossing.

D. Plugs:

1. Temporarily plug installed pipe at end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.

2. Install standard plugs in bells at dead ends, tees, and crosses. Cap spigot and plain ends.
 3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.
 4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to ENGINEER.
- E. Bedding Pipe: Bed pipe as specified and in accordance with details on the Drawings.
1. Trench excavation and backfill, and bedding materials shall conform to Section 02221, Trenching, Bedding, and Backfill for Pipe, as applicable.
 2. Where ENGINEER deems existing bedding material unsuitable, remove and replace existing bedding with approved granular material furnished, placed, and compacted in accordance with Section 02223, Excavation Below Grade and Crushed Stone or Shell Refill.
 3. Where pipe is installed in rock excavation, provide minimum of three inches of granular bedding material underneath pipe smaller than four-inch nominal diameter, and minimum of six inches of granular bedding material underneath pipes four-inch nominal diameter and larger.
 4. Excavate trenches below bottom of pipe by amount shown and indicated in the Contract Documents. Remove loose and unsuitable material from bottom of trench.
 5. Carefully and thoroughly compact pipe bedding with hand held pneumatic compactors.
 6. Do not lay pipe until COUNTY approves bedding condition.
 7. Do not bring pipe into position until preceding length of pipe has been bedded and secured in its final position.
- F. Laying Pipe:
1. Conform to manufacturer's instructions and requirements of standards and manuals listed below, as applicable:
 - a. Ductile Iron Pipe: ANSI/AWWA C600, ANSI/AWWA C105, AWWA M41.
 - b. Concrete Pipe: AWWA M9.
 - c. Steel Pipe: ANSI/AWWA C206, AWWA M11.
 - d. Thermoplastic Pipe: ASTM D2321, ASTM D2774, ANSI/AWWA C605, AWWA M23, AWWA M45, AWWA, M55.
 - e. Sanitary and Storm Sewers: ASCE 37.
 2. Install pipe accurately to line and grade shown and indicated in the Contract Documents, unless otherwise approved by ENGINEER. Remove and reinstall pipes that are not installed correctly.
 3. Slope piping uniformly between elevations shown.

4. Keep groundwater level in trench at least 12 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.
5. Start laying pipe at lowest point and proceed towards higher elevations, unless otherwise approved by ENGINEER.
6. Place bell and spigot-type pipe so that bells face the direction of laying, unless otherwise approved by ENGINEER.
7. Place concrete pipe containing elliptical reinforcement with minor axis of reinforcement in vertical position.
8. Excavate around joints in bedding and lay pipe so that pipe barrel bears uniformly on trench bottom.
9. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by ENGINEER.
10. For PVC and CPVC piping with solvent welded joints, 2.5-inch diameter and smaller, and copper tubing, snake piping in trench to compensate for thermal expansion and contraction.
11. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above trench before installation. Immediately remove defective materials from the Site and replace with acceptable products.
12. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation. Bell and spigot-type mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before pipe is laid.
13. Field cut pipe, where required, with machine specially designed for cutting the type of pipe being installed. Make cuts carefully, without damage to pipe, coating or lining, and with smooth end at right angles to axis of pipe. Cut ends on push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
14. Do not place blocking under pipe, unless specifically approved by ENGINEER for special conditions.
15. Touch up protective coatings in manner satisfactory to COUNTY prior to backfilling.
16. Notify COUNTY in advance of backfilling operations.
17. On steep slopes, take measures acceptable to ENGINEER to prevent movement of pipe during installation.
18. Thrust Restraint: Where required, provide thrust restraint conforming to Article 3.3 of this Section.
19. Exercise care to avoid flotation when installing pipe in cast-in-place concrete, and in locations with high groundwater.

G. Polyethylene Encasement:

1. Provide polyethylene encasement for ductile iron piping to prevent contact between pipe and surrounding bedding material and backfill.
2. Polyethylene encasement installation shall be in accordance with ANSI/AWWA C105.

H. Jointing Pipe:

1. Ductile Iron Mechanical Joint Pipe:

- a. Immediately before making joint, wipe clean the socket, plain end, and adjacent areas. Taper cut ends and file off sharp edges to provide smooth surface.
- b. Lubricate plain ends and gasket with soapy water or manufacturer's recommended pipe lubricant, in accordance with ANSI/AWWA C111, just prior to slipping gasket onto plain end of the joint assembly.
- c. Place gland on plain end with lip extension toward the plain end, followed by gasket with narrow edge of gasket toward plain end.
- d. Insert plain end of pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
- e. Push gland toward socket and center gland around pipe with gland lip against gasket.
- f. Insert bolts and hand-tighten nuts.
- g. If deflection is required, make deflection after joint assembly and prior to tightening bolts. Alternately tighten bolts approximately 180 degrees apart to seat gasket evenly. Bolt torque shall be as follows:

Pipe Diameter (inches)	Bolt Diameter (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1.25	120 to 150

- h. Bolts and nuts, except those of stainless steel or high strength, low alloy steel, shall be coated with two coats, minimum dry film thickness of eight mils each, of high build solids epoxy or bituminous coating manufactured by Tnemec, or equal.
 - i. Restrained mechanical joints shall be in accordance with Section 15060, Ductile Iron Pipe and Fittings.
2. Ductile Iron Push-On Joint Pipe:
- a. Prior to assembling joints, thoroughly clean with wire brush the last eight inches of exterior surface of spigot and interior surface of bell, except where joints are lined or coated with a protective lining or coating.

- b. Wipe clean rubber gaskets and flex gaskets until resilient. Conform to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.
 - c. Insert gasket into joint recess and smooth out entire circumference of gasket to remove bulges and to prevent interference with proper entry of spigot of entering pipe.
 - d. Immediately prior to joint assembly, apply thin film of pipe manufacturer's recommended lubricant to surface of gasket that will come in contact with entering spigot end of pipe, or apply a thin film of lubricant to outside of spigot of entering pipe.
 - e. For assembly, center spigot in pipe bell and push pipe forward until spigot just makes contact with rubber gasket. After gasket is compressed and before pipe is pushed or pulled in the rest of the way, carefully check gasket for proper position around the full circumference of joint. Final assembly shall be made by forcing spigot end of entering pipe past gasket until spigot makes contact with base of the bell. When more than a reasonable amount of force is required to assemble the joint, remove spigot end of pipe to verify proper positioning of gasket. Do not use gaskets that have been scored or otherwise damaged.
 - f. Maintain an adequate supply of gaskets and joint lubricant at the Site when pipe jointing operations are in progress.
3. Ductile Iron Proprietary Joints:
- a. Install pipe that utilizes proprietary joints for restraint specified in Sections 15060, Ductile Iron Pipe and Fittings or other such joints, in accordance with manufacturer's instructions.
4. Ductile Iron Flanged Joints:
- a. Assemble flanged joints using ring-type gaskets, thickness as recommended by pipe manufacturer but not less than 1/8-inch thick, for raised face flanges. Use full face gaskets for flat face flanges, unless otherwise approved by ENGINEER or recommended by pipe manufacturer. Gaskets shall be suitable for service intended in accordance with manufacturer's ratings and instructions. Gaskets shall be properly centered.
 - b. Bolts shall be tightened as recommended by the manufacturer in sequence that ensures equal distribution of bolt loads.
 - c. Length of bolts shall be uniform. Bolts shall not project beyond the nut more than 1/4-inch when fully tightened. Bolts shall not fall short of the nut when fully taken up. Ends of bolts shall be machine cut and neatly rounded. Do not use washers.
 - d. Prior to assembly, lubricate bolt threads and gasket faces.
 - e. After assembly, coat all bolts and nuts, except those of stainless steel, with two coats, minimum dry film thickness of eight mils each, of high-build epoxy or bituminous coating manufactured by Tnemec, or equal.

5. Steel or Stainless Steel Pipe Joints:
 - a. Joints in steel or stainless steel pipe shall butt welded or lap welded joints, except that mechanical couplings, or flanged connections shall be provided at connections to valves, meters, and similar equipment, and where shown or indicated in the Contract Documents. Mechanical couplings are specified in Section 15120, Piping Specialties and Accessories.
 - b. Welding shall conform to ANSI/AWWA C206.
 - c. After welding, coat the joint and surrounding damaged or uncoated area with same coating and thickness as shop-applied coating.
 - d. Where flanged connections or couplings are provided, flanges, couplings, bolts, and nuts, except when stainless steel, shall be coated with two coats, minimum dry film thickness of eight-mils each, of high-build epoxy or bituminous coating manufactured by Tnemec, or equal.
 - e. Welds shall be free from embedded scale and slag and shall have tensile strength across weld not less than thinnest of connected sections.
 - f. Welds shall be watertight.
 - g. Provide cathodic protection at steel pipe joints as specified in this Section.
6. Thermoplastic Pipe Joints:
 - a. Solvent Cement Welded Joints:
 - 1) Bevel pipe ends and remove all burrs before making joints. Clean pipe and fittings thoroughly. Do not attempt to make solvent cement joints if temperature is below 40 degrees F. Do not make solvent cement welded joints in wet conditions.
 - 2) Use solvent cement supplied or recommended by pipe manufacturer.
 - 3) Apply joint primer and solvent cement and assemble joints in accordance with recommendations and instructions of manufacturer of joint materials and pipe manufacturer.
 - 4) Take appropriate safety precautions when using joint primers and solvent cements. Allow air to circulate freely through pipelines to allow solvent vapors to escape. Slowly admit water when flushing or filling pipelines to prevent compression of gases within pipes.
 - b. Bell and Spigot Joints:
 - 1) Bevel pipe ends, remove all burrs, and provide a reference mark at correct distance from pipe end before making joints.
 - 2) Clean spigot end and bell thoroughly before making the joint. Insert O-ring gasket while ensuring that gasket is properly oriented. Lubricate spigot with manufacturer's recommended lubricant. Do not lubricate bell and O-ring. Insert spigot end of pipe carefully into bell until reference mark on spigot is flush with bell.
7. Mechanical Coupling Joints:

- a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end couplings, plasticized PVC couplings, and other mechanical couplings specified in Section 15120, Piping Specialties and Accessories.
- b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with wire brush to remove foreign matter.
- c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet metal to metal, joint is complete and further tightening is not required.
- d. For plasticized PVC couplings, loosen the stainless steel clamping bands and remove clamps from coupling. Slide coupling over plain ends of pipes to be joined without using lubricants. Place clamps over each end of coupling at grooved section and tighten with torque wrench to torque recommended by manufacturer.

I. Backfilling:

1. Conform to applicable requirements of Section 02221, Trenching, Bedding, and Backfill for Pipe.
2. Place backfill as Work progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of backfill.

J. Connections to Valves and Hydrants:

1. Install valves and hydrants as shown and indicated in the Contract Documents.
2. Provide suitable adapters when valves or hydrants and piping have different joint types.
3. Provide thrust restraint at all hydrants and at valves located at pipeline terminations.

K. Closures:

1. Provide closure pieces shown or required to complete the Work.

3.2 TRACER TAPE INSTALLATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:

1. Provide polyethylene tracer tape for buried metallic piping, which includes pipe that is steel, ductile iron, cast iron, concrete, copper, and corrugated metal.
2. Provide tracer tape 12 to 18 inches below finished grade, above and parallel to

- buried pipe.
 - 3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along pipe centerline.
 - 4. Tape shall be spread flat with message side up before backfilling.
- B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
- 1. Provide polyethylene tracer tape with aluminum backing for buried, non-metallic piping, which includes pipe that is PVC, CPVC, polyethylene, HDPE, FRP, ABS, and vitrified clay.
 - 2. Provide magnetic tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
 - 3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along the pipe centerline.
 - 4. Tape shall be spread flat with message side up before backfilling.

3.3 THRUST RESTRAINT

- A. Provide thrust restraint on pressure piping systems where shown or indicated in the Contract Documents.
- B. Thrust restraint shall be accomplished by using restrained pipe joints. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Buried Piping Schedule at the end of this Section.
- C. Restrained Pipe Joints:
- 1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
 - a. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with proprietary restrained joint system as specified in Sections 15060, Ductile Iron Pipe and Fittings.
 - b. Steel Pipe Joints: Provide butt-welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Buried Piping Schedule in this Section. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.
 - c. Thermoplastic and HDPE Joints: Where bell and spigot-type or other non-restrained joints are utilized, provide tie rods across joint or other suitable joint restraint system, subject to the approval of ENGINEER.
 - d. Joints for Concrete Pipe Other than Prestressed Concrete Cylinder Pipe: Restrain joints utilizing clamp type restrained joint or snap ring-type restrained joint.

3.4 WORK AFFECTING EXISTING PIPING

- A. Location of Existing Underground Facilities:
 - 1. Locations of existing Underground Facilities shown on the Drawings should be considered approximate.
 - 2. Determine the true location of existing Underground Facilities to which connections are to be made, crossed, and that could be disturbed, and determine location of Underground Facilities that could be disturbed during excavation and backfilling operations, or that may be affected by the Work.
- B. Work on Existing Pipelines or Underground Facilities:
 - 1. Cut or tap piping or Underground Facilities as shown or required with machines specifically designed for cutting or tapping pipelines or Underground Facilities, as applicable.
 - 2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
 - 3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
 - 4. Conform to applicable requirements of Section 01730, Operating and Maintenance Data, Section 01045, Cutting and Patching, and Section 02064, Modifications to Existing Structures, Piping, and Equipment.

3.5 FIELD QUALITY CONTROL

- A. General:
 - 1. Test all piping, except as exempted in the Buried Piping Schedule in this Section.
 - 2. When authorities having jurisdiction are to witness tests, notify COUNTY and authorities having jurisdiction in writing at least 48 hours in advance of testing.
 - 3. Conduct all tests in presence of COUNTY.
 - 4. Remove or protect pipeline-mounted devices that could be damaged by testing.
 - 5. Provide all apparatus and services required for testing, including:
 - a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain COUNTY's operations.
 - b. Temporary bulkheads, bracing, blocking, and thrust restraints.
 - 6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
 - 7. Unless otherwise specified, COUNTY will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into piping being tested. CONTRACTOR shall provide fluid for other types of testing required.

8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of COUNTY. Unless otherwise included in the Work, repair of existing piping or Underground Facilities will be paid as extra Work.

B. Test Schedule:

1. Refer to the Buried Piping Schedule in this Section for type of test required and required test pressure.
2. Unless otherwise specified, required test pressures are at lowest elevation of pipeline segment being tested.
3. For piping not listed in Buried Piping Schedule in this Section:
 - a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires separate test.
 - b. Use exfiltration testing, low-pressure air testing, or vacuum testing for other piping.
 - c. Disinfect for bacteriological testing piping that conveys potable water.
4. Test Pressure:
 - a. Use test pressures listed in Buried Piping Schedule in this Section.
 - b. If test pressure is not listed in Buried Piping Schedule, or if test is required for piping not listed in the Buried Piping Schedule, test pressure will be determined by ENGINEER based on maximum anticipated sustained operating pressure and methods described in applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:

1. Preparation for Testing:
 - a. For thermoplastic pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
 - b. For steel pipe, follow procedures described in ANSI/AWWA Manual M11. Wetting period is not required for pipe that is not cement-lined.
 - c. For other piping follow procedures described in ANSI/AWWA Manual M9. Wetting period is not required for pipe that is not cement mortar-lined.
 - d. Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
2. Test Procedure:

- a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
 - b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
 - c. Examine exposed joints and valves, and make repairs to eliminate visible leakage.
 - d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
 - e. Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
 - f. Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three hour expansion phase, reduce test pressure by ten psig and do not add liquid. Test pressure shall then remain steady for one hour, indicating no leakage.
 - g. Pump from test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at 15 minute intervals for duration of test.
3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of test pressure during timed test period. Allowable leakage rates for piping are:
 - a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
 - b. Rates based on formula or table in ANSI/AWWA Manual M41:
 - 1) Metal pipe joined with rubber gaskets as sealing members, including the following joint types:
 - a) Bell and spigot and push-on joints.
 - b) Mechanical joints.
 - c) Bolted sleeve type couplings.
 - d) Grooved and shouldered couplings.
 - c. Rates based on formula or table in ANSI/AWWA C605:
 - 1) Plastic pipe joined with O-ring gasket sealing members.
- D. Exfiltration Testing:
1. Plug and bulkhead ends and lateral connections of pipe segment to be tested and admit fluid until the pipe is full. Admit fluid slowly to minimize air entrapment. Groundwater level shall be below the pipe during exfiltration test.
 2. Before measuring leakage, allow fluid to wet pipe interior for the following period:
 - a. Concrete Pipe: 48 hours.

- b. Other Pipe: Wetting period not required.
- 3. Maintain hydrostatic head during test to equal an elevation two feet above present and future maximum groundwater elevation at pipe segment tested. ENGINEER will determine test water surface elevation for each pipe segment.
- 4. Provide minimum hydrostatic head during test of two feet above crown of upstream end of pipe segment tested.
- 5. Add fluid from test container or from metered supply as required to maintain test water level within three inches of test head throughout the test.
- 6. Test duration shall be at least two hours.
- 7. Allowable Leakage Rates:
 - a. Leakage is defined as the quantity of fluid that must be supplied to pipe segment tested to maintain hydrostatic head within three inches of test head during the test after pipe has been filled and exposed to required wetting period, plus quantity required to refill to original head at end of test.
 - b. Leakage shall not exceed that allowed by authority having jurisdiction, but in any event shall not exceed 4 gallons per inch diameter per mile per hour.

E. Vertical Deflection Test for Thermoplastic Pipe:

- 1. Conduct vertical deflection test at least thirty days after backfill has been placed.
- 2. Use rigid ball or mandrel for deflection test, which shall have diameter of at least 95 percent of base inside diameter or average inside diameter of piping, depending on which is specified in applicable ASTM standard, including appendix, to which pipe is manufactured. Perform test without mechanical pulling devices. Re-install and retest pipe segments that exceed deflection of five percent.

F. Process Air Pipe Testing:

- 1. General:
 - a. Test pipe before backfilling pipe trench.
 - b. Maintain groundwater level below bottom of trench until test is successfully completed.
 - c. Required test pressure is listed in Buried Piping Schedule.
- 2. Preparation for Testing:
 - a. Provide temporary tie rods at expansion joints as required.
 - b. Verify that pipe supports, where present, are secure.
 - c. Test one pipe segment at a time. Use temporary blind flanges and isolators as required.
 - d. Install corporation cocks for filling and relieving air. Provide temporary automatic pressure relief valve and pressure gauge with range suitable for test pressure.

3. Test Procedure:
 - a. Pressurize pipe segment being tested with air to required test pressure. Maintain pressure for at least two hours.
 - b. Apply soapy water solution to all joints to check for leakage, indicated by presence of bubbles, while test pressure is maintained.
 - c. Allowable Leakage: Zero
4. Repair and retest pipelines that fail test.
5. After testing is complete remove temporary measures provided for testing and provide Type 304 stainless steel threaded plugs at taps used for testing.
6. Pressure Testing:
 - a. Fill pipe with water and hydrostatically test in accordance with Paragraph 3.5.C of this Section.
 - b. Hydrostatic test pressure shall be in accordance with the Buried Piping Schedule in this Section. When hydrostatic test pressure is not specified in Buried Piping Schedule, for pressure piping use test pressure of 1.5 times maximum operating pressure to which system may be subjected. If not otherwise specified in the Buried Piping Schedule, hydrostatically test vacuum piping to at least 25 psig.
 - c. After hydrostatic testing, replace all moisture absorbing gaskets and valve packing.
 - d. Stainless Steel Pipe: If drying after hydrostatic testing is impractical or cannot be accomplished, test steel piping by either pneumatic testing or alternate testing (weld examination) in accordance with Chlorine Institute Pamphlet No. 6. When performing pneumatic test, implement precautions to safeguard personnel and minimize risk.
7. Drying:
 - a. Steel Pipe: Accomplish drying by passing steam through piping from high end of system until piping is heated to approximately 200 degrees F unless lower temperature is required to protect system from damage. While steaming, allow condensate and foreign matter to drain from pipe. Disconnect steam supply and drain pockets and low spots in pipe. While pipe is still warm, blow dry, oil-free air with dew point of -40 degrees F or below, or nitrogen, through pipe until exiting air dew point is equal to supply air dew point. Valves shall be at half-open position during drying. Valves removed temporarily from system during drying must be free of moisture before being re-installed.

G. Examination of Welds:

1. Personnel performing examination of welds shall be qualified to at least Level II in accordance with ASNT SNT-TC-1A.
2. Conform to ASME Boiler and Pressure Vessel Code Section V and applicable articles for examination of welds.
3. Visually examine all welds, Category D Fluid Service, in conformance with

ASME B31.3.

4. Examine at least ten percent of welds using liquid penetrant examination.
5. If defect is detected, all welds shall be examined by liquid penetrant examination.
6. At conclusion of liquid penetrant examination, remove penetrant test materials by flushing, washing, or wiping clean with applicable solvents.

H. Bacteriological Testing:

1. Bacteriological testing for potable water lines, finished water lines, and other piping in accordance with the Buried Piping Schedule, is specified in Paragraph 3.6 of this Section.

3.6 CLEANING AND DISINFECTION

A. Cleaning, General: Clean pipe systems as follows:

1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in manner approved by ENGINEER, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water.
2. Piping 24-inch diameter and larger shall be inspected from inside and debris, dirt and foreign matter removed.
3. For piping that requires disinfection and has not been kept clean during storage or installation, swab each section individually before installation with five percent sodium hypochlorite solution.

B. Cleaning of Gas and Air Piping:

1. Unless otherwise specified, gas and air system piping six-inch diameter and smaller shall be blown out, using air or testing medium specified. Piping larger than six-inch diameter shall be cleaned by having a swab or "pig" drawn through each pipe reach.
2. After connecting to equipment, blow out pipe using the equipment.
3. Upon completion of cleaning, piping shall be drained and dried with blown air. Propane systems shall be purged with nitrogen and nitrogen pad maintained at ten psi until pipe is placed in service. Purge digester gas systems with nitrogen and maintain nitrogen pad at three psi until line is placed in service.

3.7 SCHEDULES

A. Schedules listed below, following the "End of Section" designation, are part of this Specification section.

1. Table 15051-A, Buried Piping Schedule.

TABLE 15051-A, BURIED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Testing	Remarks
Storage Pond Water	20 & 30	DI	CL	AC/PEW	250	RPOJ	HYD (150)	
Lake Filter Effluent	36	DI	CL	AC/PEW	250	RPOJ	HYD (150)	
Filter Backwash Waste	4	PVC	N/A	P	Sch 80	SW	HYD (150)	
Filter Backwash Waste	8	DI	CL	AC/PEW	250	RPOJ	HYD (150)	
Spray Nozzle Reclaim Water	2 and 4	PVC	N/A	P	Sch 80	SW	HYD (150)	
Sodium Hypochlorite (12.5%)	2 & 1	PVC	N/A	P	Sch 80	SW	HYD (150)	Double contained PVC everywhere outside metering skid
Sodium Hypochlorite Sample Line	½	PVC	N/A	P	Sch 80	SW	HYD (150)	
Sodium Hypochlorite Drain Line	½	PVC	N/A	P	Sch 80	SW	HYD (150)	

B. Material Abbreviations

Material	Abbrev		Material	Abbrev.
Ductile Iron	DI		Polyvinyl Chloride	PVC
Cast Iron	CI		Chlorinated Polyvinyl Chloride	CPVC
Carbon Steel	CS		Polyethylene	PE
Stainless Steel	SS		High Density Polyethylene	HDPE
Copper	C		Fiberglass Reinforced Plastic	FRP
Corrugated Metal Pipe	CMP		Acrylonitrile Butadiene Styrene	ABS
Reinforced Concrete Pipe	RCP		Vitrified Clay	VC

C. Lining/Coating Abbreviations

Lining	Abbrev		Coating	Abbrev.
Cement Mortar Lined	CL		Asphaltic Coated	AC
Glass Lined	GL		Polyethylene Wrapped	PEW
Ceramic Epoxy	CE		Painted	P
Fusion Bonded Epoxy Lined	FBEL		Fusion Bonded Epoxy Coated	FBEC
Plastic Lined	PL		Insulated	I
			Galvanized	Galv

D. Joint Abbreviations

Joint Type	Abbrev		Joint Type	Abbrev.
Bell and Spigot	BS		Butt Weld	BW
Restrained Bell and Spigot	RBS		Lap Weld	LW
Push-on Joint	POJ		Butt Fusion Weld	BFW
Restrained Push-on Joint	RPOJ		Solvent Weld	SW
Mechanical Joint	MJ		Sleeve-type Flexible Coupling	SLFC
Restrained Mech. Joint	RMJ		Split Flexible Coupling	SPFC
Soldered	Sd		Plasticized PVC Coupling	PPVC
Brazed	Bz		Grooved or Shouldered End Coupling	GSEC
Threaded	Thd		Flanged	Flg
Compression Sleeve Coupling	CSC		Compression Flange Adapter	CFA

E. Test Abbreviations

Test	Abbrev		Test	Abbrev.
Hydrostatic Test (test pressure in psig)	HYD ()		Process Air Pipe Test (test pressure in psig)	PA ()
Exfiltration	EX		Chlorine Pipe Test	CL
Low-pressure Air Sewer Test	AIR		Disinfection and Bacteriological Testing	DBT
Vacuum Test	VAC		Examination of Welds	EW
Vertical Deflection	VD		No Test Required	NR
Televised Inspection	TV			

++ END OF SECTION ++

SECTION 15052

EXPOSED PIPING INSTALLATION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to install and test all exposed piping, fittings, and specials. The Work includes the following:
 - a. All types and sizes of exposed piping, except where exposed piping installations are specified under other Sections.
 - b. Unless otherwise shown or specified, this Section includes all piping beginning at the outside face of structures or structure foundations and extending into the structure. Piping embedded in concrete within a structure or foundation shall be considered as exposed and is included herein. Piping that is permanently or intermittently submerged, or installed in sub-aqueous environments, is considered as exposed and is included in this Section.
 - c. Work on or affecting existing exposed piping.
 - d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all Work required for a complete exposed piping installation.
 - e. Supports, restraints, and other anchors.
 - f. Field quality control, including testing.
 - g. Cleaning and disinfecting.
 - h. Incorporation of valves, meters, and special items shown or specified into the piping systems per the Contract Documents and as required.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before exposed piping Work.
2. Coordinate with appropriate piping Sections of Division 15, Mechanical.

C. Related Sections:

1. Section 01730, Operating and Maintenance Data.
2. Section 02064, Modifications to Existing Structures, Piping and Equipment.
3. Section 09900, Coatings.
4. Section 10400, Identification Devices.
5. Section 15055, Pipe Hangers and Supports.
6. Section 15060, Ductile Iron Pipe and Fittings.

7. Section 15068, Thermoplastic Pipe.
8. Section 15120, Piping Specialties and Accessories.

1.2 REFERENCES

- A. Standards referenced in this Section are:
1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
 2. ASME Boiler and Pressure Vessel Code.
 3. ASTM A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 4. ASTM D4174, Standard Practice for Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems.
 5. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 6. ANSI/AWWA C206, Field Welding of Steel Water Pipe.
 7. ANSI/AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.
 8. ANSI/AWWA C651, Disinfecting Water Mains.
 9. AWWA M11, Steel Pipe - A Guide for Design and Installation.
 10. AWWA M23, PVC Piping - Design and Installation.
 11. AWWA M41, Ductile-Iron Pipe and Fittings.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Comply with requirements and recommendations of authorities having jurisdiction over the Work, including:
 - a. NFPA Standard No. 24 for ("outside protection" to fire protection systems.
 - b. UL, FM and other jurisdictional authorities.
 - c. NSF 61 for surfaces in contact with water supply systems.
 - d. Local regulatory agencies.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following Shop Drawings:
1. Detailed drawings in plan and, as applicable, section.
 2. Details of piping, valves, hangers, supports, accessories, specials, joints, harnessing, and main anchor supports, and connections to existing piping, structures, equipment, and appurtenances.
 3. Submit layout, location, and details of hanger and support systems used for all piping systems according to Section 15055, Pipe Hangers and Supports.
 4. Submit description of proposed testing methods, procedures, and apparatus, and obtain ENGINEER's approval prior to testing.

5. Laying schedules for piping.
- B. Test Reports:
 1. Submit copies of testing report for each test.
- C. Certificates:
 1. Submit a certificate signed by manufacturer of each product certifying:
 - a. That product conforms to applicable referenced standards.
 - b. Welder's Certificate to comply with Paragraph 3.5.F.
- D. Record Documents:
 1. Maintain accurate and up-to-date record documents showing field and Shop Drawing modifications. Record documents for exposed piping Work shall show actual location of all piping and appurtenances on a copy of the Drawings, unless otherwise approved by ENGINEER.
 2. Record documents shall show piping with elevations referenced to the project datum and dimensions from permanent structures. For straight runs of pipe provide offset dimensions as required to document pipe location.
 3. Include section drawings with exposed piping record documents when the Contract Documents include section Drawings.
 4. Conform to Section 01782, Project Record Documents.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Delivery:
 1. Deliver products to Site to ensure uninterrupted progress of the Work.
 2. Upon delivery, inspect pipe and appurtenances for cracked, gouged, chipped, dented, and other damage and immediately remove damaged products from Site.
 3. Conform to requirements of Section 01620, Part 1.03, Storage and Protection.
- B. Storage:
 1. Store products for convenient access for inspection and identification. Store products off the ground using pallets, platforms, or other supports. Protect packaged products from corrosion and deterioration.
 2. Pipe and fittings other than thermoplastic materials may be stored outdoors without cover. Thermoplastic pipe and fittings stored outdoors shall be covered.
 3. Conform to requirements of Section 01620, Storage and Protection.
- C. Handling:
 1. Handle pipe, fittings, specials, and accessories carefully with approved handling devices. Do not drop or roll material of delivery vehicles. Do not otherwise drop, roll, or skid piping.

2. Avoid unnecessary handling of pipe.
3. Keep pipe interiors free of dirt and foreign matter.
4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage. Repair damaged coatings.
5. Conform to requirements of 01620, Part 1.03, Storage and Protection.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Piping materials are specified in the Exposed Piping Schedule at the end of this Section. Piping materials shall conform to Specification for each type of pipe and piping appurtenances in applicable sections of Division 15, Mechanical.
- B. Markings and Identification:
 1. Pipe Markings:
 - a. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
 - b. Manufacturer shall cast or paint on each length of pipe and each fitting the pipe material, diameter, and pressure or thickness class.
 2. Pipe Identification Markers and Arrows: Refer to Section 10400, Identification Devices.
- C. Appurtenances: Provide products that conform to:
 1. Section 15055, Pipe Hangers and Supports.
 2. Section 15120, Piping Specialties and Accessories.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. General:
 1. Install piping as shown, specified and as recommended by the pipe and fittings manufacturer.

2. If there is a conflict between manufacturer's recommendations and the Contract Documents, request in writing instructions from ENGINEER before proceeding.
 3. Provide pipe manufacturer's installation specialist at Site as specified on this Section.
- B. Temporary Blind Flanges, Plugs, Caps, and Bulkheads:
1. Temporarily plug installed pipe at the end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
 2. Install standard plugs in all bells at dead ends, tees, and crosses. Cap all spigot and plain ends.
 3. Fully secure and block blind flanges, plugs, caps, and bulkheads installed for testing, designed to withstand specified test pressure.
 4. Where plugging is required for phasing of Work or subsequent connection of piping, install watertight, permanent type blind flanges, plugs, caps, or bulkhead acceptable to ENGINEER.
- C. Piping Installation:
1. Conform to manufacturer's instructions and requirements of standards and manuals listed in this Section, as applicable:
 - a. Ductile Iron Pipe: ANSI/AWWA C600, AWWA M41.
 - b. Concrete Pipe: AWWA M9.
 - c. Steel Pipe: ASME B31.3, ANSI/AWWA C206, AWWA M11.
 - d. Thermoplastic Pipe: AWWA M23
 2. Install straight runs true to line and elevation.
 3. Install vertical pipe truly plumb in all directions.
 4. Install piping parallel or perpendicular to walls of structures. Piping at angles and 45 degree runs across corners of structures will not be accepted unless specifically shown on the Contract Documents or approved by ENGINEER.
 5. Install small diameter piping generally as shown when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, and other obstructions.
 6. Install piping to leave all corridors, walkways, work areas, and similar spaces unobstructed. Unless otherwise approved by ENGINEER provide a minimum headroom clearance under piping and pipe supports of 7.5 feet. Clearances beneath piping shall be measured from the outermost edge of piping, flanges or other type of joint that extends beyond the nominal outside diameter of piping.
 7. Protect and keep clean interiors, fittings, and valves of pipe that will convey potable water, chemicals, and other pipe designated by ENGINEER.
 8. Cutting: Cut pipe from measurements verified at Site. Field cut pipe, where required, with a machine specially designed for cutting type of pipe being installed. Make cuts carefully without damage to pipe, coating, or lining, and

with a smooth end at right angles to axis of pipe. Cut ends of push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.

9. Additional General Requirements for Thermoplastic Piping:

- a. Utilize wide band supports as recommended by pipe manufacturer and approved by ENGINEER to minimize localized stresses.
- b. Provide piping passing through walls with a sleeve of wearing material to prevent abrasion damage to piping.
- c. Provide anchored supports at elbows, valves, bends in piping, and at connections to equipment and tanks.
- d. Spacing of supports shall be in accordance with the manufacturer's published recommendations at maximum design operating temperature of pipe.
- e. Provide U-clamps with wide band circumferential contact.
- f. Provide guides on long runs of piping to maintain alignment and reduce chance of elastic failure of pipe. Space guides as recommended by pipe manufacturer.
- g. Provide anchored supports to restrain joints that allow expansion. Minimize use of bellows style joints. Where required and approved by the ENGINEER provide bellows style joints with low axial force to take up pipe expansion. Flexible connectors may be used to absorb thermal movement when approved in writing by ENGINEER.
- h. Provide devices that will reduce hydraulic pulsation in piping, together with shut-off and drain valve on all discharge lines of positive displacement pumps to reduce hydraulic hammer, and provide flexible connectors to absorb vibration. Submit details for ENGINEER to review.

D. Jointing Pipe:

1. General:

- a. Make joints in accordance with pipe manufacturer's recommendations and Contract Documents.
- b. Cut piping accurately and squarely and install without forcing or springing.
- c. Ream out pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
- d. Remove all cuttings and foreign matter from inside of pipe and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.

