



CONTRACT DOCUMENTS

VOLUME 2 OF 2

LA ROSA PUMP STATION REHAB PROJECT

SAWS Job No. 18-6001

SAWS Solicitation No. CO-00256

March 2019



TETRA TECH

Texas Registration No. F-3924

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SECTION 00050

CERTIFICATION PAGE

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SAWS Project No. 18-6001

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Discipline: Process & Civil

Responsible Party: Tetra Tech, Inc. – TBPE Reg. No. F-3924

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08710 Finish Hardware

DIVISION 10 – SPECIALITIES

10140 Signage



(SEAL) Gerardo G. Noriega

Discipline: Architectural
Responsible Party: GNA Architecture – TBAE Reg. No. BR 113

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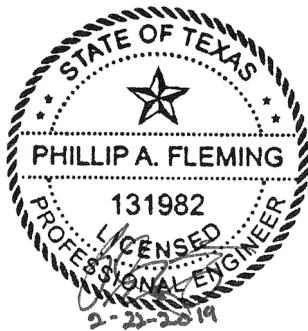
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Discipline: Structural

Responsible Party: Tetra Tech, Inc. – TBPE Reg. No. F-3924

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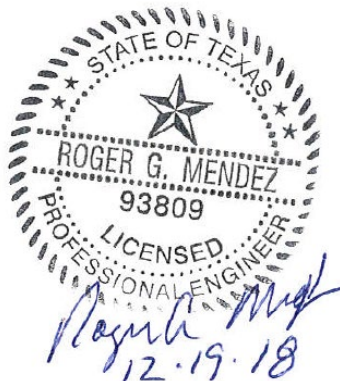
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Discipline: HVAC and Plumbing

Responsible Party: RGM Engineering – TBPE Reg. No. F-10487

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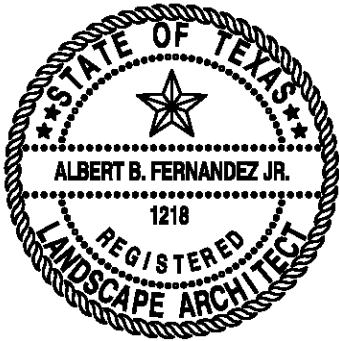
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02481 Treatment of Existing Trees



A handwritten signature in black ink that reads "Albert B. Fernandez Jr." in a cursive style.

(SEAL) _____

Discipline: Landscaping
Responsible Party: CFZ Group, LLC – LA No. 1784

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(SEAL) _____

Discipline: Electrical

Responsible Party: Grubb Engineering, Inc. – TBPE Reg. No. F-3904

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Discipline: Instrumentation and Controls
Responsible Party: Grubb Engineering, Inc. – TBPE Reg. No. F-3904

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DIVISION 13

SPECIAL CONSTRUCTION

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SECTION 13110**CATHODIC PROTECTION SYSTEM****PART 1 GENERAL****1.01 SCOPE**

- A. The cathodic protection design/install contractor shall provide all engineering services, materials, equipment, labor, testing, and supervision for the installation for the following:
- a. Automatically controlled impressed current cathodic protection system with vertical anode system to provide corrosion control for the interior submerged surface of the tank (replace the existing tank cathodic protection system).
 - b. Provide corrosion control for the new steel pipes.
 - c. Electrical isolation of above structures from adjacent metallic structures, reinforcing steel, structures of dissimilar metal, conduits, and all other metallic components that require cathodic protection.
 - d. All work furnished shall be in accordance with AWWA Standard D104, ANSI/NSF 61 and features included in this specification. The cathodic protection constructor shall be Corrpro Waterworks, or Engineer approved equal.

1.02 DESIGN

- A. All engineering services shall be provided by a Corrosion Specialist who is accredited by the National Association of Corrosion Engineers International as a Senior Corrosion Technologist, Corrosion Specialist or Cathodic Protection Specialist. The system shall be designed by a Corrosion Specialist with experience in cathodic protection for water storage tanks and steel pipes. The Corrosion Specialist shall design the system to provide effective corrosion control in accordance with criteria for protection. The criteria for protection shall be based on a tank-to-water potential, pipe-to-water potential, pipe/soil potentials, IR drop free, within a range of -0.850 volts to -1.050 volts relative to a stationary copper-copper sulfate reference electrode. This potential shall be measured free of the effect of voltage gradients (IR drop).
- B. The Corrosion Specialist shall also base system capacity and performance on:
1. Total submerged surface area of the tank. (includes area up to high water line within tank bowl and wet risers in elevated tanks which are 30" in diameter or larger)
 2. Type of coating and condition of coating.
 3. Steel pipe material and coating.
 4. Total bare surface area to be protected will be a minimum of 25% of total surface area.
 5. Minimum current density of 0.5 MA/ft.² bare surface area.
 6. Chemical analysis of water including resistivity expressed in ohm-cm.
 7. Susceptibility of tank and steel pipe to icing conditions.
 8. Minimum anode design life of twenty (20) years.

9. Selection, dimensions, and layout of system components specified in Section C. of this specification.

1.03 SUBMITTALS

- A. The cathodic protection constructor shall submit the following information to the purchaser for approval by the OWNER or his representative prior to ordering materials and equipment.
 1. Drawings showing system design/configuration.
 - a. Tank drawings showing anode layout with locations and heights of installation.
 - b. Piping layout drawings showing anode sizes and locations.
 - c. Installation details including wiring diagrams, wiring details, rectifier installation details, grounding details, anode attachment details for both piping systems and tank systems, etc.
 2. Description of system components with product data including brochures, materials specifications and test data.
 3. Copy of ANSI/NSF 61 classification for all system components located within the tank.
 4. Design calculations for required voltage, amperage & life expectancy, prepared by the identified Corrosion Specialist.
- B. Operation and Maintenance submittal:
 1. Provide operation and maintenance manual for rectifier and other major components of the cathodic protection system.
- C. Post-installation submittals:
 1. Test and inspection reports as identified in this specification showing compliance with the design and proper installation of the cathodic protection system.