2. Ductile Iron and Steel Flanged Joints:

- a. Assemble flanged joints using ring-type gaskets, with thickness as recommended by pipe manufacturer but not less than 1/8-inch thick, for raised-face flanges. Use full-face gaskets for flat-face flanges, unless otherwise approved by ENGINEER or recommended by pipe manufacturer. Gaskets shall be suitable for the service intended in

accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.

- b. Tighten bolts in a sequence that provides equal distribution of bolt loads.
- c. Length of bolts shall be uniform. Bolts shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. Machine-cut ends of bolts to be neatly rounded. Do not use washers.
- d. Prior to assembly of flanged joints, lubricate bolt threads and gasket faces.
- e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.
- f. After assembly, coat all bolts and nuts, except stainless steel bolts and nuts, with same coating specified in Section 09900, Coatings, for material of pipe and fittings being joined.

3. Field Welded Steel Pipe Joints:

- a. Joints in steel pipe shall be butt welded or lap welded, except that flexible couplings, mechanical couplings, or flanged connections shall be provided at connections to valves, meters, and similar equipment, and where shown or specified.
- b. Welding procedures and welder qualifications shall conform to ASME Boiler and Pressure Vessel Code Section IX or to American Welding Society Structural Welding Code D1.1/D1.1M, Section 5, whichever is required. Welding of steel water pipe shall conform to the requirements of AWWA C206.
- c. For all piping, submit current certificates that all welders and welding operators have been qualified in accordance with ASME Boiler and Pressure Vessel Code Section IX or American Welding Society Structural Welding Code D1.1/D1.1M, Section 5, whichever is required.
- d. Conform to field welding procedures recommended by pipe manufacturer and as specified herein.
- e. Clean ends to be welded up to at least 1/2-inch beyond the estimated toe of weld by sandblasting or other means to remove surface contamination such as paint, oil, grease, scale, oxide, rust, and other contamination.
- f. Verify that ends to be welded are adequately prepared in shop for welding.
- g. Provide full penetration welds, free of cracks, overlap and cold laps.
- h. Preheat and interpass temperatures shall be not less than 60 degrees F and not more than 350 degrees F, respectively.
- i. Limit on Undercut: 1/32-inch or ten percent of base metal thickness, whichever is less.
- j. For pipe wall thickness up to 11-gauge (0.125-inch) use GTAW (Gas Tungsten Arc Welding).
- k. For pipe wall thickness greater than 11-gauge, use GTAW root pass followed by GMAW (Gas Metal Arc Welding) or SMAW (Shielded Metal Arc Welding) Cap.

- l. Where required for pipes 36-inch diameter and larger, and heavier-wall pipes, provide joints double beveled and welded from both inside and outside with the flux core process.
 - m. Provide internal inert gas purge to exclude atmosphere.
 - n. Filler Wire: ELC grade, of matching composition or of higher molybdenum content.
 - o. Weld Thickness: Equal to or greater than parent metal. Strength of welded joints shall be equal to or greater than strength of pipes being joined.
 - p. All welds shall be smooth with an internal crown of 1/16-inch or less, and external crown of 3/32-inch or less.
 - q. For grinding operations, use iron-free grinding wheels.
 - r. After welding, joint and the surrounding damaged or uncoated area shall be coated with same coating and thickness as shop applied coating.
 - s. Tack Welds: Make tack welds when required to aid in joining, with same grade of filler metal as for finished welds. For finish welding, either completely remove tack welds or grind starting and finishing ends of tack welds for incorporation into finished welds.
 - t. Clean and de-scale all welds per ASTM A380.
- 4. Steel Pipe Threaded Joints:
 - a. For threaded joints, use standard, right hand tapered full depth threads on steel piping and apply a manufacturer's recommended joint compound to male threads only, before installation.
 - b. Remove cuttings and foreign matter from inside of pipe.
 - c. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
- 5. Thermoplastic Pipe Joints:
 - a. Solvent Cement Welded Joints:
 - 1) Bevel pipe ends and remove all burrs before making joint. Clean pipe and fittings thoroughly. Do not make solvent cement joints if temperature is below 40 degrees F. Do not make solvent cement welded joints in wet conditions.
 - 2) Use solvent cement supplied or recommended by pipe manufacturer.
 - 3) Apply joint primer and solvent cement and assemble joints in accordance with recommendations and instructions of manufacturer of joint materials and pipe manufacturer.
 - 4) Implement appropriate safety precautions when using joint primers and solvent cements. Allow air to circulate freely through pipelines to allow solvent vapors to escape. Slowly admit fluid when flushing or filling pipelines to prevent compression of gases within pipes.
- 6. Mechanical Coupling Joints:
 - a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end

couplings, plasticized PVC couplings, and other mechanical couplings used.

- b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with a wire brush to remove foreign matter.
- c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet metal to metal, joint is complete and further tightening is not required.
- d. For plasticized PVC couplings, loosen the stainless steel clamping bands and remove the clamps from the coupling. Slide the coupling over the plain ends of the pipes to be joined without using lubricants. Place clamps over each end of coupling at grooved section and tighten with a torque wrench to torque recommended by manufacturer.

E. Installing Valves and Accessories:

1. Provide supports for large valves, flow meters, and other heavy items as shown or required to prevent strain on adjoining piping.
2. Position flow measuring devices in pipe lines so that they have the amount of straight upstream and downstream runs recommended by the flow measuring device manufacturer, unless specific location dimensions are shown.
3. Position swing check valves and butterfly valves so that they do not conflict with upstream and downstream elements of the piping system.

F. Unions:

1. Install dielectric unions, where dissimilar metals are connected, except for bronze or brass valves in ferrous piping.
2. Provide a union downstream of each valve with screwed connections.
3. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

G. Closures:

1. Provide closure pieces, such as blind flanges and caps, shown or required to complete the Work.

3.3 THRUST RESTRAINT

- A. Provide thrust restraint on all pressure piping systems and where otherwise shown or specified.

- B. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Exposed Piping Schedule at end of this Section.
- C. Restrained Pipe Joints:
 - 1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
 - a. Steel Pipe Joints: Provide butt-welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Exposed Piping Schedule. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.

3.4 WORK AFFECTING EXISTING PIPING

- A. Location of Existing Piping:
 - 1. Locations of existing piping shown on Drawings is approximate.
 - 2. Determine the true location of existing piping to which connections are to be made, crossed, and that could be disturbed, and determine location of other facilities that could be affected by the Work.
- B. Work on Existing Pipelines:
 - 1. Cut or tap pipes as shown or required with machines and tools specifically designed for cutting or tapping pipelines.
 - 2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
 - 3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
 - 4. Conform to applicable requirements of Section 01730, Operating and Maintenance Data and Section 02064, Modifications to Existing Structures, Piping and Equipment.

3.5 PAINTING

- A. Field painting shall conform to Section 09900, Coatings.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Installation Specialist:
 - 1. Provide services of a competent installation specialist of the pipe manufacturer when pipe installation commences for site welded stainless steel pipe.
 - 2. Retain installation specialist at Site for a minimum of 1 day (eight hours per day at the Site) or until competency of the pipe installation crew has been satisfactorily demonstrated to COUNTY.

B. Testing, General:

1. Test all piping, except as exempted in the Exposed Piping Schedule.
2. Notification:
 - a. Notify COUNTY at least 48 hours prior to testing.
 - b. When authorities having jurisdiction are to witness tests, notify COUNTY and authorities having jurisdiction in writing at least 48 hours in advance of testing.
3. Conduct all tests in presence of COUNTY.
4. Remove or protect pipeline-mounted devices that could be damaged by testing.
5. Provide all apparatus and services required for testing, including:
 - a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain COUNTY's operations.
 - b. Temporary bulkheads, bracing, blocking, and thrust restraints.
6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
7. Unless otherwise specified, COUNTY will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into the pipe being tested. CONTRACTOR shall provide fluid for other types of testing required.
8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.

C. Test Schedule:

1. Refer to the Exposed Piping Schedule for type of test required and required test pressure.
2. Unless otherwise specified, the required test pressures are at lowest elevation of pipeline segment being tested.
3. For piping not listed in Exposed Piping Schedule:
 - a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires a separate test.
 - b. Disinfect for bacteriological testing piping that conveys potable water.
4. Test Pressure:
 - a. Use test pressures listed in Exposed Piping Schedule.
 - b. If test pressure is not listed in Exposed Piping Schedule, or if a test is required for piping not listed in the Exposed Piping Schedule, test pressure will be determined by ENGINEER based on the maximum anticipated sustained operating pressure and the methods described in the applicable ANSI/AWWA manual or standard that applies to the piping system.

D. Hydrostatic Testing:

1. Preparation for Testing:

- a. For thermoplastic pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
- b. For steel pipe, follow procedures described in AWWA Manual M11. Wetting period is not required for pipe that is not cement-lined.
- c. For other piping follow procedures described in AWWA Manual M9. A wetting period is not required for pipe that is not cement mortar-lined.
- d. Prior to testing, ensure that adequate thrust protection is in place and all joints are properly installed.
- e. Piping for Hydraulic Fluid, Lube Oil, and Diesel Fuel: Hydrostatically test system using the fluid with which system will function permanently. Allowable leakage is zero. For fluid power systems, manufacturer shall supervise installation and testing of system components, including field piping.

2. Test Procedure:

- a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in the pipe being tested.
- b. Expel air from pipe as required. Obtain approval of COUNTY prior to tapping pipe for expelling air.
- c. Examine joints and valves, and make repairs to eliminate visible leakage.
- d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
- e. Timed test period shall not begin until after the pipe has been filled, exposed to the required wetting period, air has been expelled, and pressure stabilized.
- f. Timed Test Period: After the stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. The test pressure shall then remain steady for one hour, indicating no leakage.
- g. Pump from a test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at fifteen minute intervals for duration of test.

3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of the test pressure during timed test period. Allowable leakage rates for piping are:

- a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.

E. Process Air Pipe Testing:

1. General:

- a. Required test pressure is listed in Exposed Piping Schedule.

2. Preparation for Testing:
 - a. Provide temporary tie rods at expansion joints as required.
 - b. Verify that pipe supports, where present, are secure.
 - c. Test one pipe segment at a time. Use temporary blind flanges and isolators as required.
 - d. Install corporation cocks for filling and relieving air. Provide temporary automatic pressure relief valve and pressure gauge with range suitable for test pressure.
 3. Test Procedure:
 - a. Pressurize pipe segment being tested with air to the required test pressure. Maintain pressure for at least two hours.
 - b. Apply a soapy water solution to all joints to check for leakage, indicated by presence of bubbles, while test pressure is maintained.
 - c. Allowable Leakage: Zero
 4. Repair and retest pipelines that fail the test.
 5. After testing is complete remove temporary measures provided for testing and provide Type 304 stainless steel threaded plugs at taps used for testing.
- F. Examination of Welds:
1. Personnel performing examination of welds shall be qualified to at least Level II, in accordance with ASNT SNT-TC-1A.
 2. Conform to ASME Boiler and Pressure Vessel Code Section V and applicable articles for examination of welds.
 3. Visually examine all welds, Category D Fluid Service, in conformance with ASME B31.3.
 4. Examine at least ten percent of welds using liquid penetrant examination.
 5. If a defect is detected, all welds shall be examined by liquid penetrant examination.
 6. At conclusion of liquid penetrant examination, remove penetrant test materials by flushing, washing, or wiping clean with applicable solvents.
- G. Bacteriological Testing:
1. Bacteriological testing for potable water lines, finished water lines, and other piping per Exposed Piping Schedule, is specified in Article 3.6 of this Section.

3.7 CLEANING AND DISINFECTION

- A. Cleaning, General: Clean pipe systems as follows:
1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in a manner approved by ENGINEER, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water.
 2. Piping 24-inch diameter and larger shall be inspected from inside and debris, dirt and foreign matter removed.

3. For piping that requires disinfection and has not been kept clean during storage or installation, swab each section individually before installation with a five percent hypochlorite solution.

B. Cleaning of Gas and Air Piping:

1. Unless otherwise specified, non-chlorine gas and air system piping 6-inch diameter and smaller shall be blown out, using air or the testing medium specified. Piping larger than 6-inch diameter shall be cleaned by having a swab or "pig" drawn through each pipe reach.
2. After connecting to equipment, blow out pipe using the equipment.
3. Upon completion of cleaning, piping shall be drained and dried with blown air. Propane systems shall be purged with nitrogen and a nitrogen pad maintained at ten psi until put in service. Digester gas systems shall be purged with nitrogen and a nitrogen pad maintained at three psi until put in service.

3.8 EXPOSED PIPING SCHEDULE

- A. The schedules listed below, following the "End of Section" designation, are a part of this Specification section.
1. Table 15052-A, Exposed Piping Schedule.

TABLE 15052-A, EXPOSED PIPING SCHEDULE

Service	Diameter (inch)	*Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Testing	Remarks
Storage Pond Water	20	DI	CL	AC/PEW	250	FL	HYD (150)	
Lake Filter Effluent	20	DI	CL	AC/PEW	250	FL	HYD (150)	
Filter Backwash Waste	4	PVC	N/A	P	Sch 80	SW	HYD (150)	
Spray Nozzle Reclaim Water	2	PVC	N/A	P	Sch 80	SW	HYD (150)	
Sodium Hypochlorite (12.5%)	2 & 1	PVC	N/A	P	Sch 80	SW	HYD (150)	Double contained PVC everywhere outside metering skid
Sodium Hypochlorite Sample Line	½	PVC	N/A	P	Sch 80	SW	HYD (150)	Connection to Analyzer
Sodium Hypochlorite Drain Line	½	PVC	N/A	P	Sch 80	SW	HYD (150)	

Notes *: Refer to drawings for delineation of piping material

**: Applies to suction and discharge piping and equipment connecting piping

The following abbreviations are used in the Exposed Piping Schedule.

B. Material Abbreviations

Material	Abbrev		Material	Abbrev.
Ductile Iron	DI		Polyvinyl Chloride	PVC
Cast Iron	CI		Chlorinated Polyvinyl Chloride	CPVC
Carbon Steel	CS		Steel	ST
Stainless Steel	SS			
Copper	C			

C. Lining/Coating Abbreviations

Lining	Abbrev		Coating	Abbrev.
Cement Mortar Lined	CL		Asphaltic Coated	AC
Glass Lined	GL		Polyethylene Wrapped	PEW
Ceramic Epoxy	CE		Painted	P
Fusion Bonded Epoxy Lined	FBEL		Fusion Bonded Epoxy Coated	FBEC
Plastic Lined	PL		Insulated	I
			Galvanized	G

D. Joint Abbreviations

Joint Type	Abbrev		Joint Type	Abbrev.
Bell and Spigot	BS		Flanged	Flg
Restrained Bell and Spigot	RBS		Butt Weld	BW
Push-on Joint	POJ		Lap Weld	LW
Restrained Push-on Joint	RPOJ		Butt Fusion Weld	BFW
Mechanical Joint	MJ		Solvent Weld	SW
Restrained Mech. Joint	RMJ		Sleeve-type Flexible Coupling	SLFC
Soldered	Sd		Split Flexible Coupling	SPFC
Brazed	Bz		Plasticized PVC Coupling	PPVC
Threaded	Thd		Grooved or Shouldered End Coupling	GSEC
			Flanged Adapter	FA

E. Test Abbreviations

Test	Abbrev		Test	Abbrev.
Hydrostatic Test (test pressure in psig)	HYD ()		Disinfection and Bacteriological Testing	DBT
Process Air Pipe Test (test pressure in psig)	PA ()		Examination of Welds	EW
Chlorine Pipe Test	CL		Exfiltration Test	EX
			No Test Required	NR

++ END OF SECTION ++

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SECTION 15055

PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to design, furnish, and install all hangers, supports and appurtenances necessary to complete the Work.

B. Coordination:

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the pipe hangers and supports Work.

C. Related Sections:

1. Section 03300, Cast-In-Place Concrete.
2. Section 09900, Coatings.
3. Division 15, Mechanical.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American Society for Testing and Materials, (ASTM).
 - a. ASTM A 575, Specification for Steel Bars Carbon, Merchant Quality, M-Grades.
 - b. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
2. Federal Specification, (FS).
 - a. FS A-A-1192, Hangers, Pipe.
3. Manufacturers Standardization Society of the Valve and Fittings Industry, (MSS).
 - a. MSS SP 58, Pipe Hangers and Supports-Materials, Design and Manufacture.
 - b. MSS SP 69, Pipe Hangers and Supports - Selection and Application.
4. Underwriters' Laboratories, Inc., (UL).
 - a. UL 203, Pipe Hanger Equipment for Fire Protection Service.

1.3 QUALITY ASSURANCE

- A. Each type of pipe hanger or support shall be the product of one manufacturer.
- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single pipe hangers and supports manufacturer.
 - 2. The pipe hangers and supports equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the pipe hangers and supports equipment manufacturer.

1.4 SUBMITTALS

- A. Shop Drawings: Submit the following:
 - 1. Detailed drawings showing all hangers and supports for each piping system specified. Shop Drawings shall show location, installation, material, loads or forces, and deflection of all hangers and supports.
 - 2. Each pipe system shall be analyzed for all loads and forces on the hangers and supports, and their reaction forces to the structure to which they are fastened. Any revisions or changes to the supports from how they are shown in the design documents shall be signed and sealed by a Florida registered professional structural engineer.
 - 3. Submit and coordinate these with Shop Drawings required for all piping systems.
- B. Product Information: Submit manufacturers' catalogs, literature, and engineering data on all hangers and supports. Load ratings, materials and installation shall be consistent with the recommendations of the MSS SP 58, MSS SP 69 and Federal Specification A-A-1192.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports.

Protect steel members and packaged materials from corrosion and deterioration.

2. Store materials in covered storage off the ground and prevent condensation.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify COUNTY, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 – PRODUCTS

2.1 GENERAL

A. Hangers and supports shall meet with the following requirements:

1. Standard and fabricated hangers and supports shall be furnished complete with necessary inserts, bolts, nuts, rods, washers, and other accessories.
2. Generally, run piping in groups where practicable and parallel to building wall. Provide minimum clearance of 1-inch between pipe and other work.
3. Install hangers or supports at all locations where pipe changes direction.
4. All hangers and supports shall be capable of adjustment after placement of piping.
5. Different types of hangers or supports shall be kept to a minimum.
6. All suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub.
7. Support vertical piping at each floor and between floors by stays or braces to prevent rattling and vibration.
8. Hanger rods shall be straight and vertical. Chain, wire, strap or perforated bar hangers shall not be used. Hangers shall not be suspended from piping.
9. Maximum support spacing unless otherwise shown or approved for standard weight steel pipe shall be as follows:

Pipe Size (inches)	Maximum Pipe Span ¹ (feet)			
	Steel	Copper	Plastic ²	Cast/Ductile Iron ⁴
3/8 to 3/4	5	6	Cont. ³	-
1	6	6	5	-
1-1/4	6	6	5	-
1-1/2	6	6	5	-
2	10	10	5	-
2-1/2	10	10	5	-

Pipe Size (inches)	Maximum Pipe Span ¹ (feet)			
	Steel	Copper	Plastic ²	Cast/Ductile Iron ⁴
3	10	10	5	-
4	12	12	5	12 feet for pressure pipe
6	12	12	5	
8	12	12	5	
10	12	-	5	
12	12	-	10	
14	12	-	-	10 feet for soil pipe
16	12	-	-	
18	12	-	-	
20	12	-	-	
24	12	-	-	

¹ Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

² Span shown is for Schedule 80 CPVC pipe at 100°F. Spans for other plastics, other CPVC pipe Schedules and pipes at higher temperatures shall be shortened in accordance with the pipe manufacturer's recommendations.

³ Continuous means pipe shall be in unistrut or similar channel.

⁴ Pipe hanger and support selection shall be as shown and in this Section.

10. Maximum support spacing, unless otherwise shown for plastic pipe at ambient temperature, shall be one-half of the values specified for steel pipe.
11. Plastic pipe at temperature greater than 130 degrees F shall be continuously supported in a metal cradle or tray.
12. Where proper hanger or support spacing does not correspond with joist or rib spacing, structural steel channels may be attached to joists or ribs and pipes suspended there from.
13. Prevent contact between dissimilar metals when supporting copper tubing, by use of copper plated, rubber or vinyl coated, or stainless steel hangers or supports.
14. Isolate thin walled stainless steel piping from carbon steel by use of plastic coated hangers or supports or by taping at points of contact with PVC or vinyl.
15. Supports and hangers shall be of a material that is compatible with the fluid being conveyed in such pipe being supported.
16. Anchors for pipe support systems shall be compatible or protected by a coating system which is compatible with the fluid being conveyed in such pipe being supported.

- B. Expansion compensation shall be designed for individual exposed piping systems with the following Design Criteria:
1. $\Delta L = L \times \Delta T \times \alpha$
 - a. Where ΔL = pipe length change (inches).
 - b. L = pipe length between anchors (inches).
 - c. ΔT = 100 (F).
 - d. α = coefficient of thermal expansion (inches/inches/F).
 2. Expansion compensation shall be designed as an integral part of the piping hanger, support and anchorage system.
 3. Expansion compensation shall be achieved via expansion joints specified in Section 15120, Piping Specialties and Accessories.

2.2 HANGERS AND SUPPORTS

- A. Hangers and supports where shown shall be in accordance with detail drawings. Hangers and supports not shown shall be in accordance with MSS SP 58.
- B. Products and Manufacturers: Provide one of the following:
1. Manufacturers
 - a. Anvil International, Inc.
 - b. Elcer.
 - c. B-Line.
 - d. Unistrut Corporation.
 - e. Or approved equal.
- C. Chemical Piping Systems:
1. All pipe supports and fasteners shall be glass fiber-reinforced plastic with a flame spread rating of 25, in accordance with ASTM E 84.
 2. Materials shall be manufactured by either the pultrusion or extrusion process.
 3. All pipe supports shall have a surface veil over 100 percent of the surface which, along with a filler system, shall protect against degradation from ultra-violet light.
 4. All fasteners shall be manufactured from long glass fiber-reinforced polyurethane to ensure strength and corrosion resistance.
 5. All-thread rods shall be made from vinylester resin.
 6. Manufacturers: Provide products of one of the following:
 - a. Unistrut Company.
 - b. Or approved equal.

2.3 ACCESSORIES

- A. Hanger rods shall be made from ASTM A 575, with square head nut on top and running thread on bottom end.

B. Concrete Inserts:

1. Concrete inserts shall be MSS SP 58 malleable Type 18.
2. Concrete inserts shall be of the continuous type capable of supporting pounds per foot of insert as shown.
3. Manufacturers: Provide products of one of the following:
 - a. Unistrut Corporation, Wayne, Michigan.
 - b. Elcan Metal Products, Company, Franklin Park, Illinois.
 - c. B-Line.
 - d. Anvil International, Inc.
 - e. Or approved equal.

C. Steel Beam Clamps:

1. Steel beam clamps shall be of malleable iron and conform to MSS SP 58 Type 21.

D. Inserts for Pipe Insulation:

1. Insulated pipe, larger than 1-1/2-inches in diameter, shall be supported by a rigid insert to protect the insulation. A steel metal saddle of sufficient gauge to carry the weight of the pipe and its fluid without deforming shall extend 2-inches minimum on each side of the rigid insert. The joints between insert and insulation shall be sealed before saddle is installed. Sizes up to 6-inches IPS shall be MSS SP 58, Type 40, and for sizes over 10-inches shall be MSS SP 58, Type 39.

E. Brackets:

1. Brackets for wall mounting shall conform to MSS SP 58 Type 34.

F. Pipe Roll:

1. To provide for pipe expansion, pipe shall be supported on adjustable malleable or steel pipe rolls, Type 45.

G. Fabricated Pipe Rack:

1. Pipes shall be supported and anchored to the fabricated pipe rack as shown. Clamps, rollers, and supports for piping shall conform to the general requirements of MSS SP 69.

2.4 PAINTING

A. Clean and prime ferrous metal surfaces in the shop in accordance with the requirements of Section 09900, Protective Coatings.

B. Field painting shall conform to the requirements of Section 09900, Protective Coatings.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Locate hangers, supports, and accessories to support piping, valves, and at all concentrated loads.
- B. Locate hangers, supports, and accessories within maximum span lengths specified to support continuous pipeline runs unaffected by concentrated loadings.
- C. Locate hanger, supports to prevent vibration or swaying and to provide for expansion and contraction.
 - 1. Temperature differential specified in this Section.
 - 2. Support piping independently so that equipment is not stressed by piping weight or expansion.
 - 3. For Uninsulated Copper Pipe or Tubing: Clamps and supports, electroplated copper finish. Instrumentation tubing shall be supported in steel or aluminum troughs with covers. All tubing layout and connections shall be as approved by the manufacturer of the equipment.
 - 4. Uncoated Hangers, Rods and Supports: Dip in zinc chromate primer before installation.
 - 5. Maximum spacing for horizontal piping shall be the lesser of lengths specified in Paragraph 2.1 or as follows:
 - a. Steel 1-Inch and Smaller: Seven feet.
 - b. Steel 1-1/2-Inch and Larger: Ten feet.
 - c. Brass or Copper 3-Inch and Smaller: Seven feet.
 - d. Brass or Copper 4-Inch and Larger: Ten feet.
 - e. Additional supports at:
 - 1) Change in direction.
 - 2) Branch piping and runouts over five feet.
 - 3) Concentrated loads due to valves, strainers or other similar items.
 - f. Maximum support spacing for plastic pipe at ambient temperature shall be one-half the above values.
 - 6. Hanger types for horizontal piping, except as noted and shown:
 - a. Forged steel adjustable clevis type, rod support for all services.
 - b. Slide Bases:
 - 1) Pipe stand, brackets, trapeze or other equivalent structural support.
 - 2) For piping 2-inches or larger.
 - c. For pipe and covering provide:
 - 1) Saddles for rollers or slide bases.
 - 2) Protective shields or saddles for all other types of supports.
 - d. Threaded Steel Rods:

- 1) Two inch vertical adjustment with two nuts each end for positioning and locking.
- 2) Size hanger rods according to the schedule below, unless otherwise noted:

Nominal Pipe (Inches)	Rod Diameter (Inches)
2 and less	3/8
2-1/2 to 3-1/2	1/2
4	5/8
6	3/4
8 through 12	7/8
14 through 18	1
20 through 30	1-1/4

- 3) For Double Rod Hangers: One size smaller than above.
- 4) Connection to Structure for Piping to 2-Inches: Concrete inserts, or expansion shields in shear into sides of beams.
- 5) Connection to Structure for Piping 2-1/2-Inch or Larger: Concrete inserts, beam clamps or suitable bridging.

7. Vertical Piping:

- a. Base Support: Base elbow or welded equivalent.
 - 1) Bearing plate on structural support.
- b. Guides not to exceed:
 - 1) 25 feet for piping to 2-inches.
 - 2) 36 feet for piping 2-1/2-inches or larger.
- c. Top Support:
 - 1) Special hanger or saddle in horizontal connection.
 - 2) Provisions for expansion.
- d. Intermediate Supports: Steel pipe clamp at floor.
 - 1) Bolted and welded to pipe.
 - 2) Extension ends bearing on structural steel or bearing plates.
- e. For Multiple Pipes: Coordinate guides, bearing plates and accessory steel.

8. Insulated Piping:

- a. Horizontal Pipe Shields at Supports:
 - 1) Minimum 120 degree arc.
 - 2) Length equal to diameter of insulation 12-inch minimum.
 - 3) To 6-Inch Pipe Size: No. 18 USSG galvanized steel.
- b. Vertical Pipe Shields at Guides:
 - 1) Full 360 degree arc, securely banded.
 - 2) Length equal to diameter of insulation, 12-inch minimum.
 - 3) To 6-Inch Pipe Size: No. 18 USSG galvanized steel.

D. Install items to be embedded before concrete placement.

- E. Fasten embedded items securely to prevent movement during concrete placement.
- F. Install hangers and support units on piping systems in accordance with manufacturer's recommendations.
- G. Adjust hangers and supports and place grout for concrete supports to bring pipelines to specified elevations.
- H. Bring all pipe systems up to operating pressures and temperatures. Cycle systems to duplicate operating conditions. Correct all support malfunctions.

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SECTION 15060

DUCTILE IRON PIPE AND FITTINGS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish ductile iron pipe and fittings.
2. Extent of piping is shown on the Drawings. Piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation, specify pipe service, diameter, material, lining, coating, pressure rating, joint type, and testing required.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before ductile iron pipe Work.

C. Related Sections:

1. Section 02221, Trenching, Bedding and Backfill for Pipe
2. Section 02223, Excavation Below Grade and Crushed Stone or Shell Refill.
3. Section 09900, Coatings.
4. Section 15051, Buried Piping Installation.
5. Section 15052, Exposed Piping Installation.
6. Section 15120, Piping Specialties and Accessories.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI B18.2.1, Square and Hex Bolts and Screws Inch Series.
2. ANSI B18.2.2, Square and Hex Nuts. (Inch Series).
3. ASTM A193, Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service.
4. ASTM A194, Specification for Carbon Steel and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
5. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
6. ASTM A354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
7. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
8. ASTM B117, Practice for Operating Salt Spray (Fog) Apparatus.

9. ASTM C283, Test Methods for Resistance of Porcelain Enameled Utensils to Boiling Acid.
10. ASTM D714, Test Method for Evaluating Degree of Blistering of Paints.
11. ASTM D792, Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
12. ASTM D5162, Discontinuity (Holiday) Testing of Non-Conductive Protective Coating on Metallic Substrates.
13. ASTM E96, Test Methods for Water Vapor Transmission of Materials.
14. ASTM G14, Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test).
15. ASTM G62, Test Methods for Holiday Detection in Pipeline Coatings.
16. ASTM G95, Test Methods for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method).
17. ANSI/AWWA C104, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
18. ANSI/AWWA C110, Ductile Iron and Gray Iron Fittings for Water.
19. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
20. ANSI/AWWA C115, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
21. ANSI/AWWA C116, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings for Water Service.
22. ANSI/AWWA C151, Ductile Iron Pipe, Centrifugally Cast, for Water.
23. ANSI/AWWA C153, Ductile Iron Compact Fittings, 3 inch through 24 inch and 54 inch through 64 inch for Water Service.
24. ANSI/AWWA C606, Grooved and Shouldered Type Joints.
25. European Standard (EN), EN 598: Ductile Iron Pipe, Fittings, Accessories and Their Joints for Sewerage Applications.
26. MSS-SP 60, Connecting Flange Joint Between Tapping Sleeves and Tapping Valves.
27. NACE RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
28. NAPF 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.
29. NSF/ANSI 61, Drinking Water System Components - Health Effects.
30. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
31. SSPC Painting Manual, Volume 1, Para. XIV.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
 - a. Manufacturer shall have a minimum of five years successful experience

producing ductile iron pipe and fittings and shall be able to show evidence of at least five installations in satisfactory operation for 5 years in the United States that are similar applications to the specified service.

- b. Lining and coating products shall be manufactured by a firm with a minimum of five years successful experience in protecting pipelines exposed to the specified service conditions , and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
- c. When not applied by the manufacturer, lining and coating Subcontractor shall have a minimum of five years successful experience in the application of the specified linings and coatings for similar applications for the specified service, and shall be able to show evidence of at least five installations in satisfactory operation in the United States.

B. Supply and Compatibility:

- 1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single ductile iron pipe manufacturer.
- 2. Ductile iron pipe manufacturer shall review and approve or prepare all Shop Drawings and other submittals for pipe, fittings, and appurtenances furnished under this Section.
- 3. Pipe, fittings, and appurtenances shall be suitable for the specified service and shall be integrated into overall piping system by ductile iron pipe manufacturer.
- 4. Ductile iron pipe manufacturer shall be responsible for all products and all factory-applied linings and coatings, whether installed at pipe manufacturer's facility or at manufacturer's Supplier's facility.

C. Regulatory Requirements:

- 1. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF/ANSI 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at Site.

1.4 SUBMITTALS

A. Action Submittals: Submit the following with Shop Drawings required under Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation:

- 1. Shop Drawings:
 - a. Detailed drawings and data for pipe, fittings, gaskets, appurtenances, linings, and coatings.
- 2. Product Data:
 - a. Surface preparation and application reports and procedures as required for lining and coating of pipe and fittings. Ductile iron pipe and fitting manufacturer and manufacturer and applicator of lining and coating, as

specified, shall mutually determine recommended surface preparation and application methods, and provide written verification of mutually selected method in the submittals.

3. Samples:
 - a. Submit Sample of pipe and fitting with each type of lining, for use at the Site to verify continuity, surface gloss, and color, as applicable, via visual inspection.
4. Test Procedures: For linings and coatings in pipe and fittings.

B. Informational Submittals: Submit the following:

1. Certificates:
 - a. Submit certificate signed by manufacturer of each product that product conforms to applicable referenced standards and the Contract Documents.
 - b. Submit certificate signed by applicator of the linings and coatings stating that product to be applied conforms to applicable referenced standards and that the applicator shall conform to the Contract Documents.
2. Source Quality Control Submittals:
 - a. Submit results of specified shop tests for pipe, fittings, linings, and coatings.
 - b. Lining and coating test coupons.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
- B. Handling of Pipe and Fittings Lined with Ceramic Epoxy, Fusion Bonded Epoxy, or Glass: Lifting devices shall not come into contact with lined surfaces. Use hooks, forks, chains, straps, and other lifting devices only on exterior of pipe and fittings. Pipe and fittings with damaged lining shall be replaced regardless of cause of damage.
- C. Handling of Fittings Coated with Fusion Bonded Epoxy: Hooks, forks, chains, straps, and other lifting devices shall be rubber-coated and be used only on exterior of fittings in manner to avoid damaging coating. If coating becomes damaged, notify pipe and coating manufacturer to determine if repair of damaged area or re-coating is required. Perform repairs using recommended procedures and materials provided by manufacturer, as accepted by ENGINEER. Pipe and fittings requiring re-coating shall be removed from Site and returned to manufacturer's facility. Repaired or re-coated pipe and fittings shall comply with requirements of this Section.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General:

1. Piping systems shall be suitable for their intended use.
2. Joints shall be as specified in Section 15051, Buried Piping Installation and Section 15052, Exposed Piping Installation. If not specified, provide flanged joints for exposed piping and push-on or mechanical joints for buried piping. Provide couplings on pipe with plain or grooved ends where shown or where approved by ENGINEER.

B. Ductile Iron Pipe, Joints, and Fittings:

1. Flanged Pipe: Fabricate in accordance with ANSI/AWWA C115.
 - a. Pressure Rating: As specified in piping schedule in Section 15052, Exposed Piping Installation. If not otherwise specified, use Special Thickness Class 53 for three-inch to 54-inch diameter pipe and Pressure Class 350 for 60-inch and 64-inch diameter pipe.
2. Non-Flanged Pipe: Conform to ANSI/AWWA C151 for material, pressure, dimensions, tolerances, tests, markings, and other requirements.
 - a. Pressure Class: As specified in piping schedules in Section 15051, Buried Piping Installation and Section 15052, Exposed Piping Installation. If not otherwise specified, use Pressure Class 250.
 - b. Special Thickness Class: As specified in piping schedules in Section 15051, Buried Piping Installation and Section 15052, Exposed Piping Installation.
3. Pipe Joints:
 - a. Flanged Joints: Conform to ANSI/AWWA C110 and ANSI/AWWA C111 capable of meeting the pressure rating or special thickness class, and test pressure specified in piping schedule in Section 15052, Exposed Piping Installation.
 - 1) Gaskets: Unless otherwise specified, gaskets shall be at least 1/8-inch thick, ring or full-face as required for the pipe, of synthetic rubber compound containing not less than 50 percent by volume nitrile or neoprene, and shall be free from factice, reclaimed rubber, and other deleterious substances. Gaskets shall be suitable for the service conditions specified, specifically designed for use with ductile iron pipe and fittings.
 - 2) Bolts: Comply with ANSI B18.2.1.
 - a) Exposed: ASTM A307, Grade B.
 - b) Buried or Submerged: ASTM A193, Grade B8M, Class 2, Heavy hex, Type 316 stainless steel.
 - 3) Nuts: Comply with ANSI B18.2.2.
 - a) Exposed: ASTM A563, Grade A, Heavy hex.

- b) Buried or Submerged: ASTM A194, Grade B8M, Heavy hex, Type 316 stainless steel.
- b. Mechanical Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure rating or special thickness class, and test pressure specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
 - 1) Glands: Ductile iron.
 - 2) Gaskets: Plain tip.
 - 3) Bolts and Nuts: High strength, low alloy steel.
 - 4) Manufacturers: Provide products of one of the following:
 - a) Clow Water Systems Company.
 - b) Atlantic States Cast Iron Pipe Company.
 - c) Canada Pipe Company, Ltd.
 - d) McWane Cast Iron Pipe Company.
 - e) Pacific States Cast Iron Pipe Company.
 - f) Griffin Pipe Products Co.
 - g) American Cast Iron Pipe Co.
 - h) U.S. Pipe and Foundry Co.
 - i) Or equal.
- c. Push-On Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure class or special thickness class, and test pressure specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
 - 1) Gaskets: Vulcanized SBR, unless otherwise specified.
 - 2) Stripes: Each plain end shall be painted with a circular stripe to provide a guide for visual check that joint is properly assembled.
 - 3) Products and Manufacturers: Provide one of the following:
 - a) Tyton or Fastite Joint by Clow Water Systems, Atlantic States Cast Iron Pipe Company, Canada Pipe Company, Ltd., McWane Cast Iron Pipe Company, Pacific States Cast Iron Pipe Company, and Griffin Pipe Products Company.
 - b) Fastite Joint by American Cast Iron Pipe Company.
 - c) Tyton Joint by U.S. Pipe and Foundry Company.
 - d) Or equal.
- d. Grooved End Joints: Comply with ANSI/AWWA C606.
 - 1) Gaskets: Flush seal type designed for ductile iron that complies with or exceeds requirements of ASTM D2000
 - 2) Bolts and nuts: As specified for flanged joints.
 - 3) Unless otherwise specified, grooved end couplings shall be rigid joint for exposed service and flexible joint for buried service.
 - 4) Products and Manufacturers: Provide one of the following:
 - a) Victaulic, Style 31.
 - b) Or equal.
- e. Restrained Joints: Restrained push-on joints shall be capable of being

deflected after full assembly. Field cuts of restrained pipe are not allowed without approval of ENGINEER.

- 1) Products and Manufacturers: Provide restrained joints for mechanical joint piping by one of the following:
 - a) Megalug, Series 1100, by EBBA Iron Sales, Inc.
 - b) MJ Coupled Joint, by American Cast Iron Pipe Co.
 - c) MJ Field Lok, by U.S. Pipe and Foundry Co.
 - d) Or equal.
- 2) Products and Manufacturers: Provide restrained joints for push-on joint piping by one of the following:
 - a) Super-Lock Joint Pipe, by Clow Water Systems, a division of McWane, Inc.
 - b) Lok-Ring Joint, or Flex-Ring Joint, by American Cast-Iron Pipe Company.
 - c) TR Flex Joint, by U.S. Pipe and Foundry Company.
 - d) Snap-Lok, by Griffin Pipe Products Company.
 - e) Or equal.
4. Flanged and Push-On Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
 - a. Material: Ductile iron.
 - b. Pressure rating, gaskets, bolts, and nuts shall be as specified for flanged joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of the connected pipe.
5. Mechanical Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
 - a. Material: Ductile iron.
 - b. Glands: Ductile iron.
 - c. Pressure rating, gaskets, bolts, and nuts shall be as specified for mechanical joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of connected pipe.

C. Lining, General:

1. Surface Preparation:
 - a. Initial Surface Inspection: Surface to be lined shall be inspected by pipe and fitting manufacturer and applicator, if applicator is other than pipe and fitting manufacturer. Inspecting parties shall inspect surface to be coated and mutually determine recommended surface preparation method.
 - b. Surface Preparation: Prepare surface in accordance with recommended method.
 - c. Finished Surface Inspection: Lining applicator shall inspect finished surface prior to application to determine acceptability. If surface is unacceptable, repeat surface preparation as necessary.

D. Cement-mortar Lining:

1. Where specified in piping schedules included with Section 15051, Buried Piping Installation and Section 15052, Exposed Piping Installation, pipe and fittings shall be lined with bituminous seal coated cement-mortar lining in accordance with ANSI/AWWA C104.

E. Ceramic Quartz-Filled, Amine-Cured Novalac Epoxy Lining:

1. Where specified in piping schedules included with Section 15051, Buried Piping Installation and Section 15052, Exposed Piping Installation, pipe and fittings shall be factory lined with a quartz-filled, amine-cured, novalac, epoxy containing at least twenty percent by volume of ceramic quartz pigment.
2. Ceramic epoxy lining shall have a permeability rating of zero when tested according to Method A of ASTM E96, Procedure A, with a test duration of thirty days.
3. Conduct the following tests on coupons from factory lined ductile iron pipe:
 - a. ASTM B117 Salt Spray (scribed panel): Results to equal zero undercutting after two years.
 - b. ASTM G95 Cathodic Disbondment 1.5 volts at 77 degrees F: Results to equal no more than 0.5 mm undercutting after thirty days.
 - c. Immersion Testing rated using ASTM D714.
 - 1) Twenty Percent Sulfuric Acid: No effect after two years.
 - 2) Twenty-five Percent Sodium Hydroxide at 140 degrees F: No effect after two years.
 - 3) Distilled Water at 160 degrees F: No effect after two years.
 - 4) Tap Water at 120 degrees F (scribed panel): Zero undercutting after two years, with no effect.
4. Ceramic epoxy lining shall have abrasion resistance of no more than four mils loss after one million cycles, in accordance with ES EN 598, Section 7.8, Abrasion Resistance.
5. Within eight hours of surface preparation, interior of pipe and fittings shall receive 40 mils dry film thickness, utilizing method recommended by lining manufacturer that will comply with requirements of this Section. Number of coats applied shall be as recommended by lining manufacturer. Minimum substrate and ambient temperature for lining application shall be 40 degrees F.
6. Inspection and Certification:
 - a. Check all ductile iron pipe and fitting linings for thickness using magnetic film thickness gage in accordance with method in SSPC PA 2 Film Thickness Rating.
 - b. Test interior lining of pipe barrels and fittings for pinholes with non-destructive, 2,500-volt test. Defects found shall be repaired in accordance with lining manufacturer's recommendations prior to shipment from lining applicator's factory.
 - c. Mark each pipe and fitting with date of application and its numerical sequence of application.

7. Products and Manufacturers: Provide one of the following:
 - a. Protecto 401 Ceramic Epoxy.
 - b. Or equal.
- F. Fusion Bonded Epoxy Lining for Fittings:
1. Where specified in piping schedules included with Section 15051, Buried Piping Installation and Section 15052, Exposed Piping Installation, fittings shall factory lined with 100 percent solids, thermosetting, dry powder epoxy, in conformance with ANSI/AWWA C116.
 2. Apply epoxy by utilizing method recommended by lining manufacturer, complying with requirements of this Section, with finished dry film thickness of not less than six mils, with exception of joint areas which shall receive thickness of not less than four mils for leak-proof joint. Heat and cure fittings in accordance with lining manufacturer's recommendations.
 3. Source Quality Control: Coating material shall be applied to test coupon cut from section of a fitting approximately six-inch diameter and approximately four inches long, split lengthwise into two approximately equal sections. It is allowable to use fitting diameter other than the fitting diameter to be furnished for the Project. Surface preparation, application procedure, thickness, and curing parameters shall be the same for test coupon as for the actual fittings to be furnished. Perform the following tests on test coupon:
 - a. Coating material shall be scribed through to bare surface of fitting with an "X" across full length of test coupon. Immerse coupon in 150-degree F bath of distilled water and, after 500 hours, coupon shall show no signs of blistering or disbonding between lining and metal.
 - b. Test coupon shall be impact tested in accordance with ASTM G14 test method with 20 in.-lbf impact applied near center of concave section of test coupon, and shall show no signs of cracking or disbonding between lining and metal.
 4. Inspection and Certification:
 - a. All lined fittings shall be visually inspected and show no sign of blisters, cracks, or lack of coverage by lining.
 - b. Check lining thickness on all lined fittings using magnetic film thickness gauge in accordance with method in SSPC PA 2 Film Thickness Rating.
 - c. Holiday-test all lined fittings in accordance with ASTM D5162, NACE RP0188, and SSPC Painting Manual Vol. 1, Para. XIV, with low-voltage, wet sponge holiday detector. Repair methods and materials for holidays shall be as recommended by lining manufacturer and made prior to shipment from lining applicator's facility.
 5. Products and Manufacturers: Provide one of the following:
 - a. PipeClad 1500, by Valspar Corporation.
 - b. Or equal.

G. Interior Glass Lining:

1. General:

- a. Where specified in piping schedules included with Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation, provide interior glass lining for pipe and fittings.
- b. Mechanical Joint and Push-on Joint Pipe and Fittings: Factory-cut lengths of pipes as required and provide complete end-to-end glass lining in pipes and fittings.
- c. Flanged Joint Pipe and Fittings: Glass-line factory-cut plain-end pipe prior to threading and installing flanges. Provide complete end-to-end glass lining in pipes and fittings.
- d. Longitudinal warping or change in roundness of pipe and fittings resulting from glass lining shall not exceed:
 - 1) Flanged or Grooved Pipe and Fittings: 0.0125 inches per foot of length.
 - 2) Buried Pipe and Fittings, with Wall Thickness Equal To or Less Than Class 52 Pipe: 0.025 inches per foot of length. For pipe thicker than Class 52, lining applicator shall submit recommended tolerances to ENGINEER for approval.
- e. Submit glass lining test results of pipe and fittings tested for Project.
- f. Failure of tests on glass lining in pipe and fittings will result in rejection of all glass-lined pipe and fittings.

2. Mechanical and Physical Properties:

- a. Total Lining Thickness:
 - 1) Pipe: 0.01 to 0.03 inch.
 - 2) Fittings: 0.01 to 0.04 inch.
- b. Hardness: Five to six on Mohs scale, minimum.
- c. Density: 2.5 to 3.0 grams per cubic centimeter when measured in accordance with ASTM D792.
- d. Flexibility: Glass lining shall withstand metal yield point of 0.001-inch per inch (yield point of base metal) without damage to glass lining.
- e. Continuity of Glass Lining: When tested with a low voltage wet sponge holiday detection unit, with a test voltage of 67.5 volts, number of pinholes detected shall not exceed:

Fitting Diameter	Maximum Pinholes per Fitting
4-inch through 8-inch	3 to 5
10-inch through 14-inch	5 to 8
16-inch through 24-inch	8 to 10
Pipe Diameter	Maximum Pinholes
4-inch through 8-inch	10 to 12 per 20-foot length of pipe
10-inch through 14-inch	18 to 20 per 20-foot length of pipe
16-inch through 24-inch	25 to 28 per 20-foot length of pipe
Note: Allowable pinholes in pipe or fitting shall be located no closer than three inches to one another in any direction. Total surface area of the pinholes shall not exceed 0.01 percent an individual length of pipe or fitting. Visible pinholes that expose the base metal are not acceptable	

- f. Thermal Shock: Glass lining shall withstand an instantaneous thermal shock at differential temperature of 350 degrees F without cracking, crazing, or spalling.
3. Corrosion Resistance:
 - a. Glass lining shall be resistant to corrosion when exposed to solutions at pH of 3 through 10, at 125 degrees F, for period of one hour.
 - b. Surface gloss shall be maintained when immersed in eight percent sulfuric acid solution at 148 degrees F for ten minutes.
 - c. Weight loss shall not exceed three mg/sq. in. when tested in boiling citric acid solution in accordance with ASTM C283.
4. Glass Lining Material and Application:
 - a. Material: Vitreous and inorganic glass frit suspended in water.
 - b. Application: Apply glass lining utilizing a method recommended by lining manufacturer that complies with requirements of this Section.
5. Initial Shop Testing of Glass Lined Test Specimens:
 - a. Glass line two, 3-inch by three-inch test specimens and one, 8-inch diameter by 12-inch long test specimen, of material and wall thickness similar to that of pipes and fittings for Project.
 - b. Surface preparation and glass lining procedure shall be similar for test specimens and Project pipe and fittings.
 - c. Perform following tests:
 - 1) Thickness.
 - 2) Hardness.
 - 3) Density.
 - 4) Flexibility.
 - 5) Continuity.
 - 6) Thermal Shock Resistance.
 - 7) Surface gloss.
 - 8) Corrosion resistance.
 - 9) Weight loss.

6. Final Source Quality Control Testing of Glass Lined Pipes and Fittings:
 - a. After application of glass lining, perform the following tests on Project pipe and fittings:
 - 1) Check thickness of glass lining in each pipe and fitting, at minimum of two locations at each end of each pipe and fitting, 180 degrees apart.
 - 2) Test hardness of glass lining in every tenth pipe and fitting. If total quantity is less than ten, test minimum of one each.
 - 3) Test continuity of glass lining in each pipe and fitting.
 - 4) Cut two test coupons, each approximately three-inch by three-inch in size, from two 6-inch or eight-inch diameter pipes and fittings, picked at random, and perform thermal shock resistance tests.
 - b. Provide permanent sticker inside each pipe and fitting indicating tested thickness of glass lining and number of pinholes, signed by manufacturer's inspector.
7. Initial and Final Source Quality Control Procedures:
 - a. Calibrate test instruments prior to starting tests.
 - b. Thickness: Test with magnetic gauge, Mikra Test IV FM Automatic, zero to 40 mils scale, made by Electro Physik or equal.
 - c. Hardness: Use Mohs test kit consisting of nine elements of varying hardness. Glass lining shall show no mark when No. 5 element, Apatite, is scraped over surface of glass lining.
 - d. Density: Comply with ASTM D792.
 - e. Flexibility: Place sample piece of eight-inch or 12-inch diameter glass-lined pipe in an arbor press or similar device. Measure outside diameter of pipe prior to applying pressure. Apply pressure at two points, 180 degrees apart from each another on exterior surface of sample until pipe is deformed by 0.025 inches from initial measurement. When visually inspected, glass lining shall show no cracking, crazing, or spalling.
 - f. Continuity:
 - 1) Comply with ASTM D5162 Test Method A - Low Voltage Wet Sponge Testing.
 - 2) Test Unit: Tinker and Razor Model M/1 Holiday Detector, or equal.
 - 3) Apply 67.5-volt potential across surface of glass. Move wetted sponge over glass lining. Pinholes or discontinuity in glass surface due to moisture from sponge shall close the circuit and produce an audible signal.
 - g. Thermal Shock Resistance: Heat test specimens to 400 degrees F and instantly drop into water at 50 degrees F. Maintain temperature differential of 350 degrees F between the specimen temperature and the water temperature during testing. Visual inspection of glass lining shall reveal no crazing, blistering, or spalling.
 - h. Surface Gloss: Immerse test specimen in an eight-percent sulfuric acid solution at 148 degrees F for ten minutes. Glass lining shall show no loss

- of surface gloss.
- i. Corrosion Resistance:
 - 1) Immerse test specimen in a solution of sulfuric acid and distilled water with pH of three and temperature of 125 degrees F for one hour.
 - 2) Immerse test specimen in solution of sodium hydroxide and distilled water with pH of ten and a temperature of 125 degrees F for one hour.
 - 3) Glass lining shall show no change in surface gloss, roughening of surface, or visible deterioration.
- j. Weight Loss Test: Test in boiling citric acid solution in accordance with ASTM C283.
- 8. Witness Test for Glass Lining:
 - a. Following tests shall be witnessed by one representative of COUNTY and one representative of ENGINEER for one day per each test:
 - 1) Initial shop testing of glass lined test specimens.
 - 2) Final shop testing of glass lined pipe and fittings.
 - b. Pay for travel, lodging, and meal expenses for each representative for witness tests specified. If repeat testing is required because products fail tests, pay expenses and labor costs for each representative to attend retesting.
 - c. Notify ENGINEER and COUNTY at least one month in advance of scheduled witness test dates.
- 9. Manufacturers of Glass Lining: Provide products of one of the following:
 - a. Vitco Industries, Inc.
 - b. Or equal.

H. Couplings:

- 1. Refer to Section 15120, Piping Specialties and Accessories.

I. Specials:

- 1. Transition Pieces:
 - a. Provide suitable transition pieces (adapters) for connecting to existing piping.
 - b. Unless otherwise shown or indicated, expose existing piping to determine material, dimensions, and other data required for transition pieces.
- 2. Taps:
 - a. Provide taps where shown or required for small-diameter piping or instrumentation connections.
 - b. Provide corporation stops where shown or required.
 - c. Where pipe wall thickness or tap diameter will not allow engagement of 2 full threads, provide tapping saddle with outlet joints conforming to requirements of Paragraph 2.1.B.3.a of this Section for four-inch through 12-inch diameter pipe, and Paragraph 2.1.B.3.b. for 14-inch through 54-

- inch diameter pipe.
- d. For flanged connections on tapping saddle outlet branch, counterbore flange in accordance with MSS SP-60 dimensions. Inside diameter of outlet shall be 1/4-inch greater than nominal diameter.
- 3. Tangential Outlets:
 - a. Provide tangential outlet fittings where shown or indicated.
 - b. Weld-on fittings are acceptable.
 - c. Flanged and grooved end joints are not allowed.

2.2 MARKING FOR IDENTIFICATION

- A. In addition to identification markings specified in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation, also stamp, mark, and identify push-on joint and mechanical joint pipe with:
 - 1. Name or trademark of manufacturer.
 - 2. Weight, class or nominal thickness, and casting period.
 - 3. Country where cast.
 - 4. Year the pipe was produced.
 - 5. Letters "DI" or "Ductile" shall be cast or metal stamped
- B. In addition to identification markings specified in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation, also stamp, mark, and identify flanged pipe with:
 - 1. Flange manufacturer's mark, size, and letters "DI" cast or stamped on the flanges.
 - 2. Fabricator's mark if other than flange manufacturer.
 - 3. Length and weight.
- C. In addition to identification markings specified in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation, also stamp, mark, and identify fittings with:
 - 1. Manufacturer's identification.
 - 2. Pressure rating.
 - 3. Nominal diameters of openings.
 - 4. Country where cast.
 - 5. Number of degrees or fraction of the circle on bends.
 - 6. Letters "DI" or "Ductile" cast on them.

2.3 EXTERIOR SURFACE PREPARATION AND COATINGS

- A. General Coating Requirements:
 - 1. Coating types are specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

B. Exposed Pipe and Fittings:

1. Surface Preparation:
 - a. Initial Surface Inspection: Pipe and fitting manufacturer and coating applicator shall inspect surface to be coated and mutually determine recommended NAPF 500-03 surface preparation method.
 - b. Surface Preparation: Prepare surface in accordance with recommended NAPF 500-03 method.
 - c. Finished Surface Inspection: Prepared surfaces shall be inspected by coating applicator prior to application to determine acceptability of finished surface. If surface is unacceptable, repeat surface preparation and re-application as necessary.
2. After recommended surface preparation, prime coat exterior ferrous metal surfaces of pipe and fittings in the shop in accordance with Section 09900, Coatings.
3. Field painting shall comply with Section 09900, Coatings.

C. Buried Pipe and Fittings:

1. Asphaltic Coating: Where specified in piping schedule in Section 15051, Buried Piping Installation, coat pipe and fittings with an asphaltic coating approximately one-mil thick, in accordance with ANSI/AWWA C151, ANSI/AWWA C115, ANSI/AWWA C110, and ANSI/AWWA C153, as applicable.
2. Fusion Bonded Epoxy Coating for Fittings:
 - a. When specified in piping schedule in Section 33 05 05, Buried Piping Installation, fittings shall be factory coated with 100 percent solids, thermosetting, dry powder epoxy, in conformance with ANSI/AWWA C116.
 - b. Apply coating utilizing a method, recommended by manufacturer that meets requirements of this Section, with finished dry film thickness of at least six mils, with exception of joint areas, which shall receive at least a four-mil dry film thickness coating. Heat and cure fittings in accordance with coating manufacturer's recommendations.
 - c. Source Quality Control: Cut a test coupon from coated fitting no less than six inches in diameter, and approximately four inches long, and split coupon lengthwise into two equal sections. Surface preparation, application procedure, thickness, and curing parameters shall be the same for test coupon as for Project fittings. Perform the following tests on test coupon:
 - 1) Scribe coating material through to bare surface of fitting with an "X" across full length of test coupon. Immerse coupon for 500 hours in 150-degree F bath of distilled water. Coating shall show no signs of disbondment or blistering.
 - 2) Test coupon shall be impact tested using ASTM G14 test method with 20 in.-lbf impact applied near center of convex section of test

coupon. Coating shall show no signs of cracking or disbondment without magnification.

- d. Manufacturer's Inspection and Certification:
 - 1) All coated fittings shall be visually inspected by manufacturer and show no sign of blisters, cracks, or lack of coverage.
 - 2) Check all coated fittings for coating thickness using magnetic film thickness gage utilizing method outlined in SSPC PA 2 Film Thickness Rating.
 - 3) Holiday-test all coated fittings in accordance with ASTM D5162, NACE RP0188, and SSPC Painting Manual Volume 1, Paragraph XIV, with low-voltage, wet sponge holiday detector. Repair methods and materials for holidays shall be as recommended by coating manufacturer and made prior to shipment to the Site.
- e. Products and Manufacturers: Provide one of the following:
 - 1) PipeClad 1500, by Valspar Corporation.
 - 2) Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Inspect piping to assure that piping is free from defects in material and workmanship. Verify compatibility of pipe, fittings, gaskets, linings, and coatings.

3.2 INSTALLATION AND FIELD QUALITY CONTROL

- A. For buried piping installation and testing, refer to Section 15051, Buried Piping Installation.
- B. For exposed piping installation and testing, refer to Section 15052, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 15068

THERMOPLASTIC PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install thermoplastic pipe and appurtenances complete and operational as shown and specified.
- B. Related Divisions and Sections:
 - 1. Division 1, General Requirements.
 - 2. Division 2, Site Work.
 - 3. Division 9, Finishes.
 - 4. Division 15, Mechanical.

1.2 QUALITY ASSURANCE

- A. Manufacturer's and Installer's Qualifications: Manufacturer and installer shall have experience in producing similar type materials and show evidence of five separate, substantially similar installations which have been in satisfactory operation for a minimum of five years.
- B. Thermoplastic pipe, fittings and all incidentals, with the exception of double containment piping, shall be furnished by one supplier or manufacturer who, with the CONTRACTOR, shall assume full responsibility for the completeness of the system. The supplier or manufacturer shall be the source of information on all equipment furnished regardless of the manufacturing source of that equipment.
- C. Double containment pipe and fittings shall be furnished by one supplier.
- D. Source Quality Control:
 - 1. Shop Tests: Pipe manufacturer shall maintain a continuous quality control program. Submit certification that all plastic molding materials used to manufacture pipe and fittings under this Section are tested for conformance to ASTM D 1784 or ASTM D 1248.
 - 2. Field Tests: Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation, for field testing information.
- E. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. ASTM D 412, Test Methods for Vulcanized Rubber and Thermoplastic

- Rubbers and Thermoplastic Elastomers - Tension.
2. ASTM D 638, Tensile Properties of Plastics.
 3. ASTM D 746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 4. ASTM D 790, Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 5. ASTM D 1598, Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure.
 6. ASTM D 1599, Test Method for Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings.
 7. ASTM D 1784, Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 8. ASTM D 1785, Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
 9. ASTM D 2122, Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
 10. ASTM D 2152, Test Method for Adequacy of Fusion of Extruded Poly (Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion.
 11. ASTM D 2240, Test Method for Rubber Property-Durometer Hardness.
 12. ASTM D 2412, Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
 13. ASTM D 2444, Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).
 14. ASTM D 2464, Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 15. ASTM D 2467, Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
 16. ASTM D 2564, Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
 17. ASTM D 2774, Underground Installation of Thermoplastic Pressure Piping.
 18. ASTM D 2837, Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
 19. ASTM F 493, Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
 20. ASTM F 656, Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
 21. NSF 14, Plastics Piping System Components and Related Materials.
 22. NSF 51, Food Equipment Materials.
 23. NSF 61, Drinking Water System Components - Health Effects.
 24. Standards of the American National Standards Institute.
 25. Standards of the American Association of State Highway and Transportation Officials.
 26. Standards of the Food and Drug Administration.

1.3 SUBMITTALS

- A. Shop Drawings: CONTRACTOR shall submit for approval in accordance with Section 01340, Shop Drawings, Project Data, and Samples, showing the following:
 - 1. Detailed procedures to be used in jointing and installing piping systems including manufacturer's recommendations.
 - 2. Interfacing of piping systems to equipment and appurtenances.
 - 3. Detail requirements for burial, supports, anchors, guides, expansion joints, and all accessories required for satisfactory piping systems.
 - 4. Certificates of conformance with referenced standards.
- B. Manufacturer's Qualifications: In accordance with Part 1.2.A of this Section.
- C. Operation and Maintenance Data: Submit Operations and Maintenance Manuals in accordance with Section 01730, Operating and Maintenance Data.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. See Section 01600 part 1.03, Transportation and Handling, and Section 01620, Storage and Protection, for additional details.
- B. Deliver materials to the site to insure uninterrupted progress of the Work. All necessary precautions shall be taken to prevent damage to pipe, fittings and other materials during shipment and delivery. All materials shall be securely fastened to truck or rail car to prevent movement or damage during shipment. Inspector shall examine all materials before unloading.
- C. All pipe materials shall be handled to prevent damage. Pipe and fittings shall not be dropped, rolled, or pushed off from any height on delivery, storage or installation.
- D. Storage: All pipe materials shall be stored off the ground. Pipe ends shall be secured by caps or plugs. Do not store pipe or fittings in sunlight. Pipe shall be stored to prevent sagging or bending. Store off the ground, under cover, and in a dry location. Storage of equipment shall be in accordance with Section 01620, Storage and Protection.

1.5 WARRANTY

- A. All material supplied under these Specifications shall be warranted by the Contractor and the manufacturers for a period of three (3) years. Warranty period shall commence on the date of COUNTY acceptance.
- B. The material shall be warranted to be free from defects in workmanship, design and materials. If any part of the system should fail during the warranty period, it shall be replaced at no expense to the COUNTY.

- C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty or guarantee period. No exception to this provision shall be allowed. The Contractor shall be responsible for obtaining warranties from each of the respective suppliers or manufacturers for all the material specified under these contract specifications.
- D. In the event that the manufacturer is unwilling to provide a three-year warranty commencing at the time of COUNTY acceptance, the Contractor shall obtain from the manufacturer a four (4) year warranty starting at the time of equipment delivery to the job site. This four-year warranty shall not relieve the Contractor of the three-year warranty starting at the time of COUNTY acceptance of the equipment.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

- A. PVC Pipe:
 - 1. PVC pipe shall be Type 1, Grade 1, Schedule 80, unless otherwise shown or specified. Material shall conform to ASTM D 1784. Pipe schedule shall conform to ASTM D 1785.
 - 2. Fittings: Solvent welded fittings shall conform to ASTM D 2467 for socket type. Provide Teflon filled or natural rubber gaskets for any threaded or flanged fittings. Connecting hardware for flanged connections shall be 316 SS.
 - 3. Primer and solvent cement:
 - a. Unless otherwise specified below, PVC pipe joints shall be solvent-welded using primer and solvent cement as recommended by PVC pipe manufacturer. Primer shall be in accordance with ASTM F 656. Solvent cement shall be in accordance with ASTM D 2564. Solvent cement shall be Weld-on 724 or compatible with chemical used.
 - 4. Manufacturers: Provide products of one of the following:
 - a. Chemtrol as manufactured by Nibco, Inc.
 - b. Spears Manufacturing Company.
 - c. Or approved equal.
- B. Double Containment Piping:
 - 1. Double containment piping shall be furnished for all chemical piping outside of the containment area.
 - 2. All double containment piping shall be:

Chemical Pipe Diameter	Containment Pipe Diameter
3-inch	6-inch
2-inch to 1 ½-inch	4-inch
1-inch to ¾-inch	3-inch
½-inch	2-inch

3. Double containment piping shall be Schedule 80, PVC construction, with fittings, as required. Inner and outer systems shall be factory assembled.
4. Double containment piping shall be rated for 50 psig.
5. System shall have centralizers that center and support carrier pipe within double containment pipe. No mechanical elastomeric seal system will be accepted.
6. Installation of all containment piping shall be as recommended by the containment pipe manufacturer.
7. Manufacturer: Provide the products of the following:
 - a) Spears.
 - b) FloSafe.
 - c) Or approved equal.

C. High Density Polyethylene Pipe:

1. Piping 3-inches and smaller shall conform to ASTM D 3035.
2. Piping larger than 3-inches shall conform to ASTM F 714.
3. Potable water pipe less than 4-inches shall conform to AWWA C901.
4. Potable water pipe 4-inches and greater shall conform to AWWA C906.
5. Color: Natural.
6. Fittings: Color of fittings shall match pipe. Both pipe and fittings shall carry the same pressure rating. Molded and machined fittings shall meet the requirements of ASTM D 3261.
7. Joints:
 - a. Heat Fusion: Heat fusion fittings shall comply with the requirements of ASTM D 2683.
 - b. Electrofusion: Electrofusion fittings shall be manufactured in conformance with ASTM F 1055, ASTM D 2513, ASTM D 1248, and ASTM D 3350. Fittings shall be rated for a working pressure of 165 psi.
 - c. Flanged: Provide flanged fittings with Neoprene, Viton, Teflon or EPDM gasket as recommended by the manufacturer.
8. Transition of Unlike Materials: Unlike materials shall not be joined together by heat fusion. Accomplish transition from unlike materials by mechanical or flanged couplings capable of identical pressure ratings.
9. Manufactures: Provide products of one of the following:
 - a. Polypipe, as manufactured by CSR America, Inc.
 - b. Driscopipe, as manufactured by Phillips, A Division of Phillips Petroleum Company.
 - c. Or approved equal

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Inspection:
 - 1. The CONTRACTOR shall inspect all piping to ensure that it is free of defects in material and workmanship. The compatibility of all pipe, fittings, and coatings shall be verified.
 - 2. Any defective or broken pipe shall be removed from the site; if installed, it shall be removed and replaced at the CONTRACTOR's expense.
- B. Preparation:
 - 1. Excavation required for buried piping shall conform to the requirements of Section 02223, Excavation Below Grade and Crushed Stone or Shell Refill.
- C. General:
 - 1. All piping shall be installed in complete accordance with the manufacturer's instructions and recommendations.
 - 2. If any piping must be cut, the work shall be done in a satisfactory manner using a machine specifically designed for cutting the pipe, so as to avoid damage to the pipe and to leave a smooth end.
- D. Double Containment Piping:
 - 1. Buried piping shall be installed to even grade towards a low point as indicated on the drawings.
 - 2. Jointing:
 - a. The inner and the outer pipe shall be joined by solvent cement welding, in accordance with manufacturers' guidelines and installation instructions. Consult manufacturer's data for appropriate cure times. Consult manufacturer for selection of proper cement suitable for installation, environment and design. Joints should not be disturbed nor tested prior to complete curing of cement.
 - 3. Testing:
 - a. Upon completion of installation, the primary piping system shall be hydrostatically pressure tested at 150 percent of the system designed pressure for a period of one hour. Additionally, the containment piping shall be pneumatically tested at 10 psig for a maximum of one hour in duration. The external joints shall be soaped and visually inspected for leaks. Installers shall use testing equipment recommended by the double containment piping manufacturer.
- E. PVC Pipe:
 - 1. Joint Assembly:

- a. General: The procedure below may be used as a guide, the approved pipe manufacturers recommended procedures should be followed unless the procedures listed below are more stringent.
- b. Cut pipe square with mitre box or plastic tube cutter.
- c. Chamfer pipe to a 10 to 15 degree angle (1/16 inch to 1/32 inch).
- d. Clean and dry socket of all dirt, moisture and grease.
- e. Check dry fit of pipe in fitting. Pipe should enter socket about 1/3 to 3/4 depth.
- f. Dissolve inside socket surface by brushing with primer. Use brush 1/2 the size of pipe diameter. Use a scrubbing motion to assure penetration. Repeat application as necessary.
- g. Dissolve surface of male end of pipe to be inserted into socket to depth of fitting socket by brushing on liberal coat of primer. Be sure entire surface is well dissolved.
- h. Brush inside socket with primer one more time, then without delay apply proper cement liberally to male end of pipe. The amount of cement should be more than sufficient to fill any gap.
- i. Apply proper cement lightly to inside of socket. Keep excess cement out of socket to prevent solvent damage to pipe. Apply a second coat of cement to the pipe end. Time is important at this stage. Two people may be required when cementing larger size pipe and fittings.
- j. While both inside socket and outside surface of male end of pipe are SOFT and WET with cement, forcefully bottom the male end of pipe into socket, giving the male a one-quarter (1/4) turn. The pipe must go to the bottom of the socket. Hold joint together until both surfaces are firmly gripped (approximately 30 seconds).
- k. After assembly, wipe excess cement from the pipe at the end of the fitting socket. A properly made joint will normally show a bead around its entire perimeter. Any gaps at this point may indicate a defective assembly job, due to insufficient cement, or use of light bodied cement on large diameters where heavy bodied cement should have been used.
- l. Do not disturb joint until initial setup of the cement occurs. See manufacturers' solvent cement set time schedule for setup times at various ambient temperatures.