PART 2 PRODUCTS

2.01 RECTIFIER

- A. Rectifier units shall perform in accordance with ANSI/AWWA Standard D104 and shall include:
 1. Transformer
 2. Silicon rectifying elements
 3. Circuit breaker(s)
 4. Lightning, surge, and overload protection
 5. Provision for air-cooling operation
 6. Digital voltmeter(s), ammeter(s) and potential meter(s)
 7. Weatherproof cabinet in accordance with NEMA 4 requirements

8. Provision to vary current output from 0% to 100% of rated capacity
9. Provisions for mounting, grounding, and locking
10. Provision for 110-120 volt, 60 Hz, single phase A.C. power.
11. D.C. output capacity in volts and amperes in accordance with Design (Section B)
12. Number of circuits in accordance with Design (Section B)
13. Automatic controller shall adjust current output to compensate for changes in water level, temperature of water, water chemistry, and cathodic polarization, and shall include the following provisions:
 - a. Utilize long-life reference electrode(s) installed within the tank
 - b. Monitor the tank-to-water potential, free of IR drop
 - c. Automatically adjust the tank-to-water potential, free of IR drop, to a preset value
 - d. Operate within 25MV of preset value
 - e. Limit current to a preset value
 - f. Utilize digital potential meter(s) to display tank-to-water potential, free of IR drop

The rectifier unit shall be a Corppower TASC VIII automatic rectifier Model #TASCA-CJ or approved equal.

- B. LONG LIFE REFERENCE ELECTRODE(S): The permanent reference electrode shall consist of a copper-copper sulfate electrode which is manufactured to remain stable (plus or minus 10MV) for minimum of ten (10) years. The reference electrode to lead wire connection shall be encapsulated to prevent water migration. The stationary reference electrode shall be positioned within the tank to provide the most representative measurements for the submerged surface area(s). The reference electrode shall be a Corpro Companies Model #IHRP-801 Permacell or approved equal.
- C. VERTICAL ANODE "HANGING" SYSTEM: The anode suspension system shall be designed to be resistant to ice damage and in accordance with ANSI/AWWA Standard D104, Section 4.2.4.1.2 Type B, Extendable Vertical System. The anode suspension system shall consist of a minimum 5/16" polyester cord. Tanks with wet risers which are 30" diameter or larger shall incorporate an anode suspension system with the steel anchors welded to the sidewall of the riser pipe. All cord to cord connections shall be tied and taped. The anode system shall be a Corpro Waterworks anode system or approved equal.
- D. ANODE MATERIALS: The anode materials shall be selected in accordance with Design (Section B) and shall consist of one of the following:
1. Minimum .062" diameter titanium with a mixed metal oxide coating.
- All anode to header cable connections shall be sealed to prevent water migration.
- E. PRESSURE ENTRANCE FITTING: For icing tanks the pressure entrance fitting shall accommodate anode and reference electrode lead wires at the base of the tank or at the base of wet risers for elevated tanks, which are 30" diameter or larger. The fitting shall be

manufactured to prevent leakage through the fitting and to prevent water migration through the wire insulation. The entrance fitting shall be sized for a 1.0 inch NPT, 3000 psi steel coupling.

- F. WIRING: All wiring within the tank shall be insulated to prevent copper conductor to water contact. All wiring on the exterior of the tank shall be insulated and run in rigid conduit.
- G. HARDWARE: All hardware used in conjunction with the system shall be protected against corrosion.
- H. ANSI/NSF 61: All materials in contact with the water or exposed to the interior of the tank shall be classified in accordance with ANSI/NSF 61 "Drinking Water System Components".

2.02 MAGNESIUM ANODES

- A. High Potential Magnesium Anode Alloy: Anodes shall be cast magnesium alloy ingots conforming to ASTM B843 as manufactured by the Dow Chemical Company, Federated Metals Company, Magnesium Corporation of America, or equal. The Open Circuit voltage of this alloy should be minimum 1.70 volt with respect to a copper sulfate reference electrode. The high potential magnesium alloy chemical composition shall be as shown below:

<u>Component</u>	<u>Composition by Weight</u>
Aluminum	0.01 percent maximum
Manganese	0.5 percent to 1.3 percent
Copper	0.02 percent maximum
Silicon	0.05 percent maximum
Nickel	0.001 percent maximum
Iron	0.03 percent maximum
Others, each	0.05 percent max. each
Magnesium	Remainder

- B. Special Backfill Cloth Bag: Each magnesium anode shall be prepackaged in a permeable cloth bag and backfill. The backfill grains shall be such that 100 percent is capable of passing through a 100 mesh screen. The backfill shall be firmly packed around the anode by mechanical vibration to a density that will maintain the magnesium ingot in the center of the bag surrounded on average by at least one inch of backfill. The backfill shall have the following composition:

Gypsum	75 percent
Powdered Bentonite	20 percent
Anhydrous Sodium Sulfate	5 percent

- C. Anode Core: The anode shall be cast with a galvanized steel wire, strip or rod core and shall be recessed at one end so that the core is accessible for the lead wire connection.
- D. Anode Lead Wire Connections: The lead wire shall be connected to the anode core with silver solder. The connection shall be mechanically secure before soldering and shall have at least 1-1/2 turns of wire at the connection. The connection shall be insulated by filling the remainder of the recess with electrical potting compound. Unless otherwise shown on the Plans, the anode lead wire shall be No. 12 AWG stranded copper wire with black HMWPE insulation. The anode wire shall be long enough to extend to the anode test box without any splices and provide for a minimum of 18 inches of slack within the test box.
- E. Magnesium anode weight, alloy, total anode bag weight, and dimensions shall be determined by the Corrosion Specialist.