F. Buried Pipe:

1. Pipe shall not be installed until COUNTY approves the bedding conditions.
2. The CONTRACTOR's attention is directed to the fact that bulkheaded, empty pipelines are subject to flotation in an open trench. Trench dewatering operations must be maintained while empty pipe remains exposed in the trench.
3. All pipe and fittings shall be laid or placed to the lines and grades shown. Unless otherwise shown, the minimum cover over the pipe shall be 3 feet.

4. Special care shall be taken to keep the inside of the pipe clean and free from dirt, water or other materials during laying operations. At the end of each day's laying operations, the pipe shall be inspected and an approved watertight bulkhead shall be placed to keep dirt, water or other materials from entering the pipe.
5. Permissible deflections at joints shall not exceed two-thirds of the maximum deflection allowed by the pipe manufacturer.
6. Maximum length of uncovered trench shall be 100 feet.

G. Exposed Pipe:

1. All piping shall be supported in a manner that will not put undue strain on equipment. Supports shall prevent transmission of vibration and strain to equipment and shall keep piping aligned.
2. Where supports are not shown, horizontal runs shall be supplied with sufficient supports to maintain deflection of pipelines in a span at less than 1/4-inch, when filled with chemical.
3. Piping shall not interfere with access to valves or equipment, or obstruct passages, doorways, access aisles and removal spaces required for maintenance of equipment.
4. Piping 3-inch and Smaller: Run adjacent to walls, where possible, and support with unistruts. Provide adequate clearance between walls and flanges, valves or other devices installed in the piping.

3.2 FIELD TESTING

A. General:

1. Hydrostatic and leakage tests shall be performed on all piping systems as specified below.
2. CONTRACTOR shall submit a plan for the hydrostatic testing of all pressure pipelines.
3. Hydrostatic testing shall be performed on closed loops or subsystems not exceeding a total length of five thousand (5000) feet.
4. CONTRACTOR shall give 24 hours advance notice prior to hydrostatic testing. No testing shall be commenced without COUNTY's Project Representative in attendance.
5. Repair and retest all lines which do not pass the tests as specified herein.
6. Inspect all valves, joints and specialties for tightness and for proper operation while under test pressure.

B. Tests:

1. Destructive Pressure Tests:
 - a. Allow all concrete supports and blocking to reach design strength before testing.
 - b. Ensure that piping and appurtenances are in place and operational.
 - c. Fill section to be tested slowly with water and expel all air. Install

- corporation stops, if necessary, to remove all air.
- d. All piping shall be tested between valves or bulk heads.
- e. Test pressure shall be 80 psi.
- 2. Hydrostatic and Leakage Testing:
 - a. Hydrostatic and leakage test shall be conducted after satisfactory completion of the destructive pressures tests.
 - b. Testing for acceptance shall only be performed after the road base had been installed and compacted.
 - c. Hydrostatic and leakage testing shall be performed in accordance with AWWA C-600, latest revision. All systems shall be tested at 100 psi. Test pressure shall be maintained by pumping from a calibrated container or use of an approved, low flow totalizer meter for at least two hours.
 - d. All chemical PVC piping shall have zero leakage.
 - e. If the lines do not meet the above leakage test, they shall be repaired and retested as necessary until the leakage requirement is met. All work found defective shall be repaired or replaced at the expense of the CONTRACTOR.

3.3 DETAILED REQUIREMENTS

- A. Workmanship: The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other defects. The pipe shall be uniform in color, opacity, density, and other physical properties.
- B. Dimensions and Tolerances: Dimensions and tolerances shall be measured in accordance with ASTM D 2122. The eccentricity of the inside and outside circumferences of the pipe walls shall not exceed 12 percent.
- C. Sustained Pressure: The pipe shall not fail, balloon, burst, or weep as defined in ASTM D 1598.
- D. Burst Pressure: The minimum burst pressure shall be as given, when determined in accordance with ASTM D 1599.
- E. Piping and fittings shall have ultraviolet inhibitor pigment to resist ultraviolet deterioration.
 - 1. All valves shall be supported independently of the piping system.
 - 2. Wide band supports as recommended by manufacturer and approved by ENGINEER shall be used to minimize localized stresses.
 - 3. Piping passing through walls shall be provided with a sleeve of wearing material to prevent abrasion damage to piping.
 - 4. When anchors are required at locations other than equipment or tanks they shall be paced at elbows, valve locations and at bands in pipe line.
 - 5. Do not install pipe when temperature is less than 60 degrees F except as

otherwise recommended by manufacturer and approved by ENGINEER.

3.4 IDENTIFICATION

- A. All pipe line materials shall be permanently marked with the following:
 - 1. Name of manufacturer.
 - 2. Date of manufacture.
 - 3. Operating design pressure at operating design temperature.
 - 4. Mark number to match Shop Drawings.
 - 5. Type of pipe and nominal size.
 - 6. Manufacturer's part number.
- B. Pipe markings shall be in complete accordance with requirements of Section 10400, Identification Devices.

3.5 FIELD PAINTING

- A. Field painting shall be in complete accordance with requirements of Section 09900, Coatings.

++ END OF SECTION ++

SECTION 15082

INSULATION OF PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, material, equipment and incidentals as shown, specified and required to furnish and install insulation for all heating piping systems, condensate drains, refrigerant piping and all potable water piping systems with all accessories, including valves and fittings.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the insulation of piping and equipment Work.
- C. Related Sections:
 - 1. Division 15, Applicable Sections on Piping and HVAC Elements.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American Society for Testing and Materials, (ASTM).
 - a. ASTM C 449/C 449M, Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - b. ASTM C 547, Specification for Mineral Fiber Pipe Insulation.
 - c. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
 - 2. Federal Specifications, (FS).
 - a. FS HH-1-558B, Insulation Blocks, Boards, Blankets, Felts, Sleeving, Pipe Fitting Covering.
 - b. FS SS-C-160, Cement, Insulation, Thermal.
 - 3. National Fire Protection Association, (NFPA).
 - a. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Manufacturer shall have a minimum of five years experience of producing

substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

- B. Component Supply and Compatibility:
 - 1. Obtain all equipment included in this Section, regardless of the component manufacturer, from a single insulation of piping and equipment manufacturer.
 - 2. The insulation of piping and equipment manufacturer to review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the insulation of piping and equipment manufacturer.
- C. Regulatory Requirements: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. National Fire Protection Association, (NFPA).
 - 2. Underwriters' Laboratories, Inc., (UL). Fire hazard ratings to be verified by Underwriters' Laboratories, Inc. label or listing or a certified test report from an approved independent testing laboratory.
 - 3. Local and State Building Codes and Ordinances:
 - a. Uniform Building Code
 - b. Uniform Mechanical Code.
 - c. Model Energy Code.
 - 4. Permits: CONTRACTOR shall obtain and pay for all required permits, fees, inspections and approvals by authorities having jurisdiction.

1.4 SUBMITTALS

- A. Shop Drawings: Submit the following:
 - 1. Manufacturers' catalog literature, specifications, and illustrations with the following information:
 - a. Thermal properties.
 - b. Physical properties.
 - c. Fire hazard ratings.
 - d. Facing information.
 - e. Installation instructions.
 - f. Jointing recommendations for butt joints and longitudinal seam.
 - 2. Fabrication instructions for pipe fittings and valve insulation and coatings.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-

- in-place concrete in ample time to prevent delay of that Work.
2. Material shall be packed and shipped in corrugated carton.

B. Storage and Protection:

1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Store all materials in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
3. Store material in clean, dry area, out of the weather.
4. Material shall be tightly covered to protect against dirt, water, mechanical injury or chemical damage.
5. Material shall remain in original cartons until time of installation.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify COUNTY, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

- A. Insulation systems including covering, mastics, adhesives, sealers and facings shall have the following fire hazard classifications:
1. Flame Spread: 25 maximum.
 2. Fuel Contributed: 50 maximum.
 3. Smoke Developed: 50 maximum.

2.2 MATERIALS

A. Mechanical Equipment Insulation:

1. Type: Semi-rigid fiberglass board.
2. Minimum Thickness: Three-inches.
3. Insulation Jacket: All service jacket.
4. Density: Three lbs. per cubic foot.
5. Fasteners: 3/4-inch by 0.015-inch stainless steel bands.
6. Wrapping: One-inch wire mesh.
7. Finish: Two, 1/2-inch thick coats of insulating cement with open weave glass cloth.
8. Lagging Adhesive:

- a. Products and Manufacturers: Provide one of the following:
 - 1) Foster Products Division, Sealfast 30-36.
 - 2) Or equal.
 - b. Type: Asbestos free, fire retardant coating.
 - c. References:
 - 1) MIL-A-3361B, Class 1, Grade A.
 - 2) NFPA 90A.
 - 9. Insulating Cement:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Ryder Sales: Thermokote 1.
 - 2) Insulation Industries Inc., Smooth Kote.
 - 3) Or equal.
 - b. Type: Asbestos free, hydraulic setting refractory type insulating cement, non-corrosive to ferrous metals.
 - c. Reference:
 - 1) ASTM C 449/C 449M.
 - 2) Federal Specification SS-C-160 Type III GRF.
 - 10. Products and Manufacturers: Provide one of the following:
 - a. Certain-Teed Products Corporation, Snap Wrap.
 - b. Owens-Corning Fiberglass Corporation, Pipe Wrap.
 - c. Or approved equal.
- B. Weatherproof Insulation Jacket (for insulated piping exposed to ambient conditions):
- 1. Type: Smooth embossed aluminum metal jacket.
 - 2. Thickness: 0.016-inches.
 - 3. Moisture Barrier: Polycraft.
 - 4. Fastening: Pre-formed "Z"-lock seam with 2-inch butt strap with sealant.
 - 5. Bands: 1/2-inch aluminum bands with wing seals.
 - 6. Fittings:
 - a. Type: Pre-fabricated aluminum fittings.
 - b. Thickness: 0.016-inches.
 - 7. Manufacturers: Provide products of one of the following:
 - a. Certain-Teed Products Corporation.
 - b. Childers Products Company, Lock-On and Slip-On.
 - c. Or approved equal.
- C. Flexible-Elastomeric Thermal Insulation (for refrigerant piping):
- 1. Type: Expanded close cell structure elastomeric thermal insulation.
 - 2. Thermal Conductivity: 0.25 Btu-inch/hr. - ft²-°F.
 - 3. Density: Six lbs. per cubic foot.
 - 4. Products and Manufacturers: Provide one of the following:
 - a. Halstead Industries, Type "Insul-tube".
 - b. Or approved equal.

2.3 SOURCE QUALITY CONTROL

- A. Source Quality Control: Perform the following tests and inspections at the factory:
 - 1. Flame spread.
 - 2. Smoke developed.
 - 3. Fuel contributed.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Ensure that surfaces of all equipment including pipes, valves, and fittings are clean and dry before applying insulation.

3.2 PREPARATION

- A. Ensure that piping and equipment has been tested, inspected and released for application of insulation.

3.3 INSTALLATION

- A. Pipe insulation shall be continuous through walls and floor openings, except where walls or floors are required to be firestopped or required to have a fire resisting rating.
- B. Where hangers are in direct contact with piping the hanger and supporting rod shall be wrapped with foil-faced blanket insulation and vapor sealed. Hanger rod insulation and vapor barrier shall extend up to the rod a minimum distance equal to the diameter of the pipe.
- C. Install insulation so as to make surfaces smooth, even, and substantially flush with adjacent insulation.
- D. Follow manufacturer's application instructions for all materials used.
- E. Provide insulation protection shields for insulated piping supported by pipe hangers.
- F. Install and coat insulation in accordance with the manufacturer's recommendations.
- G. After applying initial equipment insulation, wrap equipment and insulation with wire mesh and apply two separate coats of insulating cement. Apply one coat of insulating finish cement. When dry, apply one coat of fire retardant lagging adhesive. Embed a layer of open weave glass cloth overlapping all seams by 2-

inches, and finish with a second coat of fire retardant lagging adhesive.

H. Weatherproofing for Piping Insulation:

1. Piping: Apply field applied jacket with moisture barrier around pipe or equipment and slip edge into preformed Z lock position to shed water. Butt next jacket section leaving approximately 3/8-inch gap. Place preformed 2-inch butt strap with sealant over the seam and secure with 1/2-inch aluminum band and wing seal.
2. Fittings: Apply prefabricated metal fittings identical in composition to pipe jacketing.

3.4 FIELD QUALITY CONTROL

- A. Ensure that insulation is dry when installed, and before and during application of any finish.
- B. Protection:
1. All material applied in one day shall have the vapor barrier applied the same day and any exposed ends shall be temporarily protected with a moisture barrier and sealed to the pipe.

3.5 SCHEDULE

- A. Refer to Schedule below for minimum thickness of pipe insulation:

Specified Piping:	1-1/2 thick w/weatherproof jacket.
Specified Equipment:	3-inches thick

- B. The following equipment and piping shall be insulated:

1. Fuel Oil Lines.
2. Cold Water supply piping.
3. Condensate drain piping.

- C. All unions, valves and fittings shall be insulated.

++ END OF SECTION ++

SECTION 15100

PROCESS VALVES, FOUR-INCH DIAMETER AND LARGER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install process valves, four-inch diameter and larger, and appurtenances, complete and operational.
2. Valves for digester gas and air have been specifically identified. All other valves are for liquid service.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before process valves Work.

C. Related Sections:

1. Section 05051, Anchor Systems.
2. Section 09900, Coatings.
3. Section 15051, Buried Piping Installation.
4. Section 15052, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American Bearing Manufacturers Association (ABMA).
2. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
3. ANSI B16.34, Valves-Flanged, Threaded and Welding end. (ASME B16.34).
4. ANSI/NSF 61 Drinking Water Components – Health Effects.
5. API STD 594, Check Valves, Flanged Lug, Wafer and Butt-Welding.
6. API STD 598, Valve Inspection and Testing.
7. API STD 609, Butterfly Valves: Double Flanged, Lug-Type and Wafer-Type.
8. ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

9. ASTM A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
10. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service, or Both.
11. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
12. ASTM A276, Specification for Stainless Steel Bars and Shapes.
13. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
14. ASTM A351/A351M, Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.
15. ASTM A380, Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems.
16. ASTM A536, Specification for Ductile Iron Castings.
17. ASTM A564/A564M, Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
18. ASTM A743/A743 M, Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
19. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
20. ASTM B98/B98M, Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
21. ASTM B138/B138M, Specification for Manganese Bronze Rod, Bar and Shapes.
22. ASTM B265, Specification for Titanium and Titanium Alloy Strip, Sheet and Plate.
23. ASTM B584, Specification for Copper Alloy Sand Castings for General Applications.
24. ASTM D429, Test Methods for Rubber Property - Adhesion to Rigid Substrates.
25. AWWA C500, Metal-Seated Gate Valves for Water Supply Service.
26. AWWA C501, Cast-Iron Sluice Gates.
27. AWWA C502, Dry-Barrel Fire Hydrants.
28. AWWA C504, Rubber-Seated Butterfly Valves.
29. AWWA C507, Ball Valves, 6-inch through 48-inch.
30. AWWA C508, Swing-Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
31. AWWA C509, Resilient-Seated Gate Valves for Water Supply Service.
32. AWWA C540, Power-Actuating Devices for Valve and Slide Gates.
33. AWWA C550, Protective Interior Coatings for Valves and Hydrants.
34. AWWA Manual M49, Butterfly Valves: Torque, Head Loss, and Cavitation Analysis.

35. FS TT-C-494, Coating Compound, Bituminous, Solvent Type, Acid-Resistant.
36. NEMA MG 1, Motors and Generators.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Manufacturer shall have minimum of five years of experience producing substantially similar materials and equipment to that required and be able to provide evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:

1. Obtain each type of equipment and appurtenances included in this Section, regardless of the component manufacturer, from a single manufacturer of the type of process valve. For each type of valve, do not furnish valves of more than one manufacturer.
2. Supplier of each type of equipment specified shall review and approve or prepare all Shop Drawings and other submittals for all components associated with the type of process valve Supplier is furnishing.
3. Components shall be suitable for use in the specified service conditions. Components shall be integrated into the overall assembly by the process valve manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Installation drawings showing orientation of valve in both plan and elevation view. Drawings shall clearly identify valve and its appurtenances, including controls, actuators, valve stems, and other components. Show dimensions of valves and appurtenances in relation to piping and structural and architectural components, where applicable.
 - b. Controls for and control characteristics of modulating valves.
 - c. Power and control wiring diagrams, including terminals numbers for electric-motor actuators.
 - d. Calculations for sizing of electric actuators.
 - e. Calculations for sizing of operating mechanism with extension stems.
 - f. Calculations for sizing of gear actuators.
2. Product Data:
 - a. Product data sheets.

- b. Complete catalog information, including dimensions, weight, specifications, and identification of materials of construction of all parts.
 - c. Corrosion resistance information to confirm suitability of valve materials for the application. Furnish information on chemical resistance of elastomers from elastomer manufacturer.
 - d. Cv values and hydraulic headloss curves.
 - 3. Samples:
 - a. If requested by ENGINEER, furnish one foot of chain for chainwheel-operated valves.
 - 4. Testing Plans:
 - a. Submit plan for shop testing of each valve for which shop testing is specified, including testing plan's and test facility's limitations proposed.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Certificates of compliance with referenced standards, where applicable, including those of AWWA, NSF, and others required by ENGINEER.
 - 2. Manufacturer Instructions:
 - a. Submit manufacturer's instructions for handling, storing, and installing valves and appurtenances. Provide templates and setting drawings for valves and appurtenances that require anchor bolts or similar anchorages.
 - 3. Source Quality Control Submittals:
 - a. Submit copies of shop test results and inspection data, certified by manufacturer.
 - 4. Field Quality Control Submittals:
 - a. Submit results of field tests required.
 - 5. Supplier's Reports:
 - a. When requested by ENGINEER, submit written report of results of each visit to Site by Supplier's serviceman, including purpose and time of visit, tasks performed and results obtained.
 - 6. Qualifications Statements:
 - a. When requested by ENGINEER, submit manufacturer's qualifications demonstrating compliance with the Specifications, including list of existing installations with contact names and telephone number(s) for each.
- C. Closeout Submittals: Submit the following:
 - 1. Operations and Maintenance Data:

- a. Furnish operation and maintenance manuals in accordance with Section 01730, Operations and Maintenance Data.
 - b. Furnish in operations and maintenance manuals complete nameplate data for each valve and electric actuator.
- D. Maintenance Material Submittals: Submit the following:
 - 1. Spare Parts, Extra Stock Materials, and Tools:
 - a. Spare Parts and Extra Stock Materials: Furnish as specified for each valve type.
 - b. Tools: Furnish two sets of special tools (excluding metric tools, if applicable) for each size and type of valve furnished.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
 - 1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
 - 2. Inspect boxes, crates, and packages upon delivery to Site and notify COUNTY in writing of loss or damage to materials and equipment. Promptly remedy loss and damage to new condition in accordance with manufacturer's instructions.
 - 3. Conform to Section 01600, Material and Equipment.
- B. Storage and Protection:
 - 1. Keep products off ground using pallets, platforms, or other supports. Store equipment in covered storage and prevent condensation and damage by extreme temperatures. Store in accordance with manufacturer's recommendations. Protect steel, packaged materials, and electronics from corrosion and deterioration.
 - 2. Conform to Section 01620, Storage and Protection.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Valves, General:
 - 1. Provide each valve with manufacturer's name and rated pressure cast in raised letters on valve body.
 - 2. Provide valves with brass or Type 316 stainless steel nameplate attached with Type 316 stainless steel screws. Nameplates shall have engraved letters displaying the following minimum information:

- a. Valve size.
 - b. Pressure and temperature ratings.
 - c. Application (other than water and wastewater).
 - d. Date of manufacture.
 - e. Manufacturer's name.
3. Provide valves to turn clockwise to close, unless otherwise specified.
 4. Provide valves with permanent markings for direction to open.
 5. Manually operated valves, with or without extension stems, shall require not more than 40-pound pull on manual operator to open or close valve against specified criteria. Gear actuator and valve components shall be able to withstand minimum pull of 200 pounds on manual operator and input torque of 300-foot pounds to actuator nut. Manual operators include handwheel, chainwheel, crank, lever, and T-handle wrench.

B. Valve Materials:

1. Valve materials shall be suitable for the associated valve's service or application, as shown.
2. Protect wetted parts from galvanic corrosion caused by contact of different metals.
3. Wetted components and wetted surfaces of valves used with potable water or water that will be treated to become potable shall conform to ANSI/NSF 61.
4. Clean and descale fabricated stainless steel items in accordance with ASTM A380 and the following:
 - a. Passivate all stainless steel welded fabricated items after manufacture by immersing in pickling solution of six percent nitric acid and three percent hydrofluoric acid. Temperature and detention time shall be sufficient for removing oxidation and ferrous contamination without etching surface. Perform complete neutralizing operation by immersing in trisodium phosphate rinse followed by clean water wash.
 - b. Scrub welds with same pickling solution or pickling paste and clean with stainless steel wire brushes or by grinding with non-metallic abrasive tools to remove weld discoloration, and then neutralize and wash clean.

C. Valve Joints:

1. Exposed Valves: Unless otherwise specified, provide with flanged ends conforming to ANSI B16.1. Pressure class of flanges shall be equal to or greater than specified pressure rating of the associated valve.
2. Buried Valves: Unless otherwise specified, provide with mechanical or push-on joints, restrained or unrestrained, as required by piping with which valve is installed.

3. For stainless steel bolting, except where nitrided nuts are required, use graphite-free anti-seize compound to prevent galling. Strength of joint shall not be affected by using anti-seize compound.

2.2 ECCENTRIC PLUG VALVES

- A. Manufacturers: Provide products of one of the following:
 1. DeZurik.
 2. Or equal.
- B. General:
 1. Provide eccentric-type plug valves each with rectangular ports.
 2. Minimum Rated Working Pressure:
 - a. Valves 12-inch Diameter and Smaller: 175 psig.
 - b. Valves 14-inch through 72-inch Diameter: 150 psig.
 3. Maximum Fluid Temperature: 180 degrees F.
 4. Minimum Port Area:
 - a. Valves 20-inch Diameter and Smaller: 100 percent of nominal pipe area.
 5. Packing and packing gland shall be externally adjustable and accessible without disassembling valve and without removing the actuator.
 6. Valves shall provide drip-tight, bi-directional shutoff at rated pressures.
 7. Plug shall have cylindrical seating surface eccentrically offset from center of plug shaft. Interface between plug face and body seat, with plug in closed position, shall be externally adjustable in the field with valve in the line while under pressure.
 8. Plug shall be supported to top bearing by using spring that is externally adjustable.
 9. For sludge service, plug valves shall allow pigging of the piping with line-size pigs.
- C. Materials of Construction:
 1. Body: Cast Iron ASTM A126 Class B, or Ductile-iron ASTM A536 Grade 65-45-12.
 2. Plug:
 - a. Core: Cast Iron ASTM A126 Class B, or Ductile-iron, ASTM A536 Grade 65-45-12.
 - b. Plug Facing: Neoprene.
 - c. For valves up to eight-inch diameter, plugs shall be fully encapsulated with rubber. For valves larger than eight-inch diameter, provide plugs with rubber facing. Minimum thickness of rubber lining shall be 1/8-inch. Rubber hardness shall be a minimum of 70 (Shore A) durometer.

Rubber-to-metal bond shall withstand minimum 75-pound pull conforming to ASTM D429 Method B.

3. Seats: Minimum 1/8-inch welded overlay of minimum 90 percent pure nickel on surfaces contacting plug face. Seats shall provide contact area of at least 1/2-inch width all around.
4. Stem Bearings: Sintered, oil impregnated, permanently lubricated of Type 316 stainless steel.
5. Stem Seal: Multiple neoprene V-ring type.
6. All internal and external bolting and other hardware including pins, set screws, plug, studs, bolts, nuts and washers shall be Type 316 stainless steel.

D. Interior Coating and Lining:

1. Valves shall be coated inside. Steel, cast-iron, and ductile iron surfaces, except machined surfaces, shall be epoxy-coated in accordance with AWWA C550.

E. Shop Testing:

1. Operational Tests:
 - a. To demonstrate that complete assembly is workable, successfully operate each valve (with actuator mounted directly on valve) three times from fully closed to fully open position and reverse under no-flow condition.
2. Leakage Tests:
 - a. Test each valve for leaks while valve is in closed position.
 - b. Test valves at rated pressures. During test, valves shall be drip-tight. Test duration shall be at least five minutes for valves up to 20-inch diameter and ten minutes for valves larger than 20-inch diameter. Tests shall be repeated successfully with pressure in the unseating direction.
3. Hydrostatic Test: Test valves to an internal hydrostatic pressure equivalent to twice rated pressure of valve. During hydrostatic test, there shall be no leakage through metal, end joints, and shaft seal, nor shall any part be permanently deformed. Duration of hydrostatic test shall be sufficient to allow visual examination for leakage. Test duration shall be at least one minute for valves eight-inch diameter and smaller, three minutes for valves 10-inch through 20-inch diameter, and ten minutes for valves 24-inch diameter and larger.

F. Gear Actuators for Manually-operated Valves:

1. Provide gear actuators on buried and exposed valves, except valves four-inch diameter and smaller located less than five feet above operating floor. Gas service valves shall be provided with worm gear actuators.

2. Size gear actuators for valves eight-inch diameter and smaller for 175 psig differential pressure.
3. Provide actuators capable of holding associated valves in any intermediate position without creeping or vibrating.
4. Provide valve position indicator on each actuator. Provide stop-limiting devices for open and closed position. For buried and submerged service actuators, provide position indicators in valve box.
5. Provide adjustable stop to adjust seating pressure.
6. Make packing accessible for adjustment without requiring removal of actuator from valve, except for valves in buried and submerged service.
7. Diameter ratio of handwheel or chainwheel and gear sector shall be less than two.
8. For buried and submerged valves, gear actuator shall be grease-packed and designed to withstand submersion, and shall be drip-tight in water 20 feet deep, with self-adjusting packing.
9. Provide each actuator with gearing totally enclosed.
10. Operator shaft and gear sector shall be supported on permanently lubricated bronze or stainless steel bearings.
11. Provide metal-encased spring loaded seals in top and bottom covers of gear housing.
12. Actuators shall be provided to produce indicated torque with maximum pull of 40 pounds on handwheel or chainwheel and maximum input of 150-foot pounds on operating nuts, for both seating and unseating heads equal to maximum differential pressure rating of valve.
13. Actuator components between input and stops shall be designed to withstand, without damage, a pull of 200 pounds for handwheel or chainwheel actuators and input torque of 300-foot pound for operating nuts when operating against stops.
14. Materials of Construction:
 - a. Housing: Cast-iron, ASTM A126 Class B.
 - b. Gear Sector: Cast-iron ASTM A126 Class B, or ductile iron ASTM A536.
 - c. Worm Shaft: Steel, AISI 1144, hardened and tempered to an average Rc 40 and within range of Rc 35-45.
 - d. Bearings: Bronze oil-impregnated, or stainless steel.
 - e. Hardware, including bolts, nuts, washers, set screws, and pins, shall be Type 316 stainless steel.

2.3 BUTTERFLY VALVES

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

1. DeZurik.

2. Henry Pratt Company.
3. Or equal.

B. General:

1. Provide butterfly valves conforming to AWWA C504 and as specified herein.
2. Sizes:
 - a. Flanged: Four-inch through 72-inch diameter.
 - b. Mechanical Joint: Four-inch through 48-inch diameter.
3. Rated Working Pressure: 150 psig, Class 150B.
4. Maximum Fluid Temperature: 150 degrees F.
5. Valves shall provide drip-tight bi-directional shutoff at rated pressures.
6. Mount valve seats in valve body. Rubber seats for 24-inch diameter and larger valves shall be replaceable in the field.
7. Valves shall be capable of being maintained in open or partially open position for manual operation, and for automatic operation. When valve disc is maintained, there shall be no chatter or vibration of disc or operating mechanism.
8. Valve packing shall be replaceable without dismantling valve.
9. Disc shall be offset from shaft to provide uninterrupted 360-degree seat seal.

C. Materials of Construction: materials of construction shall conform to AWWA C504 and shall be as follows:

1. Body: Cast-iron, ductile iron, or alloy cast-iron.
2. Shaft: Type 316 stainless steel.
3. Discs:
 - a. Valves Smaller than 30-inch Diameter: Cast-iron.
 - b. Valves 30-inch Diameter and Larger: Ductile iron.
4. Seats: Buna-N or other synthetic rubber suitable for the application.
5. Seating Surfaces: Type 316 stainless steel.
6. Bearings:
 - a. Valves Smaller than 24-inch Diameter: Nylon.
 - b. Valves 24-inch Diameter and Larger: Fiberglass with Teflon lining.
7. Shaft Seals: Externally adjustable, material same as for seats. For services that are either buried or submerged, self-adjusting V-type chevron, material same as for seats.
8. Tapered Pins for Attachment of Shaft to Disc: Type 316 stainless steel.
9. Internal and external bolting and other hardware; including pins, set screws, studs, bolts, nuts, and washers shall be Type 316 stainless steel.

D. Interior Coating:

1. Valves shall be coated inside. Steel, cast-iron, and ductile iron surfaces,

except machined surfaces, shall be epoxy-coated in accordance with AWWA C550.

E. Testing:

1. Test each valve in the manufacturer's shop in accordance with AWWA C504.

F. Gear Actuators for Manual Valves:

1. Provide gear actuators conforming to AWWA C540.
2. Gear actuators for valves 20-inch diameter and smaller shall be constructed for 150 psi differential pressure and 16 feet per second port velocity.
3. Gear actuators for valves 24-inch diameter and larger shall be constructed for maximum differential pressures and velocities as specified below:
 - a. Valve Size and Location: 36" Lake filter influent SPW & 36" Lake filter effluent.
 - b. Maximum Differential Pressure Across Closed Valve: 50 psi.
 - c. Maximum Port Velocity through Full Open Valve: 3.5 feet per second.

2.4 SWING CHECK VALVES

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

1. APCO Willamette Valve & Primer Corp.
2. Crispin Valve
3. G.A. Industries.

B. General:

1. Provide valves conforming to AWWA C508 and as specified herein.
2. Sizes: Four-inch through 24-inch diameter.
3. Type: Resilient-seated.
4. Rated Working Pressure:
 - a. Smaller than 12-inch Diameter: 175 psig.
 - b. 12-inch Diameter and Larger: 150 psig.
5. Provide valves suitable for horizontal or vertical mounting.
6. Check valves shall have clear waterway with full-open area equal to nominal pipe size.
7. Provide check valves with outside adjustable weight and lever.
8. Provide valves larger than six-inch diameter with adjustable air cushion chambers.
9. Valve seats shall be mechanically attached and shall be field replaceable.

C. Materials of Construction: All materials of construction shall conform to AWWA C508 and shall be as follows:

1. Body, Disc, Cover and Gland: Cast-iron or ductile iron.
2. Disc Arm: Ductile iron.
3. Hinge Shaft: Type 316 stainless steel.
4. Hinge Shaft Bushings: Bronze, or Type 316 stainless steel for sewage service.
5. Shaft End Plate: Type 316 stainless steel.
6. Body Seat: Type 316 stainless steel.
7. Follower Ring for Rubber Seat on Disc: Type 316 stainless steel.
8. Disc Center Pin Assembly: Type 316 stainless steel.
9. Air Cushion Chamber:
 - a. Chamber and Plunger: Bronze.
 - b. Linkages and Pins: Type 316 stainless steel.
 - c. Air Check Valve and Tubing: Brass or stainless steel.
10. Rubber Items:
 - a. Applications Up to 180-degree F Fluid Temperature: Buna-N or other synthetic rubber suitable for the application.
 - b. Applications 180-degrees F and Greater Fluid Temperature: Viton, or other synthetic rubber suitable for the application.
11. Internal and external bolting and other hardware; including pins, set screws, studs, bolts, nuts, and washers shall be Type 316 stainless steel.
12. Gland Packing: Graphite and Kevlar.

D. Interior Coating:

1. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy coated in accordance with AWWA C550.

E. Testing:

1. Test each valve in manufacturer's shop in accordance with AWWA C508.
2. Allowable Leakage at Rated Pressures: Zero.

2.5 APPURTENANCES FOR EXPOSED METALLIC VALVES

A. General:

1. For valves located less than five feet above operating floor, provide levers on four-inch diameter quarter-turn valves, and provide handwheels on all other valves, unless otherwise shown or specified.
2. For valves located five feet or more above operating floor, provide chain operators.
3. Where indicated, provide extension stems and floorstands.

- B. Handwheels:
1. Conform to applicable AWWA standards.
 2. Material of Construction: Ductile iron, or cast aluminum.
 3. Arrow indicating direction of opening and word "OPEN" shall be cast on trim of handwheel.
 4. Maximum Handwheel Diameter: 2.5 feet.
- C. Chain Operators:
1. Chains shall extend to three feet above operating floor.
 2. Provide 1/2-inch stainless steel hook bolt to keep chain out of walking area.
 3. Materials of Construction:
 - a. Chain: Type 316L stainless steel.
 - b. Chainwheel: Recessed groove type made out of Type 316 stainless steel.
 - c. Guards and Guides: Type 316L stainless steel.
 4. Chain Construction:
 - a. Chain shall be of welded link type with smooth finish. Chain that is crimped or has links with exposed ends is unacceptable.
 5. Provide geared operators where required to position chainwheels in vertical position.
- D. Crank Operator:
1. Crank operator shall be removable and fitted with rotating handle.
 2. Maximum Radius of Crank: 15 inches.
 3. Materials:
 - a. Crank: Cast-iron or ductile iron.
 - b. Handle: Type 304 stainless steel.
 - c. Hardware: Type 304 stainless steel.
- E. Extension Stems and Floor Stands for Gate Valves:
1. Conform to the applicable requirements of AWWA C501 for sizing of complete lifting mechanism.
 2. Bench and Pedestal Floor Stands:
 - a. For valves requiring extension stems, provide bench or pedestal floor stands with handwheel or crank as indicated. Provide provisions for using portable electric actuator for opening and closing of valves.
 - b. Type: Heavy-duty with tapered roller bearings enclosed in a weatherproof housing, provided with positive mechanical seals around lift nut and pinion shaft to prevent loss of lubrication and to prevent moisture from entering housing. Provide lubrication fitting for grease. For valves conveying water that is potable or that will be treated to become potable, grease shall be food-grade and ANSI/NSF 61-listed. Base shall be machined.

- c. Materials of Construction:
 - 1) Housing: Cast-iron, ASTM A126, Class B.
 - 2) Lift Nut: Cast bronze, ASTM B98/B98M.
 - 3) Grease Fitting: Stainless steel.
 - 4) Bolting: Type 316 stainless steel.
 - 3. Wall brackets for floor stands shall be Type 316L stainless steel construction.
 - 4. Extension Stems:
 - a. Materials of Stems and Stem Couplings: Type 316 stainless steel.
 - b. Maximum Slenderness Ratio (L/R): 100.
 - c. Minimum Diameter: 1.5-inch.
 - d. Threads: Acme.
 - e. Provide stem couplings where stems are furnished in more than one piece. Couplings shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.
 - f. Weld to bottom of extension stem a Type 316 stainless steel cap suitable for square end of valve stem.
 - 5. Bottom Couplings: Ductile iron with Type 316 stainless steel pin and set screw.
 - 6. Stem Guides:
 - a. Material: Type 316 cast stainless steel with bronze bushing for stem. For submerged service, Type 316 cast stainless steel with stainless steel bushing for stem.
 - b. Maximum Stem Length Between Guides: Seven feet.
 - c. Stem guides shall be adjustable in two directions.
 - 7. Furnish stem cover of clear butyrate plastic or Grade 153 Lexan with cast adapter for mounting cover to bench and floor stands. Provide stem cover with gasketing and breathers to eliminate water intrusion into operator and condensation within cover. Provide stem cover with mylar tape with legible markings showing valve position at one-inch intervals and open and close limits of valve.
- F. Floor Boxes: Provide cast-iron floor boxes for valves that are to be operated from floor above valve. Boxes shall be equal in depth to floor slab. Boxes shall have cast-iron covers and be fitted with bronze bushing.

2.6 APPURTENANCES FOR BURIED METALLIC VALVES

- A. Wrench Nuts:
 - 1. Provide wrench nuts on buried valves of nominal two-inch size, in accordance with AWWA C500.
 - 2. Arrow indicating direction of opening the valve shall be cast on the nut along with the word "OPEN".

3. Material: Ductile iron or cast-iron.
 4. Secure nut to stem by mechanical means.
- B. Extension Stems for Non-Rising Stem Gate Valves and Quarter-turn Buried Valves:
1. Provide extension stems to bring operating nut to six inches below valve box cover.
 2. Materials of Stems and Stem Couplings: Type 316 stainless steel.
 3. Maximum Slenderness Ratio (L/R): 100
 4. Provide top nut and bottom coupling of ductile iron or cast-iron with pins and set screws of Type 316 stainless steel.
- C. Valve Boxes:
1. Valve boxes shall be as indicated and as required.
 2. Type: Heavy-duty, suitable for highway loading, two-piece telescopic, and adjustable. Lower section shall enclose valve operating nut and stuffing box and rest on valve bonnet.
 3. Material: Cast-iron or ductile iron.
 4. Coating: Two coats of asphalt varnish conforming to FS TT-C-494.
 5. Marking: As required for service.

2.7 ELECTRIC ACTUATORS (MODULATING)

- A. Manufacturers: Provide products of one of the following:
1. Limitorque MX Series.
 2. Rotork IQ Series.
 3. Auma SR Series
- B. Application Criteria:
1. Ambient Temperature Rating: -20 to +158 degrees F.
 2. Ambient Humidity: 100 percent.
 3. Maximum Differential Pressures across Closed Valves: Refer to Schedule of Valves with Actuators located in Section 11751.
 4. Maximum Flows Through Full Open Valves: Refer to Schedule of Valves with Actuators located in Section 11751.
 5. Duty Cycle: Intermittent (minimum 1,200 starts/stops per hour), unless otherwise specified.
 6. Power Supply: 480 VAC, three-phase, 60 Hertz.
 7. Control Voltage: 120 VAC, single-phase, 60 Hertz.
 8. Torque: As recommended by valve manufacturer.
 9. Accepts 4 to 20 mA DC input to positioner.
 10. Non-intrusive calibration.

11. Fault diagnosis and data logging.

C. General:

1. Conform to AWWA C540 and this Section.
2. Provide actuator operable with handwheel even after electric motor has been disengaged and removed.
3. Provide each valve with electric actuators located more than five feet, or less than 3 feet, above operating floor with separate control panel installed with controls and indicators approximately five feet above operating floor at location approved by ENGINEER . Modify electrical wiring as required for remote location of control panels.
4. Coordinate sizing of each electric actuator with valve manufacturer who shall furnish valve and electric actuator as a unit.
5. Electric actuators shall be suitable for valve orientation shown.

D. Electric Motor:

1. General:
 - a. Provide motors suitable for modulating service, of high torque characteristics and minimum 70 degrees C temperature rating.
2. Motor Construction:
 - a. Enclosure: NEMA 4X.
 - b. Insulation: Class H.
 - c. Service Factor: 1.15.
 - d. Power Supply: (480 VAC).
 - e. Motor Size: as recommended by manufacturer.
 - f. RPM: as recommended by manufacturer.
 - g. Provide winding thermostats for overcurrent protection.
 - h. Efficiency: High-efficiency conforming to NEMA MG 1.
 - i. Bearings: Anti-friction, B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.

E. Actuator Gearing:

1. Housing: Die-cast aluminum.
2. Close-coupled to electric motor.
3. Input Shaft Gearing: Spur or bevel gear assembly.
4. Output Shaft Gearing: Self-locking worm gears with minimum gear backlash to prevent valve disc chatter or vibration.
5. Gearing shall be of hardened alloy steel or combination of hardened alloy steel and alloy bronze, accurately cut by hobbing machine.
6. Lubrication: Grease or oil bath.
7. Bearings: Ball or roller with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.
8. Input Shaft: Hardened alloy steel.

9. Provide mechanical stops adjustable to plus-or-minus five degrees at each end of travel.
10. Provide mechanical position indication.

F. Limit Switches:

1. Provide each actuator with "END OF TRAVEL" limit switches to allow control of desired end position for each direction of travel.
2. Provide "OPEN" and "CLOSE" limit switches geared to drive mechanism and in step at all times, whether unit is operated electrically or manually and whether or not actuator is electrically powered. Friction devices or set-screw arrangements shall not be used to maintain setting.
3. Limit switch gearing shall be appropriately lubricated.
4. Provide drive mechanism totally enclosed to prevent entrance of foreign matter or loss of lubricant.
5. Provide each limit switch with four auxiliary contacts. Two contacts shall close and two contacts shall open at desired end position for each direction of travel.
6. Switches shall be rated five amperes at 120 VAC.

G. Torque Switches:

1. Provide adjustable double-torque switches with valve actuator.
2. Torque switches shall operate during complete valve cycle without using auxiliary relays, linkages, latches, or other devices.
3. Wire torque switches to de-energize valve actuator motor when excessive torque is developed during each direction of travel.
4. It shall be possible to select torque switches to control open and close limit positions in each direction of valve travel.
5. Provide dry contacts (five-amp, 120 VAC) for remote high torque alarm for automatically controlled valves.

H. Handwheel and Chainwheel Operation:

1. Equip actuator with handwheel or chainwheel for manual operation, so connected that operation by motor will not rotate handwheel or chainwheel.
2. Should power be returned to motor while handwheel or chainwheel is in use, unit shall prevent transmission of motor torque to handwheel or chainwheel.
3. Handwheel or chainwheel shall require no more than 80-pound effort on rim for seating or unseating load, and no more than 60-pound effort on running.
4. Handwheel or chainwheel shall have an arrow and word "OPEN" or "CLOSE" indicating required rotation. Handwheel or chainwheel shall operate in clockwise direction to close.
5. Chain Operators: Provide valves located more than five feet above operating floor with chain operators.

I. Controls:

1. Provide following controls in a separate compartment integral with the actuator.
2. Enclosure: NEMA 4X.
3. Starter: Combination reversing magnetic starter with circuit breaker and disconnect switch.
4. Control Power Transformer: Provide transformer to transform rated three-phase, 60 Hertz power to 120 volts, single-phase. Transformer shall be complete with grounded and fused secondary and dual primary fuses.
5. Provide "LOCAL/OFF/REMOTE" selector switch. In "LOCAL" position actuator shall be operated by "OPEN/CLOSE/STOP" pushbuttons. In "OFF" position, actuator shall be disabled from local and remote operation. In "REMOTE" position, "open/close/stop" control from remote source shall be enabled.
6. Provide "OPEN/CLOSE/STOP" pushbuttons with hold-to-run or momentary contact selection.
7. Provide "OPEN/CLOSE/STOP" indicating lights and zero-to-100 percent position indication in liquid crystal display window.
8. Motor shall be de-energized when valve is jammed.
9. Provide thermal overload and single phasing protection of motor.
10. For monitoring of actuator, provide set of single-pole/double-throw (SPDT) dry contacts. Monitor relay shall indicate that actuator is available for remote operation.
11. Provide each actuator with position controller. Controller shall have the following features:
 - a. Receive 4 to 20 mADC analog control signal and position valve in proportion to this signal.
 - b. Adjustments for duty cycle, band width, span, and zero.
 - c. On loss of control signal valve shall stay in its last position.
 - d. Provision for adequate cooling of actuator.
12. Provide actuator with position transmitter capable of producing 4 to 20 mADC output signal. Transmitter shall be standard slidewire (potentiometer) position transducer providing an output corresponding to zero-to-100 percent of travel. Accuracy shall be plus-or-minus one percent of scale. Transmitter shall include integral temperature-compensated, constant-voltage source for slidewire excitation. Transmitter shall be integral to actuator.
13. Supply actuator with circuit boards for high temperature service, minimum 55 degrees C.
14. Provide 120 VAC space heaters to maintain internal housing temperature at 20 degrees C.

- J. Testing:
 - 1. Test each actuator in manufacturer's shop in conformance with AWWA C540.

2.8 ANCHORAGES AND MOUNTING HARDWARE

- A. General:
 - 1. Comply with Section 05051, Anchor Systems, except as modified in this Section.
 - 2. Obtain bolts, nuts, and washers for connection of valve and appurtenances to concrete structure or other structural members from valve Supplier.
 - 3. Bolts, nuts, and washers shall be of ample size and strength for purpose intended. Anchorages in concrete shall be at least 5/8-inch diameter.
 - 4. Provide stem guide anchorages of required strength to prevent twisting and sagging of guides under load.
 - 5. Materials: Provide bolts and washers of Type 316 stainless steel and nitrided nuts. Bolts shall have rolled threads. Bolts and nuts shall be electropolished to remove burrs.

2.9 TOOLS, LUBRICANTS, AND SPARE PARTS

- A. Provide the following T-handle operating wrenches for buried valves:
 - 1. Length of T-Handle Operating Wrench: XX feet.
 - 2. Quantity: XX.
- B. Lubricants: For valves, actuators, and appurtenances requiring lubricants, provide suitable lubricants for initial operation and for first year of use following Substantial Completion. Lubricants for equipment associated with conveying potable water or water that will be treated to become potable shall be food-grade and ANSI/NSF 61-listed.
- C. Tools, spare parts, and maintenance materials shall conform with Section 01730, Operating and Maintenance Data.

2.10 PAINTING OF EXPOSED VALVES, HYDRANTS, AND APPURTENANCES

- A. Exterior steel, cast-iron, and ductile iron surfaces, except machined surfaces of exposed valves and appurtenances, shall be finish painted in manufacturer's shop. Surface preparation, priming, finish painting, and field touch-up painting shall conform to Section 09900, Coatings.

2.11 PAINTING OF BURIED VALVES

- A. Exterior steel, cast-iron, and ductile iron surfaces, except machined or bearing surfaces of buried valves, shall be painted in valve manufacturer's shop with two coats of asphalt varnish conforming to FS TT-C 494.

PART 3 - EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. General:
 - 1. Install valves and appurtenances in accordance with:
 - a. Supplier's instructions and the Contract Documents.
 - b. Requirements of applicable AWWA standards.
 - c. Applicable requirements of Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
 - 2. Install valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment, and other causes.
 - 3. Position swing check valves and butterfly valves so that, when valve is fully open, valve disc does not conflict with piping system elements upstream and downstream of valve.
- B. Exposed Valves:
 - 1. Provide supports for large or heavy valves and appurtenances as shown or required to prevent strain on adjoining piping.
 - 2. Operators:
 - a. Install valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves, piping, structure, and equipment, and as approved by ENGINEER.
 - b. Avoid placing operators at angles to floors or walls.
 - c. Orient chain operators out of way of walking areas.
 - d. Install valves so that indicator arrows are visible from floor level.

- e. For motor-operated valves located lower than five feet above operating floor, orient motor actuator to allow convenient access to pushbuttons and handwheel.
- 3. Floor Stands and Stems:
 - a. Install floor stands as shown and as recommended by manufacturer.
 - b. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by manufacturer.
 - c. Provide sleeves where operating stems pass through floor. Extend sleeves two inches above floor.
- C. Buried Valves:
 - 1. Install valve boxes plumb and centered, with soil carefully tamped to a lateral distance of four feet on all sides of box, or to undisturbed trench face if less than four feet.
 - 2. Provide flexible coupling next to each buried valve.
- D. Plug Valves:
 - 1. Install plug valves that are in horizontal liquid piping with stem horizontal and plugs on top when valve is open. Plug shall be on upstream end when valve is closed.
 - 2. Install plug valves that are in vertical liquid piping with plug at top when closed or as recommended by valve Supplier.
 - 3. Supplier shall tag or mark plug valves to indicate proper mounting position.

3.3 FIELD QUALITY CONTROL

- A. Field Tests:
 - 1. Adjust all parts and components as required to provide correct operation of valves.
 - 2. Conduct functional field test on each valve in presence of COUNTY to demonstrate that each valve operates correctly.
 - 3. Verify satisfactory operation and controls of motor operated valves.
 - 4. Demonstrate satisfactory opening and closing of valves at specified criteria requiring not more than 40 pounds effort on manual actuators.
 - 5. Test ten percent of valves of each type by applying 200 pounds effort on manual operators. There shall be no damage to gear actuator or valve.
- B. Supplier's Services:
 - 1. Manufacturer's representative shall make a minimum of 1 visit, with a minimum of 8 hours onsite for each visit. First visit shall be for unloading supervision (if specified) and instruction of CONTRACTOR in installing equipment; second visit shall be for assistance in installing equipment; third visit shall be for checking completed installation and start-up of system;

fourth visit shall be to instruct operations and maintenance personnel. Representative shall revisit the Site as often as necessary until installation is acceptable.

2. Training: Furnish services of Supplier's qualified factory trained specialists to instruct COUNTY's operations and maintenance personnel in recommended operation and maintenance of equipment. Training requirements, duration of instruction and qualifications shall be in accordance with Section 01821, Instruction of Operations and Maintenance Personnel.
3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

+ + END OF SECTION + +

SECTION 15103

INTAKE SCREENS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, services, equipment and incidentals required to furnish, install, test and place in satisfactory operation, intake screens as shown and as specified herein. All intake screens in this Section shall be supplied by a single manufacturer.
- B. Related Divisions and Sections:
 - 1. Section 03000, Cast-In-Place Concrete.
 - 2. Section 09900, Painting.
 - 3. Section 15060, Ductile Iron Pipe and Fittings

1.2 QUALITY ASSURANCE

- A. All equipment provided under this Section shall be obtained from a single supplier or manufacturer who, with the CONTRACTOR, shall assume full responsibility for the completeness of the system. The supplier or manufacturer shall be the source of information on all equipment furnished regardless of the manufacturing source of that equipment.
- B. Qualifications: The equipment supplier or the manufacturer shall have experience in manufacturing intake screens of the same or larger size to the units specified. For an equipment supplier or manufacturer to be determined acceptable for providing intake screens on this project, it must show evidence of ten separate, substantially similar installations that have been in satisfactory operation for a minimum of five years for each required chemical.
- C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified
 - 1. I assume there will be standards referring to steel, welding, etc.
 - 2. The equipment manufacturer must maintain an ongoing quality assurance program, including ISO-9000 certification.
 - 3. All welders must maintain certification to ASME Section IX. Copies of certifications shall be provided upon request.

1.3 SUBMITTALS

- A. Shop Drawings - Submit shop drawings in accordance with Section 01340 for approval of the following:
 - 1. Drawing(s) showing screen diameter, screen length, assembly length, interface dimensions for outlet, materials of construction and assembly weight.
 - 2. Weld Certifications
 - 3. Evidence of a statistical control program
 - 4. Provide supporting flow distribution data where calculation methods are verified by physical flow distribution tests.
 - 5. Provide the manufacturer's clean screen assembly headloss per the requirements in Part 2.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work in accordance with Section 01600, Material and Equipment.
- B. Storage and Protection:
 - 1. Store materials to permit easy access for inspection and identification in accordance with Section 01620, Storage and Protection. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration. Equipment that is damaged will not be acceptable.
- C. Acceptance at Site:
 - 1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify COUNTY, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

1.5 WARRANTY

- A. The CONTRACTOR shall provide a warranty for all intake screens and appurtenances for one year from the date of Substantial Completion.
- B. During the warranty period, the CONTRACTOR shall provide the services of a trained manufacturer's representative to make all adjustments, repairs (including leaks) and replace all defective equipment at no cost to COUNTY.
- C. The CONTRACTOR shall include all costs incurred by the manufacturer, including travel and expenses, under the terms of the warranty.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Product and Manufacturer: Provide intake screens as manufactured by one of the following:
 - 1. Johnson Screens, Model T-21HC.
 - 2. Hendricks Screen, Model T21.
 - 3. Or approved equal.

2.2 CAPACITY

- A. The intake assembly capacity shall be 2,500 GPM at a maximum through-slot velocity, as a result of water withdrawal, of 0.5 feet per second. The corresponding average through-slot velocity shall be 80% - 90% of the maximum velocity. At this flow rate the pressure drop through the clean screen surface shall be approximately .0022 psi. Pressure drop through the entire intake assembly shall be less than 12 inches of water at the rated flow. The hydraulic design of this system is based on this maximum headloss screens that exceed this headloss are not acceptable.
- B. Evidence of the intake assembly capacity and flow distribution shall be able to be provided by a Computational Fluid Dynamic (CFD) analysis, supplied by the manufacturer. Any proposed alternates MUST provide a CFD to support the flow distribution claims. The CFD Analysis Method must be verified by actual physical testing.

2.3 STRENGTH

- A. The intake assembly shall be designed to withstand a differential hydrostatic collapse pressure of 4.32 psi (10 feet of water).
- B. Design stress used for determining strength of the assembly shall be no more than 90% of the published yield strength of the material used. Strength calculations verifying compliance with these criteria shall be provided upon request.

2.4 CONSTRUCTION

- A. The surface wire, support beam and stiffener structure shall be an all-welded matrix designed to provide the specific strength with minimal interference with the through screen flow pattern.
- B. End plates and tee body shall be a minimum of 0.15 inches thick. All structural butt welds shall be full penetration fillet welds and shall be the thickness of the thinner component.

2.5 SLOT OPENING SIZE

- A. The screen slot size shall be 0.50 inches. The open area for this slot opening shall be 87.57%.
 - 1. Slot size shall be controlled and continuously monitored during manufacture.
 - 2. For slot openings of 0.040" through 0.100" the mean slot size shall be within +/- 0.002" with standard deviation no greater than 0.002" throughout the assembly.
 - 3. For slot openings greater than 0.100" the mean slot size shall be within +/- 0.003" with a standard deviation no greater than 0.003" throughout the entire assembly.

2.6 MATERIALS

- A. The main outlet flange shall mate with an 18" flange with a flange pattern equal to AWWA C-207, Table 2, Class D.
- B. The intake screen material shall be manufactured of 304 stainless steel material.

PART 3 – EXECUTION

- A. The equipment furnished according to this specification is to be installed in strict conformance with the manufacturer's installation instructions.

++ END OF SECTION++

SECTION 15108

AIR RELEASE AND COMBINATION AIR VALVES

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers furnishing air release valves, combination air valves, and air release and vacuum relief valves as required by the Work.

1.2 GENERAL

- A. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by ENGINEER.
- B. Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.
- C. General Equipment Stipulations: The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.
- D. Governing Standard. Except as modified or supplemented herein, all valves furnished under this section shall conform to the applicable requirements of AWWA C512.
- E. Related Sections:
 - 1. Section 01600, Material and Equipment.
 - 2. Section 01620, Storage and Protection.
 - 3. Section 15100, Process Valves Four-inch Diameter and Larger.
 - 4. Section 09900, Coatings.
- F. Permanent Number Plates: Not used.

1.3 SUBMITTALS

- A. Complete assembly drawings, together with detailed specifications and data covering materials used and accessories forming a part of the valves furnished, shall be submitted in accordance with the Submittals section.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Shipping shall be in accordance with the Section 01600 part 1.03. Handling and storage shall be in accordance with Section 01620.

1.5 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI/AWWA C512, Air Release, Air Vacuum and Combination Air Valves for Waterworks Service.
 - 2. Ductile iron pipe flanges: ANSI B 16.1 and AWWA C115.
 - 3. ANSI/AWWA C550, Protective Interior Coatings for Valves and Hydrants.
 - 4. ANSI/NSF 61 Drinking Water Components – Health Effects.

PART 2 - PRODUCTS

2.1 AIR RELEASE VALVES

- A. Air release valves shall be designed to release small pockets of air that collect at high points in a pipe, when the pipe is full and pressurized. Air release valves shall be manufactured by Apco/Valve and Primer GA Industries Multiplex "Crispin", or Val-Matic. Valves shall be provided with two additional connections for testing and flushing.

2.2 COMBINATION AIR VALVES

- A. Combination air valves shall be designed to automatically exhaust large quantities of air during system filling, allow air to re-enter to provide vacuum protection, and vent air accumulations under pressurized system operation. Valves shall be provided with two additional connections for testing and flushing.
- B. Three inch and smaller combination air valves shall be of the integral type with a valve assembly which functions as both an air and vacuum valve and an air release valve. The valves shall be Apco/Valve and Primer "Single Body Combination Air Valves", Multiplex "Crispin Universal Air Release Valves", or Val-Matic "Combination Air Valves". Connections to piping shall be NPT

- C. Four inch and larger combination air valves shall consist of an air and vacuum valve with an externally mounted air release valve and shall have a dome cover over the vacuum breaker and 1/4-inch stainless steel insect screen (see Tampa Bay Water Standard Details). The valves shall be Apco/Valve and Primer "Custom Combination Air Valves", GA Industries "Kinetic Custom Combination Air Valves", Multiplex "Crispin Dual Air Valves", or Val-Matic "Dual Body Combination Air Valves". Connections to piping shall be flanged to ANSI B16.1, Class 125.

2.3 MATERIALS

- A. Except as modified or supplemented herein, materials of construction shall comply with the governing standard. The use of stressed thermoplastic components will not be acceptable.

Valve Trim Austenitic stainless steel

Float Austenitic stainless steel

Shop Coatings

Medium Consistency Carboline "Bitumastic 50" or Tnemec "46-465

Coal Tar H.B. Tnemecol"

Epoxy Carboline "Carboguard 891" or Tnemec "Series N140 Pota-Pox Plus"

Rust-Preventive As recommended by manufacturer
Compound

2.4 SHOP PAINTING

- A. All interior and exterior ferrous metal surfaces, except stainless steel components, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field coating. Field painting is covered in the Protective Coatings section.

Surfaces shall be painted as indicated:

Interior Surfaces NSF-61 rated epoxy

Exterior Surfaces of Valves To Be Installed Coal tar epoxy
in Manholes or Valve Vaults

Exterior Surfaces of All Other Valves Universal primer

Polished or Machined Surfaces Rust-preventive compound

Interior epoxy coatings shall comply with AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

<u>Type of Coating</u>	<u>Minimum Dry Film Thickness</u>
Medium Consistency Coal Tar	15 mils
Epoxy	10 mils
Universal Primer	3 mils

2.5 SHUTOFF VALVES

- A. A shutoff valve shall be provided in the piping leading to each air release valve and combination air valve. Connections less than 4-inches shall include a brass ball valve. Connections 4-inches and larger shall, include a butterfly valve. Each 4 inch and larger combination air valve shall be provided with a shutoff valve between the air and vacuum valve and the air release valve. Ball valves shall comply with Section 15100, Process Valves Four-inch Diameter and Larger and butterfly valves shall comply with

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install valves and appurtenances as shown on the Drawings and per Air Valve manufacturer's recommendations, approved Shop Drawings, and applicable codes and standards.
- B. Install valves plumb and vertical.
- C. Install with an isolating valve. Remove isolating valve's operating handle lever and deliver to COUNTY.
- D. Adjust throttling devices, if provided, for smooth, non-slam and waterhammer-free operation.

++ END OF SECTION ++

SECTION 15112

CHEMICAL VALVES AND APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall furnish all labor, tools, materials and equipment required to furnish, install, test and place in satisfactory operation all piping, valves and appurtenances as shown and specified herein.
 - 2. It is the intention of the Drawings and Specifications to provide complete and workable piping systems. Miscellaneous fittings and appurtenances required for proper completion of the Work shall be considered as having been included under this Section.
- B. General:
 - 1. All piping, fittings, valves and appurtenances shall be new, clean and in accordance with material specifications. In no case will used or damaged material be acceptable.
 - 2. Provisions shall be made to permit bleeding air at high points. All piping shall be of the sizes and materials shown on the Drawings or specified herein.
- C. Related Work Specified Elsewhere:
 - 1. Section 02220, Excavation, Backfill, Fill, and Grading for Structures.
 - 2. Section 02223, Excavation Below Grade and Crushed Stone or Shell Refill.
 - 3. Section 03300, Cast-in-Place Concrete.
 - 4. Division 11, Equipment.
 - 5. Division 15, Mechanical.

1.2 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Piping and valves shall be the standard product in regular production by manufacturers whose products have proven reliable in similar service. All valves and piping of the same type shall each be the product of one manufacturer.
- B. Source Quality Control: All pipe, specials and valves shall have the working pressure stenciled thereon. Pipe that has been designed for abnormal load conditions or thrust restraint shall have special markings thereon which can be

readily identified.

- C. Reference Standards: Comply with applicable provisions and recommendations of the following:
 - 1. Standards of American Water Works Association, AWWA.
 - 2. Standards of American Society for Testing and Materials, ASTM.
 - 3. Standards of American National Standards Institute, ANSI.
 - 4. Standards of American Iron and Steel Institute, AISI.
- D. Manufacturer's Field Services and Reports:
 - 1. Retain factory trained manufacturer's representative with demonstrated ability and experience in the installation and operation of electric actuators, butterfly valves, check valves and surge relief valves to perform the services listed below:
 - a. Supervise the installation.
 - b. Test, calibrate and adjust all components for optimum performance.
 - c. Assist in initial start-up and field testing.
 - d. Inspect the completed installation and prepare an inspection and performance test report.
 - e. Instruct COUNTY's personnel in the operation and user maintenance of all components.
 - f. Supervise the correction of any defective or faulty Work before and after acceptance by COUNTY.

1.3 SUBMITTALS

- A. Shop Drawings shall conform with Section 01340, Shop Drawings, Project Data, and Samples and include the following:
 - 1. Illustrations, specifications and engineering data including: dimensions, materials, size, and weight for all piping, valves, and appurtenances including pipe supports, pipe restraints, coatings, etc.
 - 2. Manufacturer's instructions and recommendations for installation of each type of pipe joint, valve and special items.

1.4 PRODUCTION DELIVERY, STORAGE, AND HANDLING

- A. Delivery, Storage and Handling of Materials: All materials shall be delivered to the site, stored, and handled in accordance with the manufacturer's instructions. CONTRACTOR shall inspect shipments for damage and content well in advance of the date scheduled for incorporation in the Work.

- B. Prior to Shipment:
 - 1. Each piece of pipe and each fitting shall be plainly marked at the manufacturer with schedule number and pressure class. All piping shall be readily identifiable.
- C. To establish minimum criteria for proper installation and handling, measures to be taken by the CONTRACTOR shall include the following:
 - 1. All piping and valves shall be thoroughly cleaned of sand, scale, rust or other foreign substances. Open ends of piping and valves shall be suitably closed to prevent the entrance of foreign matter after cleaning and during shipment and storage.
- D. Handle all pipe, fittings and accessories carefully with approved handling devices. Do not drop or roll pipe off trucks. Do not otherwise drop, roll, or skid pipe. Materials that are cracked, chipped, gouged, dented or otherwise damaged will not be approved for installation.
- E. Store pipe and fittings on heavy wood blocking or platforms. Do not store pipe in contact with ground.
- F. See Section 01600 Part 1.3, Transportation and Handling, and Section 01620, Storage and Protection, for additional details.

1.5 JOB CONDITIONS

- A. Protection:
 - 1. Take all measures to ensure that all materials are protected from damage.
- B. Work Affecting Existing Piping
 - 1. Location of Existing Piping:
 - a. Locations of existing piping shown should be considered approximate.
 - b. Determine exact location of existing piping to which connections are required; or which may be disturbed during excavations; or which may be affected by the Work.
 - 2. Work on Existing Piping:
 - a. Cut pipes as shown or required with machines specifically designed for this work.
 - b. Install temporary plugs to keep out all mud, dirt, water and debris.
 - c. Provide all necessary adapters, fittings, taps, outlets, pipe and appurtenances required.
 - d. Verify dimensions of all existing piping to which connections are required and provide all necessary adapters, specials and section

- pieces required to make the connections.
- e. COUNTY does not guarantee watertight closing of isolation valves. CONTRACTOR shall provide, at no additional expense to COUNTY, all temporary caps, plugs, dewatering, pumping and other measures required to ensure proper installation of new piping.

1.6 WARRANTY

- A. All material supplied under these Specifications shall be warranted by the Contractor and the manufacturers for a period of three (3) years. Warranty period shall commence on the date of COUNTY acceptance.
- B. The material shall be warranted to be free from defects in workmanship, design and materials. If any part of the system should fail during the warranty period, it shall be replaced at no expense to the COUNTY.
- C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty or guarantee period. No exception to this provision shall be allowed. The Contractor shall be responsible for obtaining warranties from each of the respective suppliers or manufacturers for all the material specified under these contract specifications.
- D. In the event that the manufacturer is unwilling to provide a three-year warranty commencing at the time of COUNTY acceptance, the Contractor shall obtain from the manufacturer a four (4) year warranty starting at the time of equipment delivery to the job site. This four-year warranty shall not relieve the Contractor of the three-year warranty starting at the time of COUNTY acceptance of the equipment.

PART 2 - PRODUCTS

2.1 MATERIALS - SODIUM HYPOCHLORITE FEED SYSTEM

- A. Strainers:
 - 1. Service: Liquid (sodium hypochlorite).
 - 2. Type: Y-Pattern.
 - 3. Pressure Class/Rating: 250 psig.
 - 4. End Connections: True union.
 - 5. Material:
 - a. Strainers on PVC piping shall be manufactured of PVC.
 - b. PVC shall be Type 1, Grade 1 in accordance with ASTM D 1784, and shall be dark gray in color.
 - c. Screens shall be manufactured of PVC with 1/32 perforations with Viton seals.

6. Manufacturer:
 - a. Hayward Industrial Products, Inc.
 - b. Or approved equal.
- B. Vented Ball Valves:
 1. Size and extent: As shown on Drawings
 2. Connections: End entry design with dual union design, solvent-weld socket ends.
 3. Material: ASTM D1784, Type 1, Grade 1 polyvinyl chloride full port body, ball, and stem. Teflon seat, Viton O-ring stem, face and carrier seals.
 4. Rated: 250 psi at 73 degree F
 5. Manufacturer:
 - a. Nibco (Chemtrol); True-Bloc.
 - b. Asahi-America.
 - c. Or equal.
- C. Ball Check Valve 4 Inches and Smaller:
 1. Extent: As shown on Drawings
 2. Connections: single or dual union socket weld ends
 3. Rated: 250 psi at 73 degrees F
 4. Material: ASTM D1784, Type I, Grade 1 polyvinyl chloride body and Viton seat and seal
 5. Manufacturer:
 - a. R&G Sloane Manufacturing Co., Inc.
 - b. Nibco Chemical.
- D. Vacuum Breakers:
 1. Size and Extent: Sodium hypochlorite metering pumps discharge line as shown on Drawings.
 2. Minimum Working Pressure: 10 psi.
 3. Venting Capacity: 8 cfm minimum.
 4. Materials:
 - a. Body: PVC.
 - b. Diaphragm: Viton.
 5. Manufacturer:
 - a. Hayward.
 - b. Asahi.
 - c. Or equal.
- E. Duckbill Valves:
 1. Size and Extent: Storage tank overflow lines as shown on Drawings
 2. End: Clamped
 3. Sleeve material: Viton.
 4. Manufacturer:

- a. Tideflex as manufactured by Red Valve Co., Inc.
 - b. Or Equal.
- F. Pressure-Relief Valve 2 Inches and Smaller:
 - 1. Service: Liquid (chemical and water).
 - 2. Size Range: 1/4-inch to 2 inches.
 - 3. Valve Pressure Class/Rating: 250 psig.
 - 4. Relief settings: 5-140 psig.
 - 5. Valve End Connections: Threaded.
 - 6. Material:
 - a. Valves on PVC piping shall be manufactured of PVC material with Viton seals.
 - b. PVC shall be Type 1, Grade 1 in accordance with ASTM D 1784, and shall be dark gray in color.
 - 7. Manufacturer:
 - a. Hayward.
 - b. Or approved equal.
- G. Pressure Gages:
 - 1. Extent: As shown on drawings.
 - 2. Range: 0 to 200 psi and as noted on returned shop drawings.
 - 3. Dial Size: 4-1/2 inches except where smaller dials are specified.
 - 4. Case: Phenolic turret case for surface mounting.
 - 5. Bourbon Tube: Stainless steel or bronze.
 - 6. Connection: Brass, 2-inch NPT-Bottom.
 - 7. Accuracy: +0.5 percent of span.
 - 8. Accessories: Provide 2-inch needle valve and diaphragm for pressure snubbing isolation with each gage.
 - 9. Product and Manufacturer:
 - a. Ametek, U.S. Gage Division, Fig. 1980.
 - b. Or equal.
 - 10. Diaphragm seal housing shall be of Type 316 stainless steel, the diaphragm of Telon or Kel-F, and the filling liquid of silicone oil. Seal shall have a 1-inch diameter process connection, cleanout ring, and flush connection. Factory mount a stainless steel cartridge snubber between the gage and diaphragm seal.
- H. Backpressure Valves:
 - 1. Service: Liquid (chemical and water).
 - 2. Size Range: 1/4-inch to 2 inches.
 - 3. Valve Pressure Class/Rating: 250 psig.
 - 4. Valve End Connections: Threaded.
 - 5. Material:
 - a. Valves on PVC piping shall be manufactured of PVC with Viton seals.