2.03 PIPE LEAD, ANODE HEADER AND BOND WIRE

- A. Use stranded copper wire. Wires with cut or damaged insulation are not acceptable and replacement of the entire lead will be required. Wires shall be sufficient length to extend from the point of installation on the pipeline to the appropriate corrosion monitoring test box without splices and provide for a minimum of 18 inches of slack within the test box.
- B. Direct Buried CP Wires: Wires shall be stranded copper that conform to ASTM B3 and ASTM B8. All test wires and anode header/collector cable shall be minimum No. 10 AWG. Test wires and anode header/collector cable shall have HMWPE insulation specifically designed for cathodic protection service and suitable for direct burial in corrosive soil, conforming to ASTM D1248, Type I, Grade J3, Class C, Category 5 (HMW-PE Type CP). Wire insulation color shall be as shown on the Drawings.
- C. Pipe Joint Bonding Wire: Wire shall be No. 4 AWG and shall have 7/64-inch thick HMWPE black insulation specifically designed for cathodic protection service and suitable for direct burial in corrosive soil, conforming to ASTM D1248, Type I, Grade J3, Class C, Category 5 (HMW-PE Type CP).

2.04 CP TEST STATIONS

- A. Test stations shall not rust, corrode, shatter, peel, or absorb heat. Test stations shall be environmentally safe, resist attack from alkaline, acid, or organic compounds commonly found in soil and salt, herbicides, pesticides, and fertilizers. Test stations shall have dimensional and electrical stability from -20°F to 175°F and be stable under ultraviolet exposure.
- B. Each CP Test Station shall include a cross-laminated phenolic terminal board with a minimum thickness of 1/4 inch. The terminal board shall contain individual lugs for each wire entering the test station or junction box.
- C. Wire and cable identification markers. Provide a durable wire identification tag for each cable. Acceptable tags are military grade heat shrink labels with minimum dimensions of one-inch width and 1/4-inch height. Print the labels per the job specific identification legend on the Drawings.

2.07 BELOW GRADE CP TEST BOXES

- A. Provide an electrical pull box or concrete valve box for all below grade CP Test Stations. Generally, boxes shall be installed outside of any roads or parking lots. Where traffic loading of the boxes is required, they shall be designed to withstand H-20 traffic loads. Boxes shall be a minimum of 10-3/8 inches inside diameter, 12 inches deep, and have a cast iron cover. Covers for test stations shall have the words "CP TEST" cast or welded thereon. Letters shall be minimum 3/4 inches tall and 1/4 inch raised from the surrounding flat area. Use Christy Concrete Products, G5, or engineering approved equal.

PART 3 EXECUTION**3.01 WORKMANSHIP AND INSTALLATION QUALIFICATIONS**

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

3.02 PERFORMANCE

- A. All work shall be in accordance with the following requirements:
1. Components of the cathodic protection system shall be installed in the manner and at the locations as shown on the design drawings prepared by the Corrosion Specialist.
 2. Pressure entrance fitting shall be installed in accordance with AWWA D100.
 3. Welding, cutting, and coating shall be in accordance w/AWWA Standards D100, D102 & D105
 4. Welding of steel coupling and anchors for vertical anode suspension and rectifier mounting bracket shall be performed by the prime contractor prior to coating the tank. The cathodic protection constructor shall furnish drawings and materials to the prime contractor prior to coating.
 5. Verification of electrical continuity of all sections of bolted or riveted tanks shall be the responsibility of the purchaser of the cathodic protection system.
 6. Materials and equipment shall be inspected prior to installation. Any defective component shall be repaired or replaced.
 7. Electrical work shall be in accordance with the National Electrical Code.
 8. Lead wires shall be installed to prevent damage from abrasion.
 9. Electrical connections within the tank shall be sealed to prevent water migration.
 10. The rectifier shall be mounted at a convenient height (eye level) above grade for monitoring and service purposes.
 11. A.C. power to the rectifier shall be furnished by the purchaser.
 12. Disinfection of the tank shall be the responsibility of the purchaser.
 13. Work provided by the constructor shall be completed in a clean and safe manner.

3.03 ENERGIZING THE SYSTEM

- A. After the system is installed and the tank/steel pipe is filled, the cathodic protection constructor shall provide start-up service which includes energizing, testing, and adjusting the system for optimum performance of the cathodic protection system. This start-up service shall be performed in accordance with ANSI/AWWA D104 Section 5.2 Testing. This start-up service shall be coordinated with the OWNER or his representative. All tank-to-water potential and pipe/water/soil potential measurements shall be conducted with a calibrated portable copper-copper sulfate reference electrode and a portable high impedance voltmeter. A minimum of five (5) locations shall be measured. All test data shall be reviewed and evaluated by the Corrosion Specialist. Following the initial calibration and setup completion, the system will be de-energized for 11 months until after the one year anniversary inspection. The final test and adjustment of the system shall be conducted approximately twelve (12) months after the start-up service, upon completion of the warranty inspection and tank paint touchup. In addition to the start-up service, four (4) copies of "plan of record" drawings and OWNER's Maintenance Manuals shall be submitted to the purchaser.

3.04 MONITORING

- A. The cathodic protection constructor shall furnish self-addressed report cards to be completed by the OWNER. Report cards received by the cathodic protection constructor during the guarantee and service period(s) shall be evaluated for system performance.

3.04 GUARANTEE

- A. All workmanship, equipment, and materials furnished by the cathodic protection constructor shall be guaranteed for two (2) years.

3.05 SERVICE AGREEMENT

- A. After the warranty period, the cathodic protection constructor shall furnish a service agreement to the OWNER for the type of system installed. The agreement shall include the annual service rate and a complete description of the scope of work proposed. The agreement for annual inspection and potential testing shall be in accordance with AWWA D104, Appendix C and include as a minimum:
1. One (1) annual job site visit.
 2. Tank-to-water potential measurements conducted at representative locations within the tank. A minimum of five (5) locations shall be measured.
 3. Pipe/soil/water potential measurements conducted at representative locations within the pipe. A minimum of three (3) locations shall be measured.
 4. Measurements shall be conducted with a portable high impedance voltmeter and a calibrated copper-copper sulfate reference electrode.
 5. Adjustments for optimum corrosion control shall be in accordance with criteria for protection.
 6. Data recorded shall provide sufficient information to evaluate the performance for the system relating to criteria for protection.

7. In the event additional work is required, the constructor shall submit a report with recommendations for optimizing corrosion control.

END OF SECTION

SECTION 13122**PRE-ENGINEERED FIBERGLASS SHELTERS****PART 1 GENERAL****1.01 SUMMARY**

- A. Section Includes: Extent of pre-engineered fiberglass shelters as shown on Drawings, including pre-engineered shelter, and required electrical wiring, devices, heating, ventilation and cooling equipment.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to Work of this Section.

1.02 REFERENCES

- A. ASTM C 518 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM D 256 – Standard Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics.
- C. ASTM D 618 – Standard Practice for Conditioning Plastics for Testing.
- D. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.
- E. ASTM D 732 – Standard Test Method for Shear Strength Plastics by Punch Tool.
- F. ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- G. ASTM D 792 – Standard Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
- H. ASTM D 1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics.
- I. ASTM D 2583 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
- J. Unless otherwise noted, all specifications and references are made to current edition of the publications.

1.03 RELATED WORK

- A. Section 03300 – Cast-In-Place Concrete: Concrete slab.
- B. Division 15: HVAC requirements.
- C. Division 16: Electrical connections.

- D. Other Mechanical and Electrical Specifications: Reference for coordination and inclusion of miscellaneous equipment, louvers, and shelter penetrations.

1.04 SYSTEM DESCRIPTION

- A. Provide three (3) one-piece molded construction FRP shelter plus Alternate, if selected, of the following size:
 - 1. Fluoride Shelter Size: 12' W x 16' D x 9'-6" H as shown on Drawings.
- B. Paneled wall construction shall not be acceptable.
- C. Design factory-fabricated, pre-engineered shelter per ASCE 7-10 and the following Design Loads:
 - 1. Risk category: 3
 - 2. Dead Load: Self Weight
 - 3. Roof Live Load: 20psf
 - 4. Snow Load: Ground Snow per Site Location, Importance Factor = 1.1
 - 5. Wind Load: Speed per Site Location, Exposure Category C
 - 6. Seismic Load: Accelerations and Site Class per Site Location, Importance Factor = 1.25
- D. Install and anchor pre-engineered shelter on sloped cast-in-place concrete slab conforming to Section 03300.

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: The Pre-fabricated FRP shelter manufacturer shall exhibit satisfactory performance under service conditions of an equal magnitude for a period of not less than five (5) years.
- B. Pre-installation Conference: Verify that the concrete slab is level, true to plane, and of the correct dimensions to receive the pre-engineered FRP shelter. Correct all deficiencies before proceeding.
- C. Use only qualified workers trained to handle and erect pre-engineered FRP shelters.

1.06 SOURCE QUALITY CONTROL

- A. The manufacturer shall maintain a continuous quality control program and upon request shall furnish to the engineer certified test results of the physical properties.

1.07 SUBMITTALS

- A. Submit in accordance with provisions of Section 01300, covering the items included under this Section. Submittals shall include:

1. Product Data: Shelter accessories including heating, ventilation and cooling, electrical and certified independent test results of representative wall laminate.
 2. Submit Shop Drawings showing:
 - i. Critical dimensions, jointing and connections, fasteners and anchors.
 - ii. Materials of construction.
 - iii. Sizes, spacing, and location of structural members, connections, attachments, openings, and fasteners.
 - iv. Color.
 3. Calculations: Structural design calculations, sealed by an independent licensed Professional Engineer in the state of Texas.
- B. Samples: 8-inch square sample of representative wall construction, upon request.
- C. Manufacturer's installation instructions.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. All equipment shall be delivered in good, sound condition, and free from damage. Equipment which has been damaged will be rejected.
- B. Contractor shall be responsible for proper unloading, handling, and storage of equipment in accordance with the Manufacturer's instructions.
- C. Manufacturer shall include lifting eyes, gasket for slab mounting, and door spacers to be used in moving and positioning shelter for installation.
- D. Store products indoors or in weather protected area until installation. Protect from construction traffic and damage.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include, but are not limited to, the following:
 1. TRACOM, Inc.; 6575-A Industrial Way, Alpharetta, Georgia 30004; Tel. (877) 435-8637, Fax (770) 664-6565, www.tracomfrp.com.
 2. Jacobs Manufacturing
 3. Warminster Fiberglass.
- B. Substitutions shall be made in accordance with the provisions of Section 01600.