- b. PVC shall be Type 1, Grade 1 in accordance with ASTM D 1784, and shall be dark gray in color.
 - 6. Manufacturer:
 - a. Hayward.
 - b. Or equal.
- I. Expansion Joints:
 - 1. General: Expansion joints shall be standard single spool type.
 - 2. Material: Shall be suitable for the specified chemical as shown on the drawings at temperatures up to 150 F.
 - 3. Flanges: Shall be duck and rubber construction with companion pipe flanges. Flanges shall be full faced with 150 lb. ANSI standard drilling. Retainer rings shall be stainless steel.
 - 4. Product and Manufacturer: Expansion joints shall be Red Flex as manufactured by Red Valve or equal.
- J. Miscellaneous Items:
 - 1. PVC Pipe supports:
 - a. PVC Pipe Supports: Provide fiberglass/plastic supports for chemical pipes as follows:
 - 1) Pipe 2-inch and larger shall be supported at 6 foot maximum spacing. Pipe smaller than 2-inch shall be supported at 4 foot maximum spacing.
 - 2) Pipes adjacent to or on walls shall be supported from molded polypropylene clamp halves complete with cover plate, hex bolts and base weld plate attached to wall with expansion anchors.
 - 3) Manufacturer:
 - a) Unistrut.
 - b) Or equal.
 - 2. Flanged Joints:
 - a. Assemble flanged joints using 1/8-inch ring-type gaskets for raised face flanges. Use full face gaskets for flat face flanges unless otherwise approved. Gaskets shall be suitable for the chemical service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
 - b. Bolts shall be tightened in a sequence that will ensure equal distribution of bolt loads.
 - c. The length of bolts shall be uniform, and they shall not project beyond the nut more than 1/4 - inch or fall short of the nut when fully taken up. The ends of bolts shall be machine cut so as to be neatly rounded. Washers shall be used.
 - d. Bolt threads and gasket faces for flanged joints shall be lubricated prior to assembly.

- e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.
- f. All bolts and hardware shall be Type 316 stainless steel.
- 3. Unions shall be installed for easy disassembly of pipes and where shown on Drawings.
- 4. Expansion Joints:
 - a. General: Expansion joints shall be three convolutions type.
 - b. Material: Shall be teflon or viton.
 - c. Flanges: Shall be ductile iron construction. Flanges shall be full faced with 150 lb. ANSI standard drilling. Retainer rings shall be stainless steel.
 - d. Product and Manufacturer: Expansion joints shall be Proco Series 443 or equal.
- 5. Pipeline Identification: All exposed piping shall be identified by Brady B-500 vinyl cloth self sticking arrows and markers. Equivalent products by Seton Name Plate Corporation or equal are acceptable.
 - a. Markers shall be of wording of "sodium hypochlorite".
 - b. Install markers and arrows at following locations:
 - 1) At intervals not exceeding 50 feet along continuous runs of pipe.
 - 2) Wherever pipes pass through walls, floor or panels.
 - 3) At each valve or equipment connection.
 - 4) At each branch where it connects to a main line.
 - c. Lettering shall be:
 - 1) 2-1/4 inches high for pipes 3 inches diameter and larger.
 - 2) 1-1/8 inches high for pipes less than 3 inches diameter.
 - d. Flow arrows shall be:
 - 1) 2-1/4 inches by 6 inches for pipes 3 inches diameter and larger.
 - 2) 1-1/8 inches by 3 inches for pipes less than 3 inches diameter.

2.2 QUICK DISCONNECT COUPLINGS – FILL STATION, FLUSHING CONNECTIONS, AND DRAIN CONNECTIONS FOR AQUA AMMONIA

A. Quick Disconnect Couplings:

- 1. Size and Extent: For fill stations, flushing connections, and drains.
- 2. Type: Tank fill pipes and drain pipes shall be furnished with lockable quick-connect couplings as shown in the drawing for delivery truck connection.
- 3. Materials: 316 Stainless Steel
- 4. Furnish both ends of the coupling.
- 5. Support coupling as needed inside the containment wall to accommodate coupling and chemical fill hose weights.

B. Fill Station Identification

- 1. Material: Fiberglass sheet 0.125 inches thick with 12-inch radius corners,

colored background with black Times New Roman alphabet; upper and lower case, 2-inch high capitals.

- a. Top coat with matte transparent finish for UV protection. Fill Station Identification Signs: Provide signs as shown on the Drawings, 10-inches high by 20-inches wide.
2. Product and Manufacturer: Provide one of the following:
 - a. GOF Series by ASI Sign System Inc.
 - b. Or approved equal.

2.3 QUICK DISCONNECT COUPLINGS – FILL STATION, FLUSHING CONNECTIONS, AND DRAIN CONNECTIONS FOR SODIUM HYPOCHLORITE

- A. Quick Disconnect Couplings:
 1. Size and Extent: For fill stations, flushing connections, and drains.
 2. Type: Tank fill pipes and drain pipes shall be furnished with lockable quick-connect couplings as shown in the drawing for delivery truck connection.
 3. Materials: PVC
 4. Furnish both ends of the coupling.
 5. Support coupling as needed inside the containment wall to accommodate coupling and chemical fill hose weights.
- B. Fill Station Identification
 1. Material: Fiberglass sheet 0.125 inches thick with 12-inch radiused corners, colored background with black Times New Roman alphabet; upper and lower case, 2-inch high capitals.
 - a. Top coat with matte transparent finish for UV protection. Fill Station Identification Signs: Provide signs as shown on the Drawings, 10-inches high by 20-inches wide.
 2. Product and Manufacturer: Provide one of the following:
 - a. GOF Series by ASI Sign System Inc.
 - b. Or approved equal.

PART 3 - EXECUTION

3.1 INSPECTION

- A. The CONTRACTOR shall inspect all chemical valves and appurtenances to ensure that they are free of defects in material and workmanship. The compatibility of all pipe, fittings, and coatings shall be verified.

3.2 INSTALLATION

- A. All chemical valves and appurtenances shall be installed in complete accordance with the manufacturer's instructions and recommendations.

+ + END OF SECTION + +

SECTION 15120

PIPING SPECIALTIES AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all piping specialties and accessories.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before piping specialties and accessories Work.

C. Related Sections:

1. Section 09900, Coatings.
2. Section 15051, Buried Piping Installation.
3. Section 15052, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
2. ASME B31, Standards of Pressure Piping.
3. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-dipped, Zinc-Coated, Welded and Seamless.
4. ASTM A105/A105M, Specification for Carbon Steel Forgings and Piping Applications.
5. ASTM A351/A351M, Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.
6. ASTM B650, Specification for Electro-Deposited Engineering Chromium Coatings of Ferrous Substrates.
7. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
8. AWWA C606, Grooved and Shouldered Joints.
9. AWWA C219, Bolted Sleeve-Type Couplings on Plain End Pipe.
10. AWWA C221, Fabricated Steel Slip-Type expansion Joints.
11. NSF No. 61 Drinking Water System Components -Health Effects.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer shall have at least five years experience producing substantial similar products to those specified and shall be able to provide documentation of at least five installations in satisfactory operation for at least five years within the United States, if requested by the ENGINEER.

B. Component Supply and Compatibility:

1. Each type of piping specialty shall be the product of one manufacturer.
2. Supplier shall prepare, or review, and approve all submittals for components furnished under this Section.
3. Components shall be suitable for specified service conditions and be integrated into overall assembly by the Supplier.
4. Pipe specialties shall be NSF-61 approved for use with potable water.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Coordination: Coordinate with piping layout Shop Drawings prepared by piping supplier to ensure use of correct connections and details.
2. Product Data: Submit product data on each type of coupling, expansion joint, and other piping specialties and accessories, including gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:

1. Certificates: When requested by ENGINEER submit certificate attesting to compliance with standards referenced in this Section, signed by manufacturer.
2. Manufacturer's Instructions: Provide instructions for handling, storing, installing, and adjusting of products.
3. Source Quality Control: When requested by ENGINEER, submit results of source quality control tests.
4. Qualifications Statements: Submit qualifications of manufacturer when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

- #### A.
1. Refer to Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 COUPLINGS

A. Sleeve-type, Flexible Couplings:

1. Pressure and Service: Same as connected piping.
2. Products and Manufacturers: Provide products of one of the following:
 - a. Style 38, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
 - b. Style 411, by Smith Blair, Inc.
 - c. Style 138, by JCM Industries.
3. Material: Steel, epoxy coated.
4. Gaskets: EPDM.
5. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated.
6. Harnessing:
 - a. Harness couplings to restrain pressure piping. For pipelines that will be under pressure, test pressures are specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
 - b. Tie adjacent flanges with bolts of corrosion-resistant alloy steel. Provide flange-mounted stretcher bolt plates to be designed by manufacturer, unless otherwise approved.
 - c. On plain-end piping, for harnessing couplings, provide anchor restraint system such as Dresser Piping Specialties STAR Anchor Style 443, or equal.
 - d. Conform to dimensions, size, spacing, and materials for lugs, bolts, washers, and nuts as recommended by manufacturer and approved by ENGINEER for pipe size, wall thickness, and test pressure required. Provide minimum 5/8-inch diameter bolts.
7. Remove pipe stop(s) if used, unless otherwise shown or specified.

B. Flanged Coupling Adapters:

1. Description: One end of adapter shall be flanged and opposite end shall have sleeve-type flexible coupling.
2. Products and Manufacturers: Provide one of the following:
 - a. Style 128, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
 - b. Style 913, by Smith Blair, Inc.
 - c. Style 303 by JCM Industries.
3. Pressure and Service: Same as connected piping.
4. Material: Steel, epoxy coated.
5. Gasket: EPDM.

6. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and nitrided stainless nuts.
7. Harnessing:
 - a. Harness adapters to restrain pressure piping. For pressure pipelines, test pressures are included in piping schedules in Section 15052, Exposed Piping Installation.
 - b. For flanged adapters 12-inch diameter and smaller, provide 1/2-inch diameter (minimum) Type 316 stainless steel anchor studs installed in pressure-tight anchor boss. Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by flanged adapter manufacturer.
 - c. For adapters larger than 12-inch diameter, provide split-ring harness clamps with minimum of four corrosion-resistant alloy steel bolts. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers. Harness assembly shall be as designed and recommended by flanged adapter manufacturer. Dimensions, sizes, spacing and materials shall be suitable for service and conditions encountered and shall be approved by ENGINEER.

2.2 EXPANSION JOINTS

A. Rubber-type Expansion Joints:

1. General:
 - a. Use rubber-type expansion joints at all expansion joint locations, except where other types of expansion joints are shown or specified.
2. Manufacturers: Provide products of one of the following:
 - a. Mercer Rubber Company.
 - b. U.S. Rubber Supply Company, USA.
 - c. Or equal.
3. Liquid Service:
 - a. Construct expansion joints of neoprene or Buna-N suitable for temperatures up to 180 degrees F.
 - b. Expansion joints shall be filled arch type. Provide backup or retaining rings as recommended by expansion joint manufacturer.
 - c. Expansion joints shall be yoked in manner to provide transmission of tension loading to which expansion joint may be subjected during system operation. Compressive or lateral movement of expansion joint shall not be impaired by yoking system. Details of expansion joint yoking shall be submitted to ENGINEER for approval.
4. Air Service:

- a. Provide pipe expansion joints in air piping where shown as a minimum. Provide additional expansion joints if recommended by pipe manufacturer.
 - b. Air Service Expansion Joints – General:
 - 1) Except for expansion joints required at inlet and outlet connections of air blowers, construct expansion joints of chlorobutyl rubber, reinforced with embedded steel rings and strong synthetic fabric.
 - 2) Expansion joints six-inch diameter and smaller shall be double arch units. Expansion joints larger than six-inch diameter shall be triple arch units.
 - 3) Ends shall be flanged, with flanges conforming to ANSI B16.1, Class 125. Provide epoxy-coated split steel retaining rings to prevent damage to flanges when bolts are tightened.
 - 4) Expansion joints shall be suitable for temperatures up to 300 degrees F, and pressures to 40 psi.
 - c. Air Service Expansion Joints – At Air Blower Inlet and Outlet Connections:
 - 1) Expansion joints shall be U-type units constructed of chlorobutyl rubber, reinforced with a strong synthetic fabric.
 - 2) Expansion joints shall minimize the transmission of vibration from blower to piping at suction and discharge connections.
 - 3) Expansion joint ends shall be flanged, with flanges conforming to ANSI B16.1, Class 125. Provide epoxy-coated split steel retaining rings to prevent damage to flanges when bolts are tightened.
 - 4) Expansion joints shall be suitable for temperatures up to 300 degrees F, and pressures to 40 psi.
5. Harnessing:
- a. Harness each expansion joint against thrust for test pressure in piping, as specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
 - b. Harnessing shall be by control units consisting of two or more tie rods connected between flanges, set for maximum allowable elongation of expansion joint.
 - c. Provide epoxy-coated triangular plates to connect tie rods to flanges. Tie rods shall be Series 300 stainless steel. Rubber washers shall be used between triangular plates and tie rods.
 - d. Provide control units in accordance with recommendations of expansion joint manufacturer.

B. Stainless Steel Expansion Joints:

- 1. Provide stainless steel expansion joints where shown.
- 2. Manufacturers: Provide products of one of the following:
 - a. Senior Flexonics Canada, Ltd.
 - b. Hyspan Precision Products, Inc.

- c. Or equal.
 - 3. Stainless Steel Expansion Joints – General:
 - a. Expansion joint elements shall be hydraulically formed of single-ply austenitic stainless steel, and shall withstand specified pressure and temperature conditions, and shall absorb thermal expansion of piping.
 - b. Expansion joints shall be free flexing type with internal sleeves and shall be Type 304 stainless steel with fixed rolled angle flange.
 - c. Expansion joints shall be manufactured and rated in accordance with ASME B31, wherever possible. Burst strength shall be equal to four times working pressure of pipeline, and test hydrostatic pressure shall be equal to 1.5 times rated working pressure of expansion joint.
 - d. Expansion joints in yard air piping shall have internal guide with thickness equal to piping wall thickness.
 - 4. Harnessing:
 - a. Harness each expansion joint against thrust for test pressure in piping, as specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
 - b. Harnessing shall be by two or more limit rods connected between flanges set for maximum allowable elongation of expansion joint.
 - c. Limit rods and connection accessories shall be of Series 300 stainless steel.
 - d. Limit rods shall be provided in accordance with the recommendations of expansion joint manufacturer.
- C. Stainless Steel Flexible Hose
- 1. Provide stainless steel expansion joints where shown.
 - 2. Manufacturers: Provide products of one of the following:
 - a. Senior Flexonics Canada, Ltd.
 - b. Hyspan Precision Products, Inc.
 - 3. Stainless Steel Flexible Hose, General:
 - a. Diameter: as shown on drawings
 - b. Overall length: 14".
 - c. End Connections: Flanged, ANSI B16.5 Class 150.
 - d. Material: 316L SS.
 - e. Temperature range: -320 F to 150 F.
 - f. Maximum Working Pressure: 150 psig.
 - 4. Harnessing:
 - a. Harness each expansion joint against thrust for test pressure in piping, as specified in piping schedules in Section 15051, Buried Piping Installation, and Section 15052, Exposed Piping Installation.
 - b. Harnessing shall be by two or more limit rods connected between flanges set for maximum allowable elongation of expansion joint.
 - c. Limit rods and connection accessories shall be of Series 300 stainless steel.

- d. Limit rods shall be provided and installed in accordance with the recommendations of expansion joint manufacturer.

D. Expansion/Deflection Couplings

1. Pressure and Service: 150 psi maximum working pressure, ozonated water.
2. Type: Laminated bellows type using a fixed flange at one end and a floating flange at the other.
3. Bellows:
 - a. Type 316L or 321L.
 - b. Design for maximum expansion or contraction up to 1.5-inches
4. Connecting Hardware: Type 316L.
5. Control Rods: Furnish and install control rods with each coupling. Control rods shall be Type 316SS.
6. Gasket Material: Expanded Teflon.
7. End-connections shall be flanged, ANSI B16.5 Class 150.
8. Manufacturer: Hyspan Precision Products, Inc, or equal.

E. Orifice Plate

1. Equipment shall conform to the following requirements:
 - a. Material: Type 316 stainless steel.
 - b. Minimum thickness: 0.25 inches.
 - c. Size: 18-inches x 10-inch orifice.
 - d. Design: Orifice plates shall be paddle style with identifying information stamped on the handle and manufactured to fit between ANSI 16.5, Class 150 flanges.
2. Equipment shall meet the following performance criteria:
 - a. Maximum operating upstream operating pressure: 80 psi.
 - b. Minimum operating downstream pressure: 20 psi.
 - c. Maximum Flow 16,000 gpm.
3. Manufacturer:
 - a. Mac-Weld Machining and Manufacturing LTD.
 - b. Daniel Measurement and Control, Inc.
 - c. Or equal.

2.3 SIGHT GLASSES

A. Sight Glass Assemblies for Liquid Accumulation Indication:

1. Provide ANSI Class 150 flanged sight flow assembly for indication of drain accumulation as shown on the Contract Drawings.
2. Flanges and hardware shall be 316 stainless steel.
3. Glass cylinder shall be borosilicate suitable for 100 psig pressure.
4. Gasket material shall be Teflon.
5. Manufacturer:
 - a. Papailias Co. Inc., Series LIG Sight Flow Indicator.

- b. Or equal.

2.4 PAINTING

- A. Shop Painting:
 - 1. Clean and prime-coat ferrous metal surfaces of products in the manufacturer's shop in accordance with Section 09900, Coatings, unless otherwise specified in this Section.
 - 2. Coat machined, polished and non-ferrous surfaces bearing surfaces and similar unpainted surfaces with corrosion prevention compound that shall be maintained during storage and until products are placed into operation.
- B. Field painting shall conform to Section 09900, Coatings.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect materials for defects in material and workmanship. Verify compatibility of products with pipe, fittings, valves, and appurtenances.

3.2 INSTALLATION

- A. Installation:
 - 1. Install piping specialties in accordance with the Contract Documents and manufacturer's instructions.
 - 2. For buried installations, refer to Section 15051, Buried Piping Installation.
 - 3. For exposed installations, refer to Section 15052, Exposed Piping Installation.
- B. Adjust expansion joints as required to ensure that expansion joints will be fully extended when ambient temperature is at minimum operating temperature, and fully compressed at maximum operating temperature for the system in which expansion joints are installed.

++ END OF SECTION ++

SECTION 16050

SECTION 16050

GENERAL PROVISIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to complete the electrical Work.
2. CONTRACTOR shall be responsible for:
 - a. Modifying existing MCC 11, and 12 for Disc Filters 1, 2, and 3 and In Plant Lift Stations.
 - b. Installation of required power, control and signal wiring into existing conduit for Lake Gravity Disc Filters 1, 2, and 3 and Backwash Reject Lift Station as designated on drawings.
 - c. Installation of required power, control and signal wiring and conduit to and between Lake Gravity Disc Filter Control Panels 1, 2, and 3, Lake Gravity Disc Filter PLC Panel (SP-5), Backwash Reject Lift Station.
 - d. Installation of all Disc Filter, and Backwash Reject Control Panels, along with necessary grounding, and light fixtures for applicable process areas.
 - e. Installation of power, control and signal conduit and wiring between Sodium Hypochlorite Metering Pumping Skid and its control panel, lighting panelboard, Existing SCADA Panel No. 4 (SP-4), and Bulk Tank level transmitter.

B. Coordination:

1. Review installation procedures and schedules under other Specification Sections and coordinate with other trades the installation of electrical items that will be installed with or within formwork, walls, partitions, ceilings, and panels.
2. Coordination and Intent of Electrical Drawings:
 - a. Dimensions on Drawings related to equipment are based on equipment of certain manufacturers. Verify the dimensions of equipment furnished to space available at the Site and allocated to the equipment.
 - b. Drawings show the principal elements of the electrical Work, and are not intended as detailed working drawings for the electrical Work. Drawings supplement and complement the Specifications and other Contract Documents relative to principal features of electrical systems.
 - c. Equipment and devices provided under this Contract shall be properly connected and interconnected with other equipment and devices for successful operation of complete systems, whether or not all connections

and interconnections are specifically mentioned or shown in the Contract Documents.

- d. Drawings are provided for CONTRACTOR's guidance in fulfilling the intent of the Contract Documents CONTRACTOR shall comply with Laws and Regulations, including safety and electrical codes, and provide materials, equipment, appurtenances, and specialty items necessary for complete and operable systems.
 3. Obtain from COUNTY record drawings required to execute the Work.
 4. Field Coordination:
 - a. Provide materials, equipment, and services to interface with existing circuits. Field-verify system and equipment requirements prior to modifying existing systems.
 - b. Coordinate the interface of equipment with COUNTY's personnel and field conditions.
 - c. Field-compare existing starter and panel control circuit terminations from record documents with existing circuits.
 - d. Field-trace existing circuits as required to interface the equipment provided.
 - e. Field-identify terminations for starters and panel controls for follow function for re-connection.
- C. Related Sections:
1. Section 02064, Modification to Existing Structures, Piping, and Equipment.
 2. Section 03300, Cast-in-Place Concrete.
 3. Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.
 4. Section 09900, Coatings.
 5. Section 02223, Excavation Below Grade and Crushed Stone or Shell Refill.
 6. Section 13400, Instrument and Control General Requirements.
- D. Materials and Equipment Installed by CONTRACTOR but Furnished by Others:
1. Backwash Reject Lift Station Local Control Panel (LCP).
 2. Sodium Hypochlorite Local Control Panel.
 3. SCADA Panel 5.
- E. Area Classifications:
1. Materials, equipment, and incidentals shall be suitable for the area classification(s) shown, specified, and required.
 2. Wet Locations: Comply with NEC and NEMA requirements for wet locations. Enclosures in wet locations shall comply with NEMA 4 unless specified otherwise.
 3. Corrosive Locations: Comply with NEC and NEMA requirements for corrosive locations. Enclosures in corrosive locations shall conform to NEMA 4X requirements unless specified otherwise.

4. Dusty Locations: Indoor areas not designated as hazardous, corrosive, or wet are dusty locations. Comply with NEC and NEMA 12 requirements unless specified otherwise.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Electrical Subcontractor:

- a. Electrical Subcontractor shall have not less than five years experience installing electrical systems of the types required for the Project.
- b. Electrical Subcontractor shall possess a valid electricians' and contractors' license in the jurisdiction where the Site is located.
- c. Submit the following information for not less than three successful, completed projects: project name and location; year completed; name and contact information for: prime contractor for whom electrical Subcontractor worked, project owner, and project engineer or architect, including addresses and telephone numbers.

1.3 SUBMITTALS

A. General:

1. To the extent practical, submit Shop Drawings and other CONTRACTOR submittals for each Specification Section into the smallest number of submittals possible. Do not furnish partial submittals.
2. Review of equipment submittals does not relieve CONTRACTOR of responsibility for providing complete and successfully operating systems.

B. Action Submittals: Submit the following:

1. Shop Drawings:

- a. Internal wiring diagram and drawings indicating all connections to components and numbered terminals for external connections.
- b. Dimensioned plan, section, elevations, and panel layouts showing means for mounting, conduit connection, and grounding.
- c. List of components including manufacturer's name and catalog number (or part number) for each.

2. Product Data:

- a. Manufacturer's name and product designation or catalog number.
- b. Electrical ratings.
- c. Manufacturer's technical data and specifications.
- d. Manufacturer's indication of compliance with applicable reference standards.
- e. Painting and coating systems proposed.

3. Test Procedures: Proposed testing procedures and testing limitations for source quality control testing and field quality control testing.

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

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Section 01620, Storage and Protection.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Performance Criteria:

1. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, with ambient outside air temperature of 20 degrees F to 100 degrees F and an elevation of 25 feet above mean sea level.
 2. Unless specified otherwise, electrical equipment shall have ratings based on 75 degrees C terminations.
- B. Testing Laboratory Labels: Electrical material and equipment shall bear the label of Underwriters' Laboratories, Inc. or other nationally recognized, independent testing laboratory, where standards have been established and label service applies.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. General:
1. Install materials and equipment in accordance with the Contract Documents, Laws and Regulations, approved (and accepted, as applicable) Shop Drawings and other CONTRACTOR submittals, and manufacturer's recommendations.
 2. Provide tools and equipment required to trace circuits necessary for proper execution of the Work.
 3. Define and identify all wiring, circuit terminations, and equipment to be modified to ensure proper interface of components. The Contract Price includes all costs associated with field services specified for a complete and functional system.
- B. Staging, Sequencing, and Coordination with Existing Facilities:
1. Schedule, sequence, and install materials and equipment in accordance with Section 01010, Summary of Work, Section 01015, Control of Work, and Section 01030, Special Project Procedures COUNTY. Perform the Work in a manner that will not interfere with the existing equipment and facilities or cause interruption of the functions of the Site, unless specified otherwise or otherwise allowed by COUNTY.
 2. When operation of existing facilities and Site is disrupted due to CONTRACTOR's operations, comply with Section 01143, Coordination with COUNTY's Operations, unless otherwise allowed by COUNTY.
 3. Where the Work ties in with existing installations, take precautions and provide safeguards in connecting the Work to existing operating circuits to prevent

interruption to existing circuits. Connection of Work to existing circuits shall be performed in the presence of COUNTY and ENGINEER.

4. Interruptions of existing circuits, not addressed in Section 01010, Summary of Work, Section 01015, Control of Work, and Section 01030, Special Project Procedures shall be coordinated with the COUNTY who will determine the length of time a circuit may be de-energized to maintain the COUNTY's processes in dependable and safe operation.

3.3 FIELD QUALITY CONTROL

A. Field Quality Control – General:

1. Perform field quality control for electrical Work in accordance with the Contract Documents.

B. Site Tests:

1. Prior to requesting certificate of Substantial Completion, demonstrate to ENGINEER that electrical systems and electrically-operated equipment installed or modified under the Contract operates in accordance with the Contract Documents and operates as required
2. Perform the following operational tests on electrical systems:
 - a. Operate power circuits to verify proper operation and connection to electrical systems materials and equipment, including mechanical key-interlocks for circuit breakers.
 - b. Remove and re-apply power supply to automatic transfer equipment to verify operation. Activate standby power systems to verify their automatic start-up, proper de-energization, and cool down upon resumption of normal power supply.
 - c. Operate control circuits, including pushbuttons, indicating lights, and similar devices, to verify proper connection and function. Operate all devices, such as pressure switches, flow switches, and similar devices, to verify that shutdowns and control sequences operate as required.
 - d. Operate lighting systems and receptacle devices to verify proper operation and connections.
3. Prepare and submit report on the equipment demonstration and operating field quality control tests. Report shall include complete information on the tests performed and results.

C. Manufacturer's Services:

1. Furnish at the Site qualified, factory-trained representative(s) of equipment manufacturers for the services indicated in the Contract Documents.

+ + END OF SECTION + +

SECTION 16061

GROUNDING SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

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

B. Related Sections:

1. Section 16062, Lightning Protection System.

1.2 REFERENCES

A. Standards referenced in this Section are:

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

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

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

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

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

B. Informational Submittals: Submit the following:

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

PART 2 – PRODUCTS

2.1 MATERIALS

A. Bare Ground Cable:

1. Manufacturers: Provide products of one of the following:
 - a. Cablec Corporation.
 - b. General Cable Corporation.
 - c. Southwire Cable Company.
 - d. Or equal.
2. Material: Soft-drawn, bare copper stranded cable complying with ASTM B8. No. 4/0 AWG minimum size unless otherwise shown or indicated on the Drawings.

B. Ground Rods:

1. Manufacturers: Provide products of one of the following:
 - a. Copperweld, Bimetallics Division.
 - b. ITT Blackburn Company.
 - c. Or equal.
2. Material: Copper-clad rigid steel rods, 3/4-inch diameter, ten feet long.

C. Grounding Connectors:

1. Products and Manufacturers: Provide one of the following:
 - a. Pressure Connectors:
 - 1) O.Z./Gedney, Division of General Signal Corporation.
 - 2) Burndy Corporation.
 - 3) Or equal.
 - b. Welded Connections:
 - 1) Cadweld by Erico Products, Incorporated.
 - 2) Therm-O-Weld by Burndy Corporation.
 - 3) Or equal.
2. Material: Pressure connectors shall be copper alloy castings, designed and fabricated specifically for items to be connected and assembled with Durium or silicone bronze bolts, nuts, and washers. Welded connections shall be by exothermic process utilizing molds, cartridges, and hardware designed specifically for connection to be made.

D. Ground Test Well

1. Provide heavy-duty test well suitable for heavy-duty traffic.
2. Manufacturer.
 - a. Advanced Lightning Technology.
 - b. Or equal.
3. Diameter and Material: 12.75-inch outside diameter, Schedule 80 PVC.
4. Depth: Two feet.
5. Cover: Provide test well with cast iron cover marked, "Ground" with cast iron ring to support lid.

E. Ground system components shall comply with UL 467.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 STRUCTURE GROUND SYSTEM

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

3.3 EQUIPMENT GROUNDING

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

3.4 FIELD QUALITY CONTROL

- A. Site Tests:
 - 1. Test completed grounding systems for resistance to ground using an electrical three-terminal ground resistance tester. Test all grounded cables and metal parts for continuity of connection. ENGINEER and COUNTY will witness the testing.
 - 2. Grounding system maximum resistance shall not exceed five ohms under normally dry conditions when measured by resistance tester. Resistance values

above five ohms shall be brought to ENGINEER's attention. Provide additional ground rods as required to attain a resistance to ground of less than five ohms for each ground grid. Add grounding additive installing additional ground rods to increase their effectiveness.

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SECTION 16070
SUPPORT SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install hangers and supports for electrical systems.
 2. Area Classifications: Materials shall be suitable for the area classification(s) shown or indicated on the Drawings, and specified in Section 26 05 05, General Provisions for Electrical Systems.
- B. Related Sections:
1. Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.
 2. Section 16050, General Provisions.
 3. Section 16131, Rigid Conduits.

1.2 REFERENCES

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

1.3 QUALITY ASSURANCE

- A. National Electrical Code.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. Detailed installation drawings showing dimensions and compatibility with proposed layout.
 2. Product Data:

- a. Manufacturer's name, product designation, and catalog number of each material item proposed for use.
 - b. Manufacturer's specifications including material, dimensional and weight data, and load capacity for each supporting system component proposed for use.
 - c. Pictorial views and corresponding identifying text of each component proposed for installation.
 - d. Documentation that confirms product compatibility with Laws and Regulations.
- B. Informational Submittals: Submit the following:
- 1. Certifications:
 - a. Submit certifications required under this Section.
 - 2. Manufacturer's Instructions:
 - a. Manufacturer's installation instructions, including recommended tightening torque values for all nuts and bolts.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

2.2 MATERIALS

- A. Strut, Fittings, and Accessories:
- 1. General:
 - a. Unless otherwise shown or indicated, strut shall be 1-5/8 inches by 1-5/8 inches. Double struts shall be two pieces of the same strut, welded back-to-back at the factory.
 - b. Attachment holes, when required, shall be factory-punched on hole centers approximately equal to the cross-sectional width and shall be 9/16-inch diameter.
 - c. Fittings, braces, brackets, hardware, and accessories shall be Type 316 stainless steel.
 - d. Strut nuts shall be spring captured Type 316 stainless steel.
 - e. Square and round washers shall be Type 316 stainless steel.
 - 2. Strut materials shall be suitable for area classifications indicated in Section 16050, General Provisions, and shown or indicated on the Drawings.
 - a. Dusty Locations:

- 1) Strut shall be 12-gage carbon steel, hot-dip galvanized after fabrication, complying with ASTM A123/A123M.
 - b. Wet Locations:
 - 1) Strut shall be 12-gage Type 316 stainless steel.
 - c. Corrosive Locations:
 - 1) Strut shall be 12-gage Type 316 stainless steel.
- B. Hanger Rods:
 - 1. Material:
 - a. Dry Locations: All-thread, zinc-coated
 - b. Wet, Corrosive, or Hazardous Areas: Stainless steel.
 - 2. Size: Not less than 3/8-inch diameter, unless otherwise shown on the Drawings or specified.
- C. Beam Clamps for Attaching Threaded Rods or Bolts to Beam Flanges for Hanging Struts or Conduit Hangers:
 - 1. Beam clamps shall be stainless steel equipped with stainless steel square-head set screw, and shall include threaded hole sized for attaching the all-thread rod or threaded bolt.
- D. Miscellaneous Hardware:
 - 1. Bolts, screws, and washers shall be stainless steel.
 - 2. Hex Nuts: Shall be stainless steel and include nylon inserts.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. Provide hangers and supports for electrical systems with necessary channels, fittings, brackets, and related hardware for mounting and supporting materials and equipment. Provide anchor systems, concrete inserts, and associated hardware for proper support of electrical systems.
- B. Install equipment and devices on hangers and supports as shown on the Drawings, as specified, and as required.