- C. Substitutions: Manufacturers not pre-approved shall not be allowed.
- D. Warranty: Shelters shall be warranted to be free of defects in workmanship and materials for a period of two (2) years from date of shipment.

2.02 MATERIALS

A. One-Piece Molded Composite Construction:

1. General Construction: Smooth interior and exterior satin finish. Walls and roof shall be integral with smooth radii for all corners. No roof overhang shall be allowed. External section connection flanges shall only be allowed in those instances where shelter is oversized.
2. Laminate: Isophthalic polyester resin with high performance, chopped, commercial grade glass strand fiber reinforcement with a suitable coupling agent.
 - i. Minimum glass content: 30%.
 - ii. Exterior surface: 15 mil (minimum) gel coat with U.V. inhibitors and a satin finish lightly textured and free from fiber pattern, roughness, or other irregularities.
 - iii. Exterior laminate: 1/8 inch thick (minimum); chemically bonded to the surface gel coat and encapsulating the foam core.
 - iv. Foam core (2.2.A.3)
 - v. Interior laminate: 1/8 inch thick (minimum); chemically bonded to the interior gel coat and encapsulating the foam core.
 - vi. Interior surface: 15 mil (minimum) gel coat with U.V. inhibitors and a textured finish, free from exposed glass or other irregularities.
 - vii. Laminate properties:
 1. Tensile strength (ASTM D 638): 14,000 PSI.
 2. Flexural strength (ASTM D 790): 27,000 PSI.
 3. Flexural modulus (ASTM D790): 1,000,000 PSI.
 4. Shear strength (ASTM D 732): 12,000 PSI.
 5. Barcol hardness (ASTM D 2583): 40.
 6. Density / specific gravity (ASTM D 792): 93.6 PCF/1.5.
3. Core:

- i. Rigid unfaced, closed cell, polyisocyanurate foam with a density of 3.0 pounds per cubic foot. Foam shall be P300 Elfoam without exception. Lower density foams shall not be acceptable.
 1. 1 inch thick with an initial insulating value of R~6.
 - ii. Core properties:
 1. Thermal conductivity (ASTM C 518): 0.165 BTU
inch/hr./SF/°F.
 2. Density / specific gravity (ASTM D 1622): 3.0 PCF.
 3. Shear Strength (ASTM C 273):
 - a. Parallel to rise: 35 lb/in²
 - b. Perpendicular to Rise: 30 lb/in²
 4. Tensile Strength (ASTM D 1623):
 - a. Parallel to rise: 60 lb/in²
 - b. Perpendicular to Rise: 50 lb/in²
 5. Compressive Strength (ASTM D 1621):
 - a. Parallel to rise: 65 lb/in²
 - b. Perpendicular to Rise: 40 lb/in²
 4. Coupons prepared in accordance with ASTM D 618.
- B. Doors: Provide One (1) Set of Double doors.
1. Construction:
 - a. One-piece molded fiberglass construction 78 inches high, 1-3/4 inches thick, and 72 inches wide.
 - b. Mount door with two T-304 stainless steel laminated strap hinges, 5 inches long. Door must be readily replaceable – the use of continuous piano hinges or fastening methods other than bolting shall not be acceptable.
 - c. Rubber bulb gasket with flexible lock to retain permanent grip.
 - d. One-piece, purpose built, 3 inches deep fiberglass drip cap over doors; drip cap to extend 2 inches each side past door. Cut angle shall not be acceptable.
 - e. Full threshold, heavy duty black vinyl, 4-1/2 inches deep x 1/2 inch high.
 - f. Door lock system shall be provided by the Contractor per specification 08710 Door Hardware. The door shall be prepared to accept a Mortise lock by Schlage catalog number L9080T 07A with finish 626 and primus core catalog number 20-740 with finish 626. The Contractor shall coordinate as necessary with the building supplier. All other door hardware shall be provided by the FRP building supplier.

- g. Heavy duty stainless steel, dual compression spring cushioned overhead door stop, designed for BHMA L52231 and ANSI A156.16.
 - h. Include single-flap neoprene insert style door sweep.
- C. Lifting Eyes: Include a minimum of two removable, 3/4 inch – 10 partially threaded, eye bolts with 6 inch shank lengths.
- 1. Lifting eyes shall be steel (5,200 lbs. work load limit).
- D. Internal Mounting Flange: 3 inches wide x 1/4 inch thick (minimum) with closed cell neoprene sponge rubber gasket 2 inches wide x 3/8 inch thick to provide a weather-tight seal around shelter perimeter.

2.03 SHELTER HVAC

- A. Corrosion Resistant Fan: Shutter-mounted exhaust fan with integral fiberglass gravity shutter, fiberglass reinforced polypropylene fan blades, fiberglass canopy, and epoxy coated wire guard.
- 1. Capacity: 524 CFM.
- B. Shutter: Gravity operated fiberglass intake shutter, with heavy duty fiberglass frame and exterior removable T-316 stainless steel insect screen.
- 1. Dimensions: 10 inches by 10 inches.
 - 2. Include fiberglass hood over intake shutter.
- C. Heater: Line powered wall heater. No separate electrical outlet shall be required.
- 1. 1,500 watt, 5,120 BtuH, white powder coat finish with automatic re-set thermal overload protection with indicator light and built-in thermostat.

2.04 SHELTER ELECTRICAL

- A. Electrical:
- 1. Circuit Breaker Panel: 120 / 240 VAC, 1 phase, surface mount, 125 amp, main lug, 8 branch, NEMA 1 metallic body.
 - 2. Electrical Wiring: 12 gauge stranded, color-coded THHN/THWN/MTW electrical wiring in rigid, U.L. listed, corrosion / impact resistant, non-conductive, Schedule 40 PVC conduit. SO cord or other non-encased wiring shall not be acceptable.
 - 3. Receptacle: GFCI receptacle 15A 125V, 20 A 125V feed-through, with 5mA +/- 1mA trip threshold shall be included inside shelter.
 - 4. A switch with weatherproof switch box, single toggle, for light / fan shall be provided next to the door.
- B. Lighting:

1. Interior Light: Lamp shall be wired to the weatherproof light / fan switch.
 - a. Provide a 100 watt, vapor-tight LED light.

2.05 EQUIPMENT MOUNTING ACCESSORIES

A. Mounting Panel

1. Fluoride Shelter: Include three (3) mounting panels: 48 inches wide x 72 inches high equipment mounting panel, 48 inches wide x 42 inches high mounting panel, and 66 inches wide x 36 inches high mounting panel.
2. Panels shall be 3/4 inches thick plywood equipment mounting panel laminated into wall in locations shown on Drawings.

2.06 FINISHES

- A. Gray Cloud gel coat with U.V. inhibitors
- B. Exterior Color: #2445 Gray Cloud.
- C. Interior Color: #2445 Gray Cloud.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with Drawings, Specification, and local codes, and in a manner consistent with the manufacturer's installation instructions and recommendations.
- B. Verify door operation and set all anchor bolts prior to removing door spacers provided during shipment of shelter.
- C. Move and position shelter using lifting eyes provided. Position the provided neoprene gasket between the concrete slab and shelter mounting flange. If more than one lifting eye is provided, use a spreader bar.
- D. After closing shelter doors:
 1. Layout anchor bolt pattern: Anchor bolts should be installed in accordance with manufacturer's instructions.
 2. Drill and set anchor bolts starting with one on each side of the doors. Anchor bolts behind and in front of doors shall be flat head anchors if mounting flange is external.
 3. Drill anchor bolt holes to the depth and diameter required by the anchor bolt manufacturer. Stainless steel wedge style concrete anchors [1/2 inch diameter x 4-1/2 inches long – (minimum)] are recommended and to be confirmed by Manufacturer. Anchor bolts are to be supplied by Contractor.
 4. Verify operation of doors before installing remaining anchor bolts.

- a. Failure to verify operation of doors before the remaining anchor bolts are set may result in binding of door against door frame.
- 5. Install threshold (if supplied) and re-verify operation of doors.
- 6. After all anchor bolts have been completely set, remove door spacers.
- E. Seal flange with sealant or grout to ensure watertightness.
- F. Install (as necessary) and test shelter accessories in accordance with manufacturers' instructions.
- G. For additional installation instructions refer to latest revision of document OPS-I.

3.02 ADJUST AND CLEAN

- A. Clean surfaces in accordance with the manufacturer's instructions.
- B. Remove trash and debris within and around immediate vicinity of shelter structure, and leave in clean condition.

END OF SECTION

SECTION 13200
STEEL WATER TANK REHABILITATION

PART 1 GENERAL**1.01 DESCRIPTION OF WORK**

- A. This section includes the repair and replacement of pits, holes, corrosion damage, structural damage, and various improvements to the steel water storage tank and tank appurtenances at the La Rosa Pump Station (PS) Site.

1.02 RELATED WORK

- A. Specification – 09870 – General Specification for Coating System for Steel Storage Tanks.
- B. Specification – 09871 – Exterior Coating System for Steel Storage Tanks.
- C. Specification – 09872 – Interior Coating System for Steel Storage Tanks.
- D. Specification – 09873 – Removal of Lead Base Coasting for Steel Storage Tanks.
- E. Specification – 13220 – Disinfection of Water Storage Tanks
- F. Division 15 – Mechanical
- G. Division 16 – Electrical
- H. Division 17 - Instrumentation

1.03 REFERENCE STANDARDS (Latest Revisions)

- A. American Water Works Association (AWWA)
 - 1. D100, Standard for Welded Steel Tanks for Water Storage.
- B. American Society for Testing and Materials (ASTM)
 - 1. A36, Structural Steel.
 - 2. A53, Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless.
 - 3. A325, Type 3, High Strength Bolts for Structural Steel Joints.
 - 4. A442, Pressure Vessel Plates, Carbon Steel, Improved Transition Properties.
 - 5. A516, Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service.
 - 6. A517, Pressure Vessel Plates, Alloy Steel, High Strength, Quenched and Tempered.
 - 7. A537, Pressure Vessel Plates, Heated Treated, Carbon-manganese-Silicon Steel.
 - 8. A563, Type C3 and Dh3, Carbon and Alloy Steel Nuts.
 - 9. A66, Steel Screw Spikes.
 - 10. A573, Structural Carbon Steel Plates of Improved Toughness.
 - 11. A580, Stainless and Heat Resisting Steel Wire.
 - 12. A588, High Strength Low Alloy Structural Steel.