- C. Install hangers and supports level, true, free of rack, and parallel and perpendicular to building walls and floors, so that the hangers and supports are installed in a neat, professional, workmanlike manner.
- D. Holes in suspended ceilings for rods for hangers and supports and other equipment shall be provided adjacent to bars, where possible, to facilitate removal of ceiling panels.
- E. Coordinate installation of hangers and supports with equipment, cabinets, consoles, panels, enclosures, boxes, conduit, cable tray, wireway, busway, cablebus, piping, ductwork, lighting fixtures, and other systems and equipment. Locate hangers and supports clear of interferences and access ways.
- F. Anchor Bolts, Expansion Anchors, and Concrete Inserts: Shall be in accordance with Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts, and requirements of this Section.
- G. Mounting of Conduit:
 - 1. Provide space of not less than 1/4-inch between conduit surfaces and abutting or near surfaces except struts, cable trays, steel beams, and columns.
 - 2. Fasten conduit to struts, cable trays, steel beams, and columns using specified clamps and straps as shown, specified, and required.
 - 3. Devices shall be compatible with size of conduit and type of support. Following installation, size identification shall be visible and legible.
 - 4. Install conduit supports and fasteners in accordance with Section 16131, Rigid Conduits.
- H. Supports for Cabinets, Consoles, Panels, Enclosures, and Boxes:
 - 1. Freestanding: Unless otherwise specified or shown on the Drawings, provide supports for floor-mounted equipment, cabinets, consoles, panels, enclosures, and boxes. Such supports shall be 3.5-inch high concrete equipment base with a 45 degree chamfered edge. Base shall extend two inches beyond outside dimensions of equipment on all sides.
 - 2. Wall-Mounted:
 - a. Provide space not less than 1/4-inch between cabinets, consoles, panels, enclosures, and boxes and the surface on which each is mounted. Provide non-metallic or stainless steel spacers as required.
 - b. Do not mount equipment, enclosures, panels, and boxes directly to beams or columns. Mount struts to beams or columns using beam clamps, and mount equipment, enclosures, panels, and boxes to the struts.
 - 3. Floor Stand Rack:
 - a. Where equipment, cabinets, consoles, panels, enclosures, and boxes cannot be wall-mounted, provide an independent floor stand rack.

- b. Floor stand rack shall consist of struts, plates, brackets, connection fittings, braces, accessories, and hardware assembled in a rigid framework suitable for mounting of intended materials and equipment.
 - c. Equip floor stand racks with brackets and bases for rigidly-mounting the framework to the ceiling or floor, as applicable; or equip floor stand racks with beam clamps, angle plates, washers, and bolts for fastening to beam flanges, as applicable.
 - d. When equipment, cabinets, consoles, panels, enclosures, and boxes weigh more than 100 pounds:
 - 1) Main vertical supports of floor stand rack assemblies shall be back-to-back struts.
 - 2) Bracing, clamping and anchoring of each floor stand rack shall be sufficient to ensure rigidity of the floor stand rack with the intended equipment, enclosures, conduit, cable tray, busway, cablebus, and wireway installed. Floor stand racks shall not be deflected more than 1/8-inch by a 100-pound force applied at any point on the floor stand rack in any direction.
- I. Drilling into beams or columns is not allowed unless authorized by ENGINEER.
- J. Tighten nuts and bolts to the manufacturer's recommended torque values.
- K. Field Cutting:
- 1. Cut edges of strut and hanger rod shall have rounded corners, edges beveled, and burrs removed. If field cutting the strut is required, use clean, sharp, dedicated tools. Remove oil, shavings, and other residue of cuttings prior to installation.
 - 2. Coatings: To prevent corrosion:
 - a. Coat cut edges with epoxy-base touchup paint.
 - b. Coat cut edges with zinc-rich paint.

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SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install identification for electrical apparatus and electrical Work.

B. Related Sections:

1. Section 16122, 600 Volt Cable.
2. Section 13400, Instrumentation and Control General Requirements.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:

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

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

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

PART 2 – PRODUCTS

2.1 MANUFACTURED UNITS

A. Engraved Identification Devices (Nameplates and Legend Plates):

1. Nameplates:

- a. Laminated thermoset plastic, 1/16-inch thick, engraved condensed block black lettering on white background, square corners, and beveled front edges, or match existing.
- b. Size: As required.
- c. Letter Size: Minimum 3/16-inch.
- d. Nameplates one-inch or less in height shall have one mounting hole at each end. Nameplates greater than one-inch in height shall have mounting holes in the four corners.

2. Legend Plates:

- a. Legend plates for pushbuttons, pilot lights, selector switches, and other panel-mounted devices shall be large size with dimensions of approximately 2-7/16 inches wide by 2-13/32 inches tall (Allen Bradley large automotive size), plastic, custom engraved with black letters on white background.
 - 1) Provide standard-size legend plates where devices are mounted on motor control centers and spacing of devices precludes using automotive-size legend plates.
- b. Lettering size and line weight shall be the same for all legend plates on the same panel or enclosure. Maximum size shall be 1/4-inch and minimum size shall be 1/8-inch.

B. Safety Signs and Voltage Markers:

1. Provide high voltage signs for equipment operating over 600 volts.
2. High-Voltage Safety Signs for Outdoor Applications:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-120-45471 by Brady.
 - 2) Or equal.
 - b. Unless otherwise shown or indicated, high voltage safety signs shall be not less than 10 inches high by 14 inches wide, of fiberglass reinforced plastic, and shall comply with 40 CFR 1910.145. Signs shall resist fading from exposure to temperature extremes, ultraviolet light, abrasive, and corrosive environments, and shall read, "DANGER – HIGH VOLTAGE – KEEP OUT"
 - c. Mounting hardware shall be Type 316 stainless steel.
3. High-Voltage Safety Signs for Indoor Applications:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-302-84084 by Brady.
 - 2) Or equal.

- b. High voltage safety signs for installation on indoor equipment shall be either pressure-sensitive acrylic or vinyl, and shall be not less than 10 inches high by 14 inches wide, shall comply with 40 CFR 1910.145, and shall read, "DANGER – HIGH VOLTAGE – KEEP OUT".
 - 4. Low-Voltage Safety Signs:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-302-86060 by Brady.
 - 2) Or equal.
 - b. Low voltage safety signs shall be pressure-sensitive vinyl complying with 40 CFR 1910.145, five inches by 3.5 inches in size, and shall read, "DANGER – 480 VOLTS".
 - 5. Low-Voltage Markers:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) CV442xx by Brady.
 - 2) Or equal.
 - b. Low voltage markers shall be either pressure-sensitive vinyl or vinyl cloth with black lettering on orange background and shall read, "120 VOLTS", "208 VOLTS", "120/208 VOLTS", or "240 VOLTS" as required.
- C. Voltage System Identification Directories:
 - 1. General:
 - a. Directories shall be laminated thermoset plastic, 1/16-inch thick, engraved block black letters on white background, square corners, and beveled front edges.
 - b. Directories shall identify all voltage systems within building or structure.
 - c. Directories shall list the colors that identify ungrounded and grounded conductors of each system.
 - d. Colors shall be in accordance with Section 16122, 600 Volt Cable.
 - e. Example Directory Text:

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

- 2. Large directories for rooms shall have text height not less than 1/2-inch.
 - 3. Small directories for equipment shall have text height of not less than 1/4-inch.
 - D. Conduit Labels:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. B-915-xxxxx by Brady.
 - b. Or equal.

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

E. Wire Identification:

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

F. Detectable Underground Warning Tape:

1. Products and Manufacturers: Provide one of the following:
 - a. Indentoline by Brady.
 - b. Or equal.
2. Material: Polyethylene or polyester with detectable metal core and polyester underlamine.
3. Width: Two inches.
4. Color and Labeling: Yellow or red with permanently imprinted black letters: "CAUTION – Buried Electric Line", repeated continuously over full length of tape.

G. Thermal Printing System:

1. Utilize thermal transfer process to provide non-smearing labels and markers.
2. Wire and Cable Markers:
 - a. Portable, Products and Manufacturers: Provide one of the following:
 - 1) TLS2200 by Brady.
 - 2) Or equal.
 - b. Desktop, Products and Manufacturers: Provide one of the following:

- 1) 200M by Brady.
 - 2) Or equal.
3. Cable Markers:
 - a. Portable, Products and Manufacturers: Provide one of the following:
 - 1) Handimark by Brady.
 - 2) Or equal.
 - b. Desktop, Products and Manufacturers: Provide one of the following:
 - 1) Labelizer PLUS by Brady.
 - 2) Or equal.

2.2 FABRICATION

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

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Provide electrical identification in accordance with manufacturer recommendations and as required for proper identification of equipment and materials.
- B. Engraved Identification Devices (Nameplates and Legend Plates):
 1. Unless otherwise indicated in the Contract Documents, attach permanent nameplates with permanent adhesive and with 3/16-inch diameter, round head, stainless steel machine screws into drilled and tapped holes.
 2. Provide nameplate with 1.5-inch high letters to identify each console, cabinet, panel, or enclosure as shown or indicated.
 3. Provide nameplates for field-mounted motor starters, disconnect switches, manual starter switches, pushbutton stations, and similar equipment operating components, which shall describe motor or equipment function and circuit number.
 4. Provide nameplates with 1/2-inch high letters to identify each junction and terminal box shown or indicated.
 5. Motor Control Centers:
 - a. Provide nameplate with 1.5-inch letters with motor control center designation.
 - b. Identify individual door for each unit compartment with nameplate identifying controlled equipment.
 6. Except conduit, all electrical appurtenances including lighting panels, convenience outlets, fixtures, and lighting switches, shall be provided with nameplates indicating appropriate circuit breaker number(s).

7. Push Buttons:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
 - c. Provide red buttons for stop function.
 - d. Provide black buttons for other functions.
8. Pilot Lights:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
 - c. Shall have lens colors as shown or indicated. Where no color is indicated, provide the following lens colors:

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

9. Selector Switches:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
10. Panel Mounted Instruments:
 - a. Provide nameplates for identification of function.
11. Interiors of Cabinets, Consoles, Panels, Terminal Boxes, and Other Enclosures:
 - a. Provide nameplates for identification.
 - b. Provide each item inside cabinet, console, panel, terminal box, or enclosure with laminated plastic nameplate as shown on approved Shop Drawings and CONTRACTOR's other submittals. Install nameplates with adhesive.
 - c. Interior items requiring nameplates include:
 - 1) Terminal blocks and strips.
 - 2) Bus bars.
 - 3) Relays.
 - 4) Rear of face-mounted items.
 - 5) Rear of door-mounted items.
 - 6) Interior mounted items that require identification when mounted externally.
 - d. Circuit Breaker Directory:
 - 1) Provide engraved laminated plastic directory listing function and load controlled for each circuit breaker within panel used for power distribution.
12. Re-label existing equipment whose designation have changed.

C. Safety Signs and Voltage Markers:

1. Provide safety signs and voltage markers on and around electrical equipment as shown or indicated.
 - a. Install rigid safety signs using stainless steel fasteners.
 - b. Clean surfaces before applying pressure-sensitive signs and markers.
2. Install high voltage safety signs on all equipment doors providing access to uninsulated conductors, including terminal devices, greater than 600 volts.
3. Install low voltage safety signs on equipment doors that provide access to uninsulated 480-volt conductors, including terminal devices.
4. Install low voltage markers on each terminal box, safety disconnect switch, and panelboard installed, modified, or relocated as part of the Work and containing 120/208 volt conductors.

D. Voltage System Identification Directories

1. Provide voltage system identification directories as required by NEC Article 210 and NEC Article 215.
2. Provide in each electrical room voltage system identification directory mounted on wall or door at each entrance to room.
3. For panelboards, switchboards, motor control centers, and other branch circuit or feeder distribution equipment that are not located in electrical rooms, provide voltage system identification directory mounted on equipment.
 - a. Directories shall be affixed using epoxy glue. Screws or bolts shall not penetrate equipment enclosures.
 - b. Directories shall be readily visible and not obscure labels and other markings on equipment.

E. Conduit Labels:

1. Provide conduits with conduit labels unless otherwise shown or indicated.
2. Do not label flexible conduit.
3. Do not label exposed single conduit runs of less than 25 feet between local disconnect switches and their associated equipment.
4. Conduit labels shall indicate the following information:
 - a. Contract Number: Alphanumeric, three or four digits, as applicable.
 - b. Conduit Number: Alphanumeric as shown on the Drawings, as assigned by CONTRACTOR for unlabelled conduits, and in accordance with approved submittals.
5. Conduits that contain intrinsically safe wiring shall have an additional pipe marker provided that has blue letters on white background and reads, "INTRINSICALLY SAFE WIRING".
 - a. Install intrinsically safe pipe markers in accordance with NEC Article 504 along entire installation. Spacing between labels shall not exceed 25 feet.
6. Provide conduit labels at the following locations:
 - a. Where each conduit enters and exits walls, ceilings, floors, or slabs.

- b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
- c. At maximum intervals of 50 feet along length of conduit.
- 7. Orient conduit labels to be readable.

F. Wire and Cable Identification:

- 1. Color-coding of insulated conductors shall comply with Section 16122, 600 Volt Cable.
- 2. Use heat-shrinkable wire labels where wire or cable is terminated. Use wrap-around labels where wire or cable is to be labeled but is not terminated.
- 3. Do not provide labels for the following:
 - a. Bare (uninsulated) conductors, unless otherwise shown or indicated as labeled.
- 4. Provide wire and cable labels for the following:
 - a. New, rerouted, or revised wire or cable.
 - b. Insulated conductors.
 - c. Wire and cable terminations:
 - 1) Wire labels shall be applied between 1/2-inch and one inch of completed termination.
 - 2) Apply cable labels between 1/2-inch and one inch of cable breakout into individual conductors.
 - a) Label individual conductors in a cable after breakout as specified for wires.
 - d. Wire or cable exiting cabinets, consoles, panels, terminal boxes, and enclosures.
 - 1) Label wires or cables within two inches of entrance to conduit.
 - e. Wire or cable in junction boxes and pull boxes
 - 1) Label wires or cables within two inches of entrance to conduit.
 - f. Wire and cable installed in cable tray.
 - 1) Wire and cable shall have labels at maximum intervals of 20 feet.
 - g. Wire and cable installed without termination in electrical manholes.
 - 1) Wire and cable shall have wrap-around labels applied within one foot of exiting manhole.
- 5. Wire and Cable Identification System:
 - a. Wire and cable labels shall be imprinted with an identifying designator.
 - 1) Wire and cable extending between two devices or items and that does not undergo a change of function shall be identified by a single unique designator as specified below.
 - b. Field Wiring:
 - 1) Wire or cable designator shall consist of:
 - a) Three left-most characters shall consist of the Contract number under which wiring or cable was installed.

- b) Fourth character from the left shall be an asterisk (*), a plus sign (+) or a hyphen (-). Do not use other punctuation symbols in a wire designator.
 - c) Remaining characters shall be alphanumeric and make wire designator unique.
 - d) Numbering shall reflect actual designations used in the Work and shall be documented in record documents.
 - c. Cabinet, Console, Panel, and Enclosure Wiring, Internal:
 - 1) New Cabinets, Consoles, Panels, and Enclosures:
 - a) Wire and cable inside cabinets, consoles, panels, and enclosures shall have designators as specified in Section 13401, Plant Monitoring and Control System General Requirements.
 - 6. Modified Cabinets, Consoles, Panels, and Enclosures:
 - a. New or rerouted wire or cable in existing cabinets, consoles, panels, and enclosures shall be labeled as shown on the Drawings or be assigned a ten-character designator equivalent to field wire designator.
- G. Terminal Strip Labeling:
- 1. Label panel side of terminal to match panel wire number.
 - 2. Label field side of terminal to match field wire number. Terminal number shall not include the Contract number.

+ + END OF SECTION + +

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SECTION 16121

INSTRUMENTATION CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install instrumentation and communication cables.
 - 2. Types of cables include the following:
 - a. Shielded instrumentation cables.
 - b. Data communication cables.
- B. Related Sections:
 - 1. Section 16131, Rigid Conduits.
 - 2. Section 16075, Electrical Identification.

1.2 TERMINOLOGY

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

1.3 REFERENCES

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

8. UL 910, Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air.

1.4 QUALITY ASSURANCE

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

1.5 SUBMITTALS

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

PART 2 – PRODUCTS

2.1 MATERIALS

- A. General:
 1. Cables shall bear the UL label.
- B. Single Shielded Pair Instrument Cables:
 1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.
 2. Tinned copper, XLPE-insulated, stranded conductors, not less than no. 16 AWG, twisted pair, with overall shield, stranded tinned no. 18 AWG copper drain wire and overall PVC or CPE jacket. Rated for not less than 600 volts and complying with UL 1581.
- C. Multi-Paired Shielded Instrument Cables:
 1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.

- b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.
 - 2. Tinned copper, XLPE-insulated stranded conductors, not less than no. 16 AWG, twisted pairs with shield over each pair, stranded tinned no. 18 AWG copper drain wire, and overall PVC or CPE outer jacket. Rated for not less than 600 volts and complying with either UL 1581 or UL 13.
- D. Multi-Conductor Shielded Instrument Cables:
- 1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.
 - 2. Tinned copper, XLPE-insulated stranded conductors, not less than no. 16 AWG, stranded tinned no. 18 AWG copper drain wire, with overall 100 percent foil shield and overall PVC or CPE jacket. Rated for not less than 600 volts.
- E. Cable Terminals:
- 1. Manufacturers: Provide products of one of the following:
 - a. T&B Sta-Kon.
 - b. Burndy Insulug.
 - c. Or equal.
 - 2. Fork type copper compression terminals with nylon insulation for termination of cable at terminal blocks.
- F. Patch Cords:
- 1. Patch cords are used for connecting patch panel to hub, or wall jack to equipment.
 - 2. Manufacturer: Provide products of one of the following:
 - a. Bertek.
 - b. Belden.
 - c. Mohawk.
 - d. Or equal.
 - 3. Cables shall consist of no. 24 AWG, thermoplastic-insulated, stranded conductors formed into four individually-twisted pairs and enclosed by thermoplastic jacket.
 - 4. Cables shall be riser-rated.
 - 5. Rated for Category 6 use.
 - 6. Cables shall incorporate integral strain relief into the connector at each end. Connectors shall be RJ45 plugs.
 - 7. Provide the following patch cords:
 - a. One 10-foot cable per wall jack installed.
 - b. One 3-foot cable per every two wall jacks installed.

- c. One 5 foot cable per every two wall jacks installed.

G. Patch Panels:

1. Manufacturers: Provide products of one of the following:
 - a. Black Box.
 - b. Or equal.
2. Patch panels shall utilize RJ45 (eight-pin modular) plug/receptacle configuration, and utilize T568B pin/pair assignments for receptacles.
3. Coordinate patch panel terminations with wire type (solid or stranded conductor).
4. Patch panels shall be wall-mount type or rack-mount type, as indicated on the Drawings.
5. Listed as Category 6.
6. Provide quantity of ports not less than the quantity of wall jacks installed in the building/area served, plus 50 percent additional as spares.

H. Cable Support Hardware:

1. Wire Basket:
 - a. Materials and Finishes:
 - 1) Yellow Zinc Dichromate: Straight sections shall be steel complying with ASTM A510, and shall be electro-plated yellow zinc dichromate in accordance with ASTM B633 Type SC2.
 - b. Straight section longitudinal wires shall be straight, without bends.
 - c. Wire basket runway shall be made of high-strength steel wires and formed into a standard two-inch by four-inch wire mesh pattern with intersecting wires welded together. Wire ends along runway sides (flanges) shall be rounded.
 - d. Wire basket sizes shall comply with the following:
 - 1) Straight sections shall be furnished in standard lengths of nine feet ten inches.
 - 2) Wire basket shall have one-inch usable loading depth by 4 inches wide.
 - 3) Wire basket shall have two-inch usable loading depth by 8 inches wide.
 - 4) Wire basket shall have four-inch usable loading depth by 18 inches wide.
 - a) Fittings shall be field-formed as required.
 - b) Splicing assemblies shall be bolted type with serrated flange locknuts. Hardware shall be either yellow zinc dichromate in accordance with ASTM B633 Type SC2, or AISI Type 304 stainless steel.
 - c) Wire basket runway supports shall be center-support hangers, trapeze hangers, or wall brackets, manufactured by Cooper B-Line, or equal.

- d) Trapeze hangers or center-support hangers shall be supported by 1/4-inch or 3/8-inch diameter rods.
 - e) Provide special accessories as required to protect, support, and install wire basket runway system.
- 2. Conduit:
 - a. Where conduit is shown or indicated on the Drawings, comply with Section 16131, Rigid Conduits.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. General:
 - 1. Install cables complete with proper terminations at both ends.
 - 2. Install in conduit separate from power cables, unless shown or indicated otherwise.
 - 3. Ground shield on shielded cables at one end only and as recommended by instrument manufacturer.
 - 4. Identify conductors in accordance with Section 16075, Electrical Identification.
 - 5. Install and terminate Supplier-furnished cable in accordance with equipment manufacturer requirements and cable manufacturer's recommendations.
 - 6. Install in accordance with Laws and Regulations, including NEC.

3.3 FIELD QUALITY CONTROL

- A. Site Tests:
 - 1. Test shielded instrumentation cable shields with ohmmeter for continuity along full length of cables, and for shield continuity to ground.
 - 2. Connect shielded instrumentation cables to calibrated 4 to 20 mA dc signal transmitter and receiver. Test at 4 and 20 mA transmitter settings.
 - 3. Replace with new cables the full length of cables that fail test.
 - 4. Test equipment shall be provided by CONTRACTOR.
 - 5. For testing of communications cables, test equipment used shall comply with the following:
 - a. Equipment shall consist of a "master" and a "remote" unit.
 - b. Test of all aspects of cables shall be automatic and initiated with a single command. Test over entire frequency range. Test unit shall be capable of

- accepting cable identification tag for reporting. Test unit shall return “pass/fail” status for cables and, if “fail”, shall indicate reason for failure.
- c. Test unit shall be capable of storing all test results internally and printing the results later.
 - d. For unshielded twisted pair cables, test unit shall be specifically designed and manufactured to certify cabling relative to Category 6 compliant.

+ + END OF SECTION + +

SECTION 16122

600 VOLT CABLE

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install low-voltage conductors and cabling.
 - 2. Types of cabling required include:
 - a. Insulated cable for installation in raceways.
- B. Related Sections:
 - 1. Section 16075, Electrical Identification.
 - 2. Section 02223, Excavation Below Grade and Crushed Stone or Shell Refill.

1.2 REFERENCES

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

1.3 QUALITY ASSURANCE

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

1.4 SUBMITTALS

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

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Insulated Cable In Raceways:
 - 1. Application: Use for circuits located indoors and outdoors.
 - 2. Manufacturers: Provide products of one of the following:
 - a. Southwire.
 - b. The Okonite Company.
 - c. American Insulated Wire.
 - d. General Cable.
 - e. Or equal.
 - 3. Material: Single conductor copper cable complying with ASTM B3 and ASTM B8 with flame-retardant, moisture- and heat-resistant insulation rated for 90 degrees C in dry or wet locations, listed by UL as Type XHHW-2 complying with UL 44.
 - 4. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120-volt control circuits.
 - 5. Stranding: 600-volt cable shall be stranded, except that solid cable, No. 10 and smaller may be used for lighting circuits.
- B. Cable Connectors, Solderless Type:
 - 1. Products and Manufacturers: Provide products of one of the following:
 - a. T&B Sta-Kon.
 - b. Burndy Hylug.
 - c. Or equal.
 - 2. For wire sizes No. 4 AWG and above, use either compression type or bolted type with silver-plated contact faces.
 - 3. For wire sizes up to and including No. 6 AWG, use compression type. Alarm and control wire shall be terminated using forked type connectors at terminal boards.

4. For wire sizes No. 250 KCMIL and larger, use connectors with at least two cable clamping elements or compression indents and provision for at least two bolts for joining to apparatus terminal.
5. Properly size connectors to fit fastening device and wire size. Connectors shall be rated for 90 degree C, 600 volts.

C. Cable Splices:

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

D. Wire and Cable Markers:

1. Provide wire and cable markers in accordance with Section 26 05 53, Identification for Electrical Systems.

2.2 SOURCE QUALITY CONTROL

A. Factory Tests:

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

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install cables complete with proper terminations at both ends. Check and correct for proper phase sequence and proper motor rotation.

- B. Pulling:
1. Use insulating types of pulling compounds containing no mineral oil.
 2. Pulling tension shall be within limits recommended by wire and cable manufacturer.
 3. Use dynamometer where mechanical means are used.
 4. Cut off section subject to mechanical means.
- C. Bending Radius: Limit to minimum of six times cable overall diameter.
- D. Slack: Provide maximum slack at all terminal points.
- E. Splices:
1. Where possible, install cable continuous, without splice, from termination to termination.
 2. Where required, splice as shown and also where required for cable installation. Splices below grade, in manholes, handholes, and wet locations shall be waterproof.
 3. Splices are not allowed in conduits.
- F. Identification:
1. Identify conductors in accordance with Section 16075, Identification for Electrical Systems.
 2. Identify power conductors by circuit number and phase at each terminal or splice location.
 3. Identify control and status wiring using numeral tagging system.
- G. Color-code power cables as follows:
1. No. 8 AWG and Smaller: Provide colored conductors.
 2. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, wrapped in overlapping turns to cover an area of at least two inches.
 3. Colors: Match color scheme in use at the Site. If the Site does not have an existing color scheme, use the following colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral	White
	One Hot Leg	Black
	Other Hot Leg	Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral	White
	Phase A	Black
	Phase B	Red
	Phase C	Blue
240/120 Volts	Grounded Neutral	White

System	Conductor	Color
Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Phase A	Black
	High (wild) Leg	Orange
	Phase C	Blue
480Y/277 Volts Three-Phase, Four-Wire	rounded Neutral	Gray
	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow

3.2 FIELD QUALITY CONTROL

A. Site Tests:

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

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SECTION 16131

RIGID CONDUIT

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

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

B. Coordination:

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

C. Related Sections:

1. Section 02223, Excavation Below Grade and Crushed Stone and Shell Refill.
2. Section 02513, Asphalt Concrete Paving.
3. Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.
4. Section 16070, Support Systems.
5. Section 16075, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:

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

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:

1. NEC Article 342, Intermediate Metal Conduit.
2. NEC Article 344, Rigid Metal Conduit.
3. NEC Article 352, Rigid Nonmetallic Conduit.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Assembly details of conduit racks and other conduit support systems.
 - b. Layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete, and conduits directly buried in the ground. Shop Drawings shall show locations of pull and junction boxes and penetrations in walls and floors. Shop Drawings of embedded conduits shall include cross-sections showing thickness of

- concrete slabs and locations of conduits relative to reinforcing steel, waterstops, and other features of the slab.
- 2. Product Data:
 - a. Manufacturer's catalog cuts and product data for conduit, fittings, and appurtenances.
- B. Informational Submittals: Submit the following:
 - 1. Manufacturer's Instructions:
 - a. When requested by ENGINEER, provide copies of manufacturer's recommendations for handling and installing products.
 - 2. Site Quality Control Submittals:
 - a. When requested by ENGINEER, provide copies of results of specified Site quality control testing.
- C. Closeout Submittals: Submit the following:
 - 1. Record Drawings:
 - a. Show actual routing of exposed and concealed conduit runs in record documents in accordance with Section 01 78 39, Project Record Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Rigid Steel Conduit, Elbows, and Couplings:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Allied Tube and Conduit.
 - b. Wheatland Tube Company.
 - c. Western Tube and Conduit Corporation.
 - d. Or equal.
 - 2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
- B. PVC-coated Rigid Steel Conduit, Elbows, and Couplings:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Perma-Cote Industries.
 - c. OCAL, Inc.
 - d. Or equal.
 - 2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth urethane interior coating, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size with factory exterior coating of 40-mil thick PVC.
 - 3. Color: Color of coating shall be the same on all conduit and fittings.

C. Metallic Conduit Fittings, and Outlet Bodies:

1. Manufacturers: Provide products of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or equal.
2. Material and Construction: Cast gray iron alloy, cast malleable iron or aluminum bodies and covers consistent with conduit material. Units shall be threaded type with five full threads. Materials shall comply with ANSI/NEMA FB1 and be listed by UL. Do not use "LB" fittings. Use type "LBD" fittings where use of fittings is unavoidable.
3. Use: Conduits shall be gasketed and watertight in hazardous, wet, and corrosive locations.

D. PVC-coated Conduit Fittings, and Outlet Bodies:

1. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Perma-Cote Industries.
 - c. OCAL, Inc.
 - d. Or equal.
2. Material and Construction: Cast gray iron alloy, cast malleable iron bodies and covers with factory coating of 40-mil thick PVC and smooth urethane interior coating. Units shall be threaded type with five full threads. Material shall comply with ANSI/NEMA FB1 and be listed by UL. Do not use "LB" fittings. Use type "LBD" fittings where use of fittings is unavoidable.
3. Use: Provide PVC-coated or aluminum conduit fittings and outlet bodies in hazardous, wet, and corrosive locations. Fitting material shall be consistent with conduit material.

E. Non-metallic Conduit and Fittings:

1. PVC Plastic Conduit:
 - a. Manufacturers: Provide products of one of the following:
 - 1) Amoco Chemicals Corp.
 - 2) Carlon Electrical Products.
 - 3) Or equal.
 - b. Material: Schedule 40 PVC, rated for 90 degrees C, complying with NEMA TC3 and UL 514B and 651.
 - c. Fittings: Form elbows, bodies, terminations, expansions, and fasteners of same material and manufacturer as base conduit. Provide cement by same manufacturer as base conduit.

F. Conduit Hubs:

1. Manufacturers: Provide products one of the following.
 - a. Myers Electrical Products Company.

- b. Or equal.
 - 2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw.
 - 3. Use: Provide for all conduit terminations to boxes, cabinets, and other enclosures in areas designated as wet locations.
- G. PVC-coated Conduit Hubs:
- 1. Manufacturers: Provide products one of the following:
 - a. Robroy Industries.
 - b. Perma-Cote Industries.
 - c. OCAL, Inc.
 - d. Or equal.
 - 2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw, and factory coating of 40-mil thick PVC and smooth urethane interior coating.
 - 3. Use: Provide for PVC-coated steel or aluminum conduit terminations to boxes, cabinets, and other enclosures in areas designated as corrosive location.
- H. Conduit Bushings and Locknuts:
- 1. Manufacturers: Provide products one of the following:
 - a. O-Z/Gedney.
 - b. Appleton Electric Company.
 - c. Or equal.
 - 2. Insulated Bushings: Malleable iron body with plastic liner. Threaded type with steel clamping screw. Provide with bronze grounding lug, as required.
 - 3. Locknuts: Steel for sizes 3/4-inch through two-inch diameter and malleable iron for sizes 2.5-inch through four-inch diameter.
 - 4. Use: Provide for all conduit terminations to boxes, cabinets and other enclosures except threaded type in areas designated as dusty locations.
- I. Thruwall Seals
- 1. For new construction passing through concrete floors and floor slabs.
 - a. Manufacturer: Provide one of the following:
 - 1) Type FSK and FSCS floor seals by O-Z/Gedney.
 - 2) Or equal.
 - 2. For conduits passing through new exterior masonry block walls or through core-drilled holes in existing exterior subsurface walls, exterior concrete walls, floor slabs, and roof slabs, and for conduits passing through existing interior concrete walls or floors and interior masonry block walls.
 - a. Manufacturer: Provide one of the following:
 - 1) Type CSMI sealing bushing at the inside of the structure and Type CSMC sealing bushing at the outside of the structure by O-Z/Gedney.
 - 2) Or equal.

2.2 ACCESSORIES

- A. Fasteners: To the extent possible, fastener material shall be consistent with conduit material. For PVC-coated rigid steel conduit runs, fasteners shall have factory applied PVC coating or be stainless steel. Fasten raceway systems to supporting structures using the following:
 - 1. To Wood: Wood screws.
 - 2. To Hollow Masonry Units: Toggle bolts, in accordance with Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.
 - 3. To Brick Masonry: Expansion bolts by Price, or equal.
 - 4. To Concrete: Anchors in accordance with Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.
 - 5. To Steel: Beam clamps in accordance with Section 26 05 29, Supporting Systems.
- B. Duct Sealing Compound
 - 1. Soft, fibrous, slightly tacky, non-hardening sealing compound.
 - 2. Remains workable at all temperatures.
 - 3. Manufacturer:
 - a. Type DUX by O-Z/Gedney.
 - b. Or equal.

2.3 IDENTIFICATION

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

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. Install in accordance with Laws and Regulations.
- B. Supports:
 - 1. Rigidly support conduits by clamps, hangers, or Unistrut-type channels. Conduit supports and accessories shall be in accordance with Section 16070, Supporting Systems.
 - 2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers.
- C. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures using specified materials.
- D. Exposed Conduit:
 - 1. Install parallel or perpendicular to structural members or walls.
 - 2. Where possible, run in groups. Provide conduit racks of suitable width, length, and height, arranged to suit field conditions. Provide support every ten feet, minimum.
 - 3. Install on structural members in protected locations.
 - 4. Locate clear of interferences.
 - 5. Provide six inches of clearance from hot fluid lines and 1/4-inch from walls.
 - 6. Install vertical runs plumb. Unsecured drop length shall not exceed 12 feet.
- E. Conduit Embedded in Structural Concrete:
 - 1. Run embedded conduit in structural concrete in center of slabs and walls and above waterstops. Conduit connections shall be made watertight.
 - 2. Before placing concrete, arrange for observation of conduit installation by COUNTY or ENGINEER and make necessary conduit location measurements and provide required information on record documents.
 - 3. Confirm that concrete thickness is sufficient for embedding the quantity of conduits intended. Unless specifically shown or indicated otherwise, embedded conduits shall be in accordance with the following criteria:
 - a. Minimum concrete thickness shall be as follows:
 - 1) For concrete 16 inches thick and less, minimum concrete thickness shall be 11.5 inches plus the depth of largest conduit assembly. Conduit assembly depth shall be from the top of uppermost conduit to bottom of lowest conduit.
 - 2) For concrete greater than 16 inches thick, minimum concrete thickness shall be 13.5 inches plus depth of largest conduit assembly.
 - 3) For concrete at foundation slabs, provide an one inch additional to minimum concrete thicknesses specified.