13. A633, Normalized High Strength Low Alloy Structural Steel.
 14. A662, Pressure Vessel Plates, Carbon-Manganese, for Moderate and Lower Temperature Service.
 15. A678, Quenched and Tempered Carbon Steel Plates for Structural Applications.
 16. F436, Hardened Steel Washers.
 17. F593, Stainless Steel Bolts, Hex Cap Screws, and Studs.
 18. F594, Stainless Steel Nuts.
- C. American Petroleum Institute (API)
1. API Standard 650, Welded Steel Tanks for Oil Storage.
 2. APE Standard 653, Tank Inspection, Repair, Alteration, and Reconstruction.
- D. American Welding Society (AWS)
1. Publication D1.1, Structural Welding Code, Steel.
- E. American National Standard Institute (ANSI)
1. Standard A14.3, Safety Code for Fixed Ladders.
- F. American Society of Civil Engineers (ASCE)
1. ANSI/ASCE 7, Minimum Design Loads for Buildings and Other Structures.
- G. Occupational Safety and Health Administration (OSHA)
1. Regulation 1910.23, Guarding Floor and Wall Opening and Holes.
 2. Regulation 1910.27, Fixed Ladders.
 3. Regulation 1926.1053, Ladders.
- H. Southern Building Code Congress International, Inc. (SBCCI)
1. Uniform Building Code (UBC).
- I. NACE International (NACE) Standard
1. Standard RPO178, Standard Recommended Practice – Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service.
 2. Visual Comparator – Surface Finishing of Welds (NACE Standard RPO 178).
- 1.04 SUBMITTALS**
- A. Submittals: Submittals shall be provided for review prior to performing any Work in accordance with Section 01300. The supplier will provide the CONTRACTOR with submittals.

CONTRACTOR will submit to the ENGINEER to review submittals for compliance and approve.

- B. A GST Rehabilitation Plan, to include detailed schedules, timeframes, testing, and plans for the complete rehabilitation of the GST shall be provided to the ENGINEER and OWNER 60 days prior to the shutdown of the GST for approval. Plan shall be signed by the person responsible for performing and coordinating the work.
- C. Construction Drawing Submittals: Construction Drawings of all fabricated and new items shall be submitted to the OWNER and ENGINEER for review in accordance with Section 01300. Drawings submitted shall, at a minimum, include the following:
 - 1. Drawings of new permanent manways.
 - 2. Drawings of new Cathodic Protection System.
 - 3. Drawings of all new tank appurtenances (i.e., ladders, handrails, vents, hatches, manways, and access platform handrails).
 - 4. Drawings of crow's nest and other structural item replacement or repair.

1.05 QUALIFICATIONS

- A. Welders Certification: All welders and welding operators shall be AWS certified to the procedures and processes required to accomplish the Work. Welder's certification papers shall be furnished to the Field Inspector prior to the commencement of welding on the tank. All welders shall be 6G certified.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All structural components shall be fabricated from new ASTM A36 material.
- B. All steel plates, shapes and bars shall be fabricated from new ASTM A36, A516, A537, A588, A633, A662 or A678 material if the tank is designed in accordance with Section 14 of AWWA D100. All steel plates and shapes shall be free from any laminations that bring questions as to the structural integrity of the member. Laminations exposed on the surface or edges of the steel shall be repaired or the member replaced. CONTRACTOR shall be responsible for ultrasonically or otherwise investigating the extent of subsurface laminations to the satisfaction of the ENGINEER. Members found to have internal lamination shall be replaced in a timely manner at the expense of the CONTRACTOR.
- C. New steel pipe attached to the tank shall be ASTM A53.
- D. 316 Stainless steel bolts and nuts shall conform to conform to ASTM F593 and ASTM F594.
- E. Interior nuts and bolts shall be carbon steel and, at a minimum, shall conform to ASTM A325. Threads shall not extend beyond the nut. Sikaflex shall be applied to all interior nuts and bolts.
- F. Polyurethane Sealant: with Sikaflex-1A from (Sika Corporation) or approved equal
- G. Grout:
 - 1. Duragrout (by L&M Construction Chemicals, Inc.),

2. Masterflow 928 (by Master Builders),
 3. EUCO N-S Grout (by Euclid Chemical Company)
 4. or approved equal.
- H. Curing Compound:
1. water-based curing compound,
 2. L&M Cure (from L&M Construction Chemicals, Inc.),
 3. Mastercure 200W (from Master Builders),
 4. Aqua-cure (from Euclid Chemical Company),
 5. or approved equal.
- I. Pressure Gauge: Terrice Model 700-LF-SS-40-04-L-A or approved equal.
- J. Always Safe Tank (AST) Center Vent: One (1) new 36-inch diameter aluminum roof vent. The new exterior vent screen shall be either a double aluminum screen shall be supported to not produce a gap greater than 0.10-inch by a minimum of two (2) stainless steel bands. Bolts and nuts utilized in the tank center vent shall be Type 316 stainless steel. The removable vent cap shall be designed with a vertical overhang to prevent the entrance of wind-driven rain and debris
- K. Roof Access Hatches: Aluminum water-tight hatches Manufactured by the BILCO Company or ENGINEER-approved equal.
- L. Full Body Harness: For each tank, CONTRACTOR shall supply two (2) full body harnesses, buckle type with front D-ring.
- M. Cable-Type Safety Climb:
1. Lad-Saf by DBI/SALA or approved equal.
 2. Bolt-on flexible cable style.
 3. Minimum design load: 310 LB.
 4. Stainless steel cable with by-passable intermediate supports.
 5. include telescoping extension.

PART 3 EXECUTION

3.01 REPAIRS AND ADDITIONS

- A. Interior Grinding: Grind surface protrusions, burrs, fitting scars, weld spatter, corners, sharp edges, rough weld beads, and weld overlap shall be removed from all interior surfaces of the tank. The objective of the grinding is to eliminate irregular surfaces and to provide a sufficiently smooth surface for the application of a uniform coating without pinholes, holidays, and/or voids.
- B. Roof Repair: SSPC Interior Sand blasting shall occur prior to the Engineer inspection of roof rafters to identify rafters with significant pack rust and spot blast the roof support members. Engineer and inspector will identify roof support members to be repaired. Replace all roof nuts, bolts and washers in kind.