- b. Conduit spacing shall be as follows:
 - 1) Two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of larger conduit
 - 2) When conduits cross at a point, conduits may be in direct contact and angle of cross shall be 45 degrees or greater. Conduits may also cross within the vertical spacing of multi-conduit layer assembly.
 - 3) When conduits cross structural expansion joint, two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of conduit fitting of the larger conduit

F. Underground Conduits:

- 1. Install individual, underground conduits minimum of 20 inches below grade, unless otherwise shown or indicated.
- 2. Perform excavation, bedding, backfilling, and surface restoration, including pavement replacement where required, in accordance with Section 02223, Excavation Below Grade and Crushed Stone or Shell Refill and Section 02513, Asphalt Concrete Paving.
- 3. Install warning tape 12 inches below finished grade over buried conduits.

G. Empty Conduits:

- 1. Install nylon pull wire in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose.

H. Field Bends: No indentations. Diameter of conduit shall not vary more than 15 percent at bends.

I. Joints:

- 1. Apply conductive compound to joints before assembly.
- 2. Make up joints tight and ground thoroughly.
- 3. Use standard tapered pipe threads for conduit and fittings.
- 4. Cut conduit ends square and ream to prevent damaging wire and cable.
- 5. Use full threaded couplings. Split couplings are not allowed.
- 6. Use strap wrenches and vises to install conduit. Replace conduit with wrench marks.
- 7. Apply zinc-rich paint to exposed threads and other areas of galvanized conduit system where base metal is exposed.

J. Terminations:

- 1. Install insulated bushings on conduits entering boxes or cabinets, except when threaded hubs are used.
- 2. Provide locknuts on both inside and outside of enclosure, except when threaded hubs are used.
- 3. Use of bushings in lieu of locknuts is not allowed.

4. Install conduit hubs on conduits entering boxes or cabinets in wet and corrosive areas.

K. Moisture Protection:

1. Plug or cap conduit ends at time of installation to prevent entrance of moisture and foreign materials.
2. Underground and embedded conduit connections shall be watertight.
3. Thruwall Seals and Conduit Sealing Bushings: Install for conduits passing through concrete slabs, floors, walls, or concrete block walls.
4. Drainage: Conduit runs shall be fully drainable. Where possible install conduit runs to drain to one end and away from building. Avoid pockets or depressions in conduit runs.
5. Seal conduit openings within control and instrumentation panels and distribution equipment with duct sealing compound to provide watertight seal.

L. Corrosion Protection:

1. Conduit Curb:
 - a. For conduits routed in concrete slabs or floors and stub-ups through floor, provide 4" inch high concrete curb, extending two inches from outer surface of conduit penetrating floor, to prevent corrosion. For floor-mounted equipment, concrete equipment base shall be in lieu of concrete curb.
 - b. Conduit stub-ups shall be 90-degree, PVC-coated, rigid, galvanized steel conduit elbow. PVC-coated elbow shall extend a minimum of 1/2-inch above top of concrete curb or equipment base. Should elbow not reach specified height, provide PVC-coated conduit extension to accommodate specified requirements. Provide coupling or fitting for transition from rigid galvanized steel conduit or PVC conduit in slab to PVC-coated elbow.
 - c. For conduits stubbing up and terminating at equipment enclosure mounted on concrete base, provide insulated grounding bushing on PVC-coated rigid steel elbow.
 - d. For conduits stubbing up and extending to boxes, cabinets, and other enclosures above the concrete curb in wet and dusty areas, provide conduit coupling/fittings between the PVC-coated rigid steel elbow and rigid steel conduit for transition between the two conduit types.
 - e. For conduits stubbing up and extending to boxes, cabinets, and other enclosures above the concrete curb or equipment base in corrosive areas, continue conduit system with PVC-coated rigid steel conduit
2. Dissimilar Metals:
 - a. Prevent occurrence of electrolytic action between dissimilar metals.

- b. Do not use copper products in connection with aluminum, and do not use aluminum in locations subject to drainage of copper compounds on bare aluminum.
 - c. Back paint aluminum in contact with masonry or concrete with two coats of aluminum-pigmented bituminous paint.
- M. Reused Existing Conduits:
 - 1. Pull rag swab through conduits to remove water and to clean conduit prior to installing new cable.
 - 2. Repeat swabbing until all foreign material is removed.
 - 3. Pull mandrel through conduit, if necessary, to remove obstructions.
- N. Core drill for individual conduits passing through existing concrete slabs and walls. Notify COUNTY in writing in advance of core drilling. Prior to core drilling, drill sufficient number of small exploratory holes to establish that the area to be core drilled is free of existing embedded conduits. Seal spaces around conduit as indicated in Paragraph 3.2.K.3 of this Section.
- O. Non-metallic Conduit:
 - 1. Install in accordance with manufacturer's recommendations.
 - 2. Provide manufacturer's recommended adhesives or sealants for watertight connections.
 - 3. Provide expansion fittings for expansion and contraction to compensate for temperature variations. Fittings shall be watertight and suitable for direct burial.
 - 4. Transition to PVC-coated rigid steel conduit before making turn up to enclosures.
- P. PVC-coated Rigid Steel Conduit:
 - 1. Install in accordance with manufacturer's recommendations.
 - 2. Install with manufacturer's installation tools to avoid damage to PVC coating.
 - 3. Repair damaged PVC coating with manufacturer's recommended touch-up compound.
- Q. Identify conduits, including spares, in accordance with Section 26 05 53, Identification for Electrical Systems.

3.3 FIELD QUALITY CONTROL

- A. Site Tests:
 - 1. Test conduits by pulling through each conduit a cylindrical mandrel with length not less than two pipe inside diameters, having an outside diameter equal to 90 percent of conduit's inside diameter.

2. Maintain a record, by number, of all conduits successfully tested.
3. Repair or replace conduits that do not successfully pass testing, and re-test.

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SECTION 16132

FLEXIBLE CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

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

1.2 REFERENCES

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

1.3 QUALITY ASSURANCE

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

1.4 SUBMITTALS

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

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Flexible Conduit (Non-hazardous Areas and Class 1, Division 2, Hazardous Areas):
 - 1. Material: Flexible galvanized steel core with smooth, abrasion-resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes 3/4-inch through 1.25-inch. Material shall be UL-listed.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Anaconda Sealtite Type UA by Anamet Electrical, Inc.
 - b. Liquatite Type L.A. by Electric-Flex Company.
 - c. Or equal.

B. Flexible Conduit Fittings:

1. Material and Construction: Malleable iron with cadmium finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.
2. Manufacturers: Provide products of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or equal.
3. Use: Provide on flexible conduit in non-hazardous and Class 1, Division 2 hazardous areas.

C. PVC-Coated Conduit Fittings:

1. Material and Construction: Malleable iron with standard finish and 40-mil PVC exterior coating. Fittings shall adapt the conduit to standard threaded connections, and shall have an inside diameter not less than that of the corresponding standard conduit size.
2. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Permacote Industries.
 - c. OCAL, Inc.
 - d. Or equal.
3. Use: Provide on flexible conduit in areas designated as corrosive locations.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

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

+ + END OF SECTION + +

SECTION 16133

SEALED FITTINGS

PART 1 – GENERAL

1.1 DESCRIPTION

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

1.2 REFERENCES

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

1.3 QUALITY ASSURANCE

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

1.4 SUBMITTALS

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

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Manufacturers: Provide products of one of the following:
 - 1. Crouse Hinds Company.
 - 2. Appleton Electric Company.
 - 3. Or equal.

B. Materials and Construction:

1. Cast gray iron alloy, or cast malleable iron, or copper free aluminum bodies with zinc electroplate and lacquer or enamel finish.
2. Ample opening with threaded closure for access to conduit hub for making dam.
3. In corrosive locations, fittings shall include factory-applied 40-mil PVC coating.
4. Construct fitting to allow 40 percent cross-sectional fill.

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

D. Sealing fitting, fiber, and sealing compound shall conform to UL 886.

PART 3 - EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

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

++ END OF SECTION ++

SECTION 16134

EXPANSION/DEFLECTION FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 REFERENCES

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

1.3 QUALITY ASSURANCE

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

1.4 SUBMITTALS

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

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Products and Manufacturers: Provide one of the following:
 - 1. Type DX for expansion/deflection or AX for expansion only, by O-Z Gedney Company.
 - 2. Type XD for expansion/deflection or XJ for expansion only, by Crouse Hinds Company.

3. Type DF for expansion/deflection or XJ for expansion only, by Appleton Electric Company.
 4. Or equal.
- B. Cast gray iron alloy or bronze end couplings, malleable iron, or hot-dipped galvanized body, stainless steel clamps and tinned copper braid bonding jumper. Fitting shall be watertight, corrosion-resistant, UL-listed, and compatible with the conduit system.
- C. Features:
1. Expansion/Deflection Fittings:
 - a. Axial expansion or contraction up to 3/4-inch.
 - b. Angular misalignment up to 30 degrees.
 - c. Parallel misalignment up to 3/4-inch.
 2. Expansion Fittings:
 - a. Expansion/Contraction: Eight-inch total movement.
- D. Expansion/Deflection fittings shall comply with UL 514B and UL 467.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. Install fittings in accordance with Laws and Regulations.
- B. Provide expansion fittings on exposed conduit runs crossing structural expansion joints and where necessary to compensate for thermal expansion and contraction. Provide expansion fittings on exposed conduit runs exceeding 200 feet.
- C. Provide expansion/deflection fittings on embedded conduit runs crossing structural expansion joints. Provide fittings above waterstops.
- D. Unless specifically shown or indicated otherwise, when crossing structural expansion joints larger than one inch, provide expansion fitting together with expansion/deflection fitting. Install fittings on each conduit run in accordance with manufacturer's recommendations to accommodate additional movement necessary.

- E. Provide expansion/deflection fittings for underground conduit runs at penetrations of buildings, manholes, handholes, and outdoor concrete equipment pads.
- F. Where required in non-metallic conduit and duct systems, provide rigid metal conduit nipples and metal rigid-to-PVC adapters for connection to fittings. Ensure that joints exposed to water or other liquid are made watertight.

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SECTION 16135

PULL, JUNCTION, AND TERMINAL BOXES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install pull, junction, and terminal boxes.
- B. Related Sections:
 - 1. Section 16050, General Provisions.
 - 2. Section 16070, Supporting Systems.
 - 3. Section 16075, Electrical Identification.

1.2 REFERENCES

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

1.3 QUALITY ASSURANCE

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

1.4 SUBMITTALS

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

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Pull, Junction, and Terminal Boxes:

1. General – Applicable to All Boxes:
 - a. Description and Performance Criteria:
 - 1) Provide pull, junction, and terminal boxes rated at not less than NEMA 12. Boxes shall be appropriate for each location in accordance with NEMA requirements and as required for area classifications specified in Section 16050, General Provisions.
 - 2) For flush-mounted pullboxes in slabs or pavement potentially subject to vehicular traffic, boxes and covers shall be constructed for H-20 loading in accordance with AASHTO Standard Specifications for Highway Bridges.
 - b. Manufacturers: Provide products of one of the following:
 - 1) Appleton Electric Company.
 - 2) Crouse-Hinds Company.
 - 3) Hoffman Engineering Company.
 - 4) Or equal.
 - c. Materials: Pull boxes embedded in concrete slabs shall be cast iron.
 - d. Terminal strips and terminal blocks in terminal boxes shall be mounted on terminal box sub-panels.
 - e. Identification: Boxes shall be identified in accordance with Section 16075, Electrical Identification.
2. Materials and Construction – Dusty Locations:
 - a. Material: Welded and galvanized sheet steel of USS gage.
 - b. Gasket: Oil-resistant gasket.
 - c. Access: Lift-off hinges and quick-release latches.
 - d. Material Thickness:
 - 1) Boxes with dimension two feet and smaller shall be 14-gage.
 - 2) Boxes with dimension between two and three feet shall be 12 gage.
 - 3) Boxes with dimension of three feet or more in any direction shall be 10-gage.
3. Materials and Construction - Wet, Corrosive, or Hazardous Locations:
 - a. Rating:
 - 1) Pull boxes in wet, corrosive, or outdoor areas shall be NEMA 4X.
 - 2) Boxes for areas classified as hazardous locations, where required by NEC, shall be explosion-proof and comply with UL 886.
 - b. Material:
 - 1) Cast gray iron alloy with hot-dip galvanized finish, or cast malleable iron bodies and covers.
 - 2) Large boxes not generally available in cast iron construction shall be copper-free aluminum alloy or Type 316 stainless steel, as required by location.
 - 3) In corrosive locations, where the conduit system is PVC-coated, boxes shall be cast metal with factory-applied 40-mil PVC coating, Type 316 stainless steel, or non-metallic thermoplastic or fiberglass reinforced plastic material.

- c. Gasket:
 - 1) Provide neoprene gaskets for wet and corrosive locations.
 - 2) Gaskets shall be an approved type designed for the purpose. Improvised gaskets are not acceptable.
 - d. Access: Stainless steel cover bolts.
 - e. Features:
 - 1) External mounting lugs.
 - 2) Drilled and tapped conduit holes.
 - 3) Boxes where conduits enter building or structure below grade shall have 1/4-inch drain hole at bottom of the box.
 - 4) Provide threaded connections for explosion proof boxes.
- B. Terminal Blocks:
- 1. Products and Manufacturers: Provide one of the following:
 - a. Allen-Bradley Company, Bulletin, Model 1492.
 - b. General Electric Company, Model CR151K.
 - c. Or equal.
 - 2. Material and Construction:
 - a. NEMA-rated nylon modular terminal blocks.
 - b. 600-volt rated.
 - c. Control and alarm circuit terminals shall be screwed type with permanently affixed numeric identifiers beside each connection.
 - d. Power terminals shall be copper and rated for the circuit ampacity.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. Mount boxes so that sufficient access and working space is provided and maintain clearance of not less than 1/4-inch from walls.
- B. Securely fasten boxes to walls or other structural surfaces on which boxes are mounted. Provide independent supports that comply with Section 26 05 29, Hangers and Supports for Electrical Systems, where boxes will not be mounted on walls or other structural surface.
- C. Install pull boxes where shown or indicated, and provide pull boxes where one or more of the following conditions exist:

1. Conduit runs containing more than three 90-degree bends.
 2. Conduit runs exceeding 200 feet in length.
- D. Provide removable, flame-retardant, insulating cable supports in boxes with any dimension exceeding three feet.
- E. Field-apply PVC touch-up to scratched PVC boxes damaged during installation. Touch-up work shall be in accordance with manufacturer's recommendations and instructions.
- F. Size junction, pull, and terminal boxes in accordance with NEC Article 314 and other Laws and Regulations.
- G. Provide terminal blocks in boxes where shown and where cable terminations or splices are required.

+ + END OF SECTION + +

SECTION 16136

OUTLET BOXES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install outlet boxes for mounting wiring devices and lighting fixtures.
- B. Related Sections:
 - 1. Section 16050, General Provisions.
 - 2. Section 16070, Supports Systems.
 - 3. Section 16075, Electrical Identification.
 - 4. Section 16141, Receptacles.
 - 5. Section 16142, Snap Switches.

1.2 QUALITY ASSURANCE

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

1.3 SUBMITTALS

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

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Device Boxes:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Crouse-Hinds Company.

- b. Appleton Electric Company.
 - c. Or equal.
- 2. Material:
 - a. In Wet Locations: Cast gray iron alloy or cast malleable iron with zinc electroplate finish, or aluminum bodies consistent with conduit material.
 - b. In Dusty Locations: Zinc-coated sheet steel or aluminum bodies consistent with conduit material.
 - c. Where conduit is installed concealed, boxes shall include suitable extension rings and covers, as required.
 - d. Where used with PVC-coated conduit system, boxes shall include factory applied 40-mil-thick PVC coating.
 - e. Cast boxes shall be hub-type and include external mounting lugs.
 - f. Metallic outlet boxes shall comply with UL 514A.
 - g. Fittings for outlet boxes shall comply with UL 514B.
- 3. NEMA rating of box shall be as required for area classifications specified in Section 16050, General Provisions.
- 4. Cover Plates:
 - a. Type 302 stainless steel alloy for indoor finished areas.
 - b. Plates in corrosive locations shall include factory-applied 40-mil PVC coating.
 - c. Stainless steel screws and hardware.
 - d. For receptacle and switch cover plates, comply with Section 16141, Receptacles, and Section 16142, Snap Switches.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. Fasten boxes rigidly and neatly to supporting structures.
- B. Securely fasten equipment to walls or other surfaces on which materials or equipment is mounted. Provide independent supports complying with Section 16070, Supporting Systems, where boxes are not mounted on walls or other surface capable of supporting the materials or equipment.
- C. For units mounted on masonry or concrete walls, provide suitable 1/2-inch spacers to prevent mounting back of box directly against wall.

- D. Leave no open conduit holes in boxes. Close unused openings with capped bushings.
- E. Label each circuit in boxes and identify each circuit in accordance with Section 16075, Electrical Identification.
- F. Install outlet boxes in accordance with NEC Article 314.

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SECTION 16137

UNDERGROUND DUCTBANKS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install underground ductbanks.
- B. Coordination:
 - 1. Ductbank routing on the Drawings is diagrammatic. Coordinate installation with piping and other Underground Facilities and locate ductbanks clear of interferences.
 - 2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before underground ductbank Work.
- C. Related Sections:
 - 1. Section 02223, Excavation Below Grade and crushed Stone or Shell Refill.
 - 2. Section 03200, Concrete Reinforcement.
 - 3. Section 03300, Cast-in-Place Concrete.
 - 4. Section 16061, Grounding Systems.
 - 5. Section 16075, Electrical Identification.
 - 6. Section 16131, Rigid Conduits.
 - 7. Section 16134, Expansion/Deflection Fittings.

1.2 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Layouts showing proposed routing of ductbanks and locations of manholes, handholes, and areas of reinforcement.
 - b. Profiles of ductbanks showing crossings with piping and other Underground Facilities.
 - c. Typical cross sections for each ductbank.
- B. Informational Submittals: Submit the following:
 - 1. Special Procedure Submittals:
 - a. Installation procedures.
 - 2. Field Quality Control Submittals:
 - a. Field test report.

C. Closeout Submittals: Submit the following:

1. Record Drawings:
 - a. Include actual routing of underground ductbank runs on record documents in accordance with Section 01720, Project Record Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Duct: Provide conduit and fittings in accordance with Section 16131, Rigid Conduits. Conduit types shall be as follows:
 1. Schedule 40 PVC conduits for power circuits.
 2. Galvanized rigid steel conduits for the following types of circuits: low voltage status, analog, and communication.
- B. Backfill: Provide backfill, including select backfill, in accordance with Section 02223, Excavation Below Grade and Crushed Stone or Shell Refill.
- C. Reinforcing: Provide Ductbank reinforcing in accordance with Section 03200, Concrete Reinforcing.
- D. Concrete: Provide ductbank concrete in accordance with Section 03300, Cast-in-Place Concrete.
- E. Grounding: Provide ground cable in accordance with Section 16061, Grounding Systems.
- F. Conduit Spacers: Conduit spacers shall be nonmetallic, interlocking type to maintain spacing between conduits. Provide spacers suitable for all conduit types used in multiple sizes.
- G. Duct Sealing Compound:
 1. Products and Manufacturers: Provide one of the following:
 - a. 0-Z/Gedney, Type DUX.
 - b. Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. Excavation and Backfilling:
 - 1. Provide excavation and backfilling for ductbank installation in accordance with Section 02223, Excavation Below Grade and Crushed Stone or Shell Refill.
 - 2. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material, or other materials that can damage or contribute to corrosion of ducts or cables, or prevent adequate compaction of backfill.
- B. Ductbank Layout:
 - 1. Top of ductbank concrete shall be a minimum of 2.5 feet below grade, unless shown or indicated otherwise on the Drawings.
 - 2. Slope ductbank runs for drainage toward manholes and away from buildings with slope of approximately three inches vertical per 100 feet of run.
- C. Ductbank Assembly:
 - 1. Assemble ductbanks using non-magnetic saddles, spacers, and separators. Position separators to provide minimum three-inch concrete separation between outer surfaces of each conduit. Provide side forms for each ductbank.
 - 2. Make bends with sweeps of not less than four-foot radius or five-degree angle couplings.
- D. Concrete Placing:
 - 1. Provide minimum four-inch concrete covering on each side, top, and bottom of concrete envelopes around conduits. Concrete covering shall be as shown or indicated on the Drawings.
 - 2. Provide red dye in concrete for easy identification during subsequent excavation; all concrete in entire ductbank, including top and bottom, shall be dyed.
 - 3. Firmly fix conduits in place during concrete placing. Carefully place and vibrate concrete to fill spaces between conduits.
- E. Conduit Transitions:
 - 1. Conduit installations shall be watertight throughout entire length of ductbank.
 - 2. Transition from non-metallic to galvanized rigid steel conduit where ductbanks enter structure walls and slabs.
 - 3. Terminate conduits in insulated grounding bushings.
 - 4. Continue conduits inside buildings in accordance with Section 16131, Rigid Conduits, and as shown or indicated in the Contract Documents.

5. If ducts are not concrete-encased, provide expansion and deflection fittings in accordance with Section 16134, Expansion/Deflection Fittings.
 6. Plug and seal empty spare conduits entering structures. Conduits in use entering structures shall be sealed watertight with duct sealing compound.
- F. Ductbank Reinforcing:
1. Provide reinforcing for all ductbanks:
 2. Install ductbank reinforcement as shown or indicated on the Drawings.
 3. Provide maximum clearance of 1.5 inches from bars to edge of concrete encasement.
- G. Connections to Structures:
1. Firmly anchor ductbanks to structure walls or slabs. Epoxy-grout ductbank rebar into structure concrete to eliminate sheer forces between ductbank and structure wall concrete.
 2. Ductbank penetrations through structure walls shall be watertight.
- H. Grounding:
1. Provide bare stranded copper ductbank ground cable in each ductbank envelope. Make ground electrically continuous throughout entire ductbank system.
 2. Connect ground cable to building and station ground grid or to equipment ground buses. Also, connect ground cable to steel conduit extensions of underground ductbank system.
 3. Provide ground clamp and bonding of each steel conduit extension to maintain continuity of ground system.
 4. Terminate ground cable at last manhole or handhole for outlying structures.
- I. Detectable Underground Warning Tape:
1. Provide detectable underground warning tapes complying with Section 16075, Electrical Identification, over the full length of each underground ductbank.
 2. Install warning tapes approximately 12 inches below grade.
 3. Provide multiple tapes across the width of each ductbank. Locate center of a warning tape above each edge of ductbank, and at intervals across top width of ductbank so that clear space between tapes does not exceed six inches.
- J. Reused Existing Ducts:
1. Pull rag swab through duct to remove water and to clean conduits prior to installing new cable.
 2. Repeat swabbing until all foreign material is removed.
 3. Pull mandrel through duct, if necessary, to remove obstructions.

++ END OF SECTION ++

SECTION 16141

LOW-VOLTAGE RECEPTACLES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install low-voltage receptacles.
- B. Related Sections:
 - 1. Section 16050, General Provisions.
 - 2. Section 16075, Electrical Identification.
 - 3. Section 16136, Outlet Boxes.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 498, Standard for Attachment Plugs and Receptacles.
 - 2. UL 514D, Cover Plates for Flush-Mounted Wiring Devices.
 - 3. UL 943, Standard for Ground-Fault Circuit-Interruption.

1.3 QUALITY ASSURANCE

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

1.4 SUBMITTALS

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

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Receptacles:

1. Grounding receptacle, two-pole, three-wire, NEMA 5-20R configuration, ivory color.
 - a. Single:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL5361I by Hubbell, Inc.
 - b) 5361-I by Pass & Seymour.
 - c) Or equal.
 - b. Duplex:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL5362I by Hubbell, Inc.
 - b) PS5362-I by Pass & Seymour.
 - c) Or equal.
 - c. Weather-resistant Duplex:
 - 1) UL-listed as weather-resistant.
 - 2) Products and Manufacturers: Provide one of the following:
 - a) HBL5362IWR by Hubbell, Inc.
 - b) WR5362-I by Pass & Seymour.
 - c) Or equal.
2. Corrosion-resistant grounding receptacle, two-pole, three-wire, yellow color.
 - a. Single, 125-volt, 20 ampere, NEMA 5-20R configuration:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL53CM61 by Hubbell, Inc.
 - b) CR6301 by Pass & Seymour.
 - c) Or equal.
 - b. Duplex, 125-volt, 20 ampere, NEMA 5-20R configuration:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL53CM62 by Hubbell, Inc.
 - b) CR6300 by Pass & Seymour.
 - c) Or equal.
 - c. Single, 125-volt, 30 ampere, NEMA 5-30 configuration:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL9308 by Hubbell, Inc.
 - b) 3802 by Pass & Seymour.
 - c) Or equal.
3. Grounding receptacle, two-pole, three-wire, 250-volt, 20 ampere, NEMA 6-20 configuration, brown color.
 - a. Single:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL5461 by Hubbell, Inc.
 - b) 5871 by Pass & Seymour.
 - c) Or equal.
 - b. Duplex:
 - 1) Products and Manufacturers: Provide one of the following:
 - a) HBL5462 by Hubbell, Inc.

- b) 5862 by Pass & Seymour.
 - c) Or equal.
 - 4. Provide Type 302 stainless steel cover-plate conforming to UL 514D. Provide weatherproof-while-in-use cover where shown on the Drawings as “WP” or “WPU”, and provide where receptacles are located in wet or corrosive location.
 - 5. Receptacles shall comply with UL 498.
- B. Ground Fault Interrupting Receptacles:
- 1. Duplex grounding receptacle, two-pole, three-wire, NEMA 5-20R configuration, 125-volt AC, 20 amperes, gray color with ground fault circuit interrupting (GFCI) protection.
 - 2. Ground fault interrupting receptacles shall comply with UL 943.
 - 3. Provide Type 302 stainless steel cover-plate conforming to UL 514D. Provide weatherproof-while-in-use cover where shown on the Drawings as “WP” or “WPU”, and provide where located in wet or corrosive location.
 - 4. Products and Manufacturers: Provide one of the following:
 - a. GFR5362SGY by Hubbell, Inc.
 - b. 2091-GRY by Pass & Seymour.
 - c. Or equal.
 - 5. Weather-resistant Ground Fault Interrupting Receptacles:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) 2095TRWRGRY by Pass & Seymour.
 - 2) Or equal.
- C. Weatherproof Covers:
- 1. Where receptacles are installed in damp locations as defined in area classification portion of Section 16050, General Provisions, provide receptacles as specified in Paragraphs 2.1.A through 2.1.D of this Section, as applicable, with weatherproof covers as specified below.
 - 2. Provide covers that are UL-listed weatherproof and suitable for use in damp locations in accordance with NEC 406.
 - 3. Material:
 - a. Gasketed spring door type for wet and corrosive locations. Plates in corrosive locations shall have factory-applied 40-mil PVC coating.
 - b. Stainless steel screws and hardware.
 - 4. Products and Manufacturers: Provide one of the following:
 - a. Hubbell, Inc.
 - b. Crouse-Hinds Company.
 - c. Appleton Electric Company.
 - d. Or equal.
- D. Weatherproof-While-in-Use Covers:
- 1. Where receptacles are shown on the Drawings as “WP” or “WPU”, and where receptacles are installed in wet locations as defined in area classification

portion of Section 16050, General Provisions, provide receptacles as specified in Paragraphs 2.1.A through 2.1.D of this Section, as applicable, with weatherproof-while-in-use covers as specified below.

2. Provide covers that are UL-listed, weatherproof while receptacle is in use, and are of ultraviolet-resistant construction suitable for outdoor use in accordance with NEC 406.
3. Material:
 - a. Non-metallic box with hinged, non-metallic cover.
 - b. Sealing gaskets between box and cover.
 - c. Stainless steel screws and hardware.
 - d. Color: Gray finish.
4. Products and Manufacturers: Provide one of the following:
 - a. TayMac Corporation.
 - b. Pass and Seymour Type WIU.
 - c. Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. Non-hazardous Locations: Install receptacles at locations shown, in outlet or device boxes in accordance with Section 16136, Outlet Boxes.
- B. Install receptacles with ground pole in the down position.
- C. Mount receptacles 18 inches above finished floor in non-hazardous locations and 4.5 feet above finished floor in hazardous locations, in accordance with the Americans with Disability Act, unless otherwise shown or indicated in the Contract Documents.
- D. Install in conformance with Laws and Regulations.
- E. Identification:
 1. Identify each conductor with circuit number and lighting panel number in accordance with Section 16075, Electrical Identification.
 2. Identify each receptacle with permanent phenolic tag. Tags shall include circuit number and lighting panel number.

++ END OF SECTION ++

SECTION 16142

SNAP SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install snap switches for lighting and other systems.

B. Related Sections:

1. Section 16075, Electrical Identification.
2. Section 16136, Outlet Boxes.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. UL 20, General Use Snap Switches.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data: Manufacturer's technical information for switches proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Switches for Non-Hazardous Locations:

1. Single pole AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Catalog No. 1221-I, by Harvey Hubbel, Inc.
 - 2) Catalog No. 1991-I, by Arrow-Hart, Inc.
 - 3) Catalog No. 20AC1-I, by Pass & Seymour.
 - 4) Or equal.
2. Single pole, three-way AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.

- a. Products and Manufacturers: Provide one of the following:
 - 1) Catalog No. 1223-I, by Harvey Hubbell, Inc.
 - 2) Catalog No. 1993-I, by Arrow-Hart, Inc.
 - 3) Catalog No. 20AC3-I, by Pass & Seymour.
 - 4) Or equal.
 3. Two-pole AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Catalog No. 1222-I, by Harvey Hubbell, Inc.
 - 2) Catalog No. 1992-I, by Arrow-Hart, Inc.
 - 3) Catalog No. 20AC2-I, by Pass & Seymour.
 - 4) Or equal.
 4. Switches in non-hazardous areas shall be UL-listed in accordance with UL 20.
- B. Switch Covers:
1. Indoor covers shall be Type 304 stainless steel.
 2. Outdoor, wet, or corrosive location covers shall be weatherproof and corrosion resistant.

PART 3 - EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. Install switches at locations as shown or indicated in the Contract Documents in outlet or device boxes, in accordance with Section 16136, Outlet Boxes.
- B. Mount wall switches 4.0 feet above finished floor unless otherwise noted.
- C. Identify each conductor with circuit number and lighting panel number. Identification shall be in accordance with Section 16075, Electrical Identification.

++ END OF SECTION ++

SECTION 16143

DISCONNECT SWITCHES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install disconnect switches.
- B. Related Sections:
 - 1. Section 16050, General Provisions.
 - 2. Section 16075, Electrical Identification.
 - 3. Section 16142, Snap Switches.

1.2 REFERENCES

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

1.3 QUALITY ASSURANCE

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

1.4 SUBMITTALS

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

- a. Furnish one set of spare fuses for each fused disconnect switch to be installed.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

2.2 MATERIALS

- A. Single Throw, Circuit Disconnect Switches:
 1. Type: Fused or unfused, horsepower rated, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in the "OFF" position and safety handle.
 2. Rating: Voltage and current ratings and number of poles as required for motor or equipment circuits being disconnected. Switches shall bear a UL label and shall comply with the requirements of UL 98, NEMA KS 1 and NEMA 250.
 3. Provide auxiliary dry contacts to indicate switch position.
- B. Double Throw Safety Switches:
 1. Type: Unfused, double throw with center "OFF" position, quick-make, quick-break mechanism, visible blades in the "OFF" position, and safety handle.
 2. Rating: Voltage and current ratings and number of poles as required for circuits being disconnected. Switches shall bear UL label and shall comply with UL 98, NEMA KS 1, and NEMA 250.
 3. Provide auxiliary dry contacts to indicate switch position where shown on the Drawings.
- C. Disconnect Switches for 120-volt, Single-phase Circuits:
 1. Refer to Section 16142, Snap Switches.
- D. Enclosures: NEMA rating shall be as required for area classifications specified in Section 16050, General Provisions.
- E. Identification:
 1. Identify enclosures in accordance with Section 16075, Electrical Identification.

2. Provide nameplate to identify the equipment served by disconnect switch and associated source of power.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

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

++ END OF SECTION ++

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SECTION 16144

CONTROL STATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install control stations, including pushbuttons, selector switches, and other control stations elements.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before control stations Work.
- C. Related Sections:
 - 1. Section 16050, General Provisions.
 - 2. Section 16070, Support Systems.
 - 3. Section 16075, Electrical Identification.

1.2 REFERENCES

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

1.3 QUALITY ASSURANCE

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

1.4 SUBMITTALS

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

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Control Stations:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Cutler-Hammer.
 - b. General Electric Company.
 - c. Allen Bradley Company.
 - d. Square-D Company.
 - e. Or equal.
 - 2. Type: 30.5 mm industrial, heavy duty, oil-tight construction with clearly-marked legend plates.
 - 3. Emergency Stop or Lockout Stop: Lockout stop pushbuttons shall be two-position, push-pull type with maintained contact and mushroom head. Provide control stations with padlocking attachment and legend plate reading "PUSH-TO-STOP, PULL-TO-START".
 - 4. Pushbuttons: Momentary or maintained types, NEMA A600 contact rating.
 - 5. Selector Switches: Rotary type with round or oval handles and positioning device to securely hold switch in selected position for maintained type and for spring return from left, right, or both left and right to maintained position.
 - 6. Control stations shall comply with NEMA ICS 2, NEMA ICS 5, and UL 508, and shall bear the UL label.
 - 7. Indicating Lights: 120 vac LED module, push-to-test. Lens color shall be in accordance with Section 16075, Electrical Identification.
 - 8. Enclosures: As required for area classifications specified in Section 16050, General Provisions, and complying with NEMA 250 and NEMA ICS 6.
 - 9. Identification: Identify enclosures in accordance with Section 16075, Electrical Identification. Devices shall include front-mounted nameplates identifying function and equipment controlled, if not readily apparent.

PART 3 – EXECUTION

3.1 INSPECTION

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

3.2 INSTALLATION

- A. Install equipment as shown and indicated, and provide sufficient access and working space for ready and safe operation and maintenance.
- B. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide independent supports where no wall or other surface exists, in accordance with Section 16070, Supporting Systems.

+ + END OF SECTION + +

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