- C. Seam Welding: All areas of seam deterioration shall be abrasive blast cleaned and any seam corrosion or undercutting shall be repaired by arc gouging and seal welding.
- D. Pit Welding: All areas of pitting shall be abrasive blast cleaned and any pits shall be repaired by welding.
- E. Pit Filling: All areas of apparent pitting shall be abrasive blast cleaned and any pits or seams shall be filled with solventless polyamide epoxy seam sealer of the type recommended by the manufacturer of the interior coating system. Any rough areas of the seam sealer shall be sanded smooth prior to the application of the coating system.
- F. Roof Overlaps: Apply polyurethane sealant to roof seams and overlaps. Apply sealant after cure of the finish coat.
- G. Grout Repair: All grout around the perimeter of the foundation of the tank shall be replaced with a non-staining, non-shrinking, high strength structural grout material. After the final contour of the grout has hardened sufficiently for the application of a curing compound, a water-based curing compound shall be applied to the exposed grout surfaces. After cleaning and painting, any separation between the bottom plate and the grout greater than 1/32-inch shall be filled/sealed
- H. Existing Ladder Repairs: The existing ladders and brackets shall be repaired/replaced in accordance with OSHA 1910.27, OSHA 1926.1053, AWWA D100 and the Contract Drawings. Adequate clearance for the climber in accordance with OSHA 1910.27 Fixed Ladders and ANSI A14.3, Safety Code for Fixed Ladders shall be provided. The ladders shall be secured to the side rails with complete structural welds. Exterior ladder shall be provided with an approved cable type safety climb device with guide rails spaced at 20 ft maximum and installed by a qualified "competent person" (per OSHA's definition). Any necessary temporary protective devices for compliance with Federal OSHA requirements, all State and local safety regulations, and safe working practices shall be furnished and maintained by the CONTRACTOR. All new and replacement ladders shall be blasted and primed in accordance with Contract Documents prior to installation. After installation, welded and damaged areas shall be spot blasted and primed. The repair/replacement of the ladders shall be as follows:
1. Exterior Ladder: The existing ladder located on the tank exterior shall be removed and disposed by the CONTRACTOR. The existing vandal deterrent shall be also be removed and disposed. The remaining ladder attachment brackets shall be ground flush. New carbon steel ladder shall be furnished and installed in accordance with the contract drawings. A new stainless-steel cable safety climb device and shall be installed on the exterior ladder after complete curing of the finish coat of paint. The new safety climb system shall extend at least 54 inches above the top rung. The exterior ladder shall be coated per specification 09871.
 2. Interior Ladders: One (1) existing interior access ladder shall be removed and disposed of by the CONTRACTOR. The remaining ladder attachment brackets shall be ground flush. New carbon steel ladders (one interior access ladder and one weir box access ladder) with slip-resistant rungs shall be furnished and installed in accordance with the Contract Drawings. The first rung of the interior ladders shall be a maximum of 12 inches below the curb of the corresponding roof access hatch. Two (2) new interior access ladders shall be centered within the new access hatch openings. The interior ladder shall be coated per specification 09872. If the CONTRACTOR elects to use either existing interior ladder for any rehabilitation operations, then the OWNER and ENGINEER assume no responsibility for the safety of his/her employees during use of these ladders.

- I. Center Vent: The existing roof center vent shall be removed and disposed of by the CONTRACTOR and a new aluminum roof center vent shall be installed conforming to dimensions and installation details shown in the Contract Drawings. The new tank vent flange assembly shall be seal welded with 3/16-inch fillet welds around its circumference on the inside and outside of the tank. The tank vent flange neck shall be welded to an annular eight (8) bolt flange with continuous ¼-inch fillet welds on the interior and exterior surfaces. Weld spatter and rough edges shall be ground smooth prior to cleaning (to properly receive paint).
- J. Unused Roof Penetrations: New ¼-inch thick steel patch plates shall be installed over all remaining unused penetrations in the roof with complete seal welds on the interior and exterior of the roof plates.
- K. Roof Access Hatches: Two (2) new 36-inch x 42-inch rectangular access hatches with gaskets shall be installed in accordance with the Contract Drawings.
- L. Roof Safety Railing: Additional segments of roof safety railing shall be installed around the new roof access hatches in accordance with the Contract Drawings. At a minimum, this will require that a new top handrail be installed (to comply with regulations).
- M. Electrical Apparatus: All unused electrical conduits, fixtures, electrical metering equipment and cathodic protection system equipment shall be removed and disposed of by the CONTRACTOR. Any resulting pipe openings/penetrations shall be patched with a ¼-inch steel plate seal welded to the interior and exterior of the tank.
- N. Cathodic Protection: CONTRACTOR shall remove the existing cathodic protection hand hole covers in the tanks for the cleaning, painting and curing of the paint. After curing of both the interior and exterior paint system, the hand hole covers shall be replaced with new cover plates and gaskets to cover the hand holes. The existing cathodic protection anode supports inside of the tank shall be removed for the abrasive blasting and coating application operations. Replace the Cathodic Protection system in accordance with the applicable specifications.
- O. Shell Manways: The existing manways and reinforcing pad shall be replaced with new 36-inch manways that fully complies with the SAWS standard detail (as given in the Contract Drawings). After the complete application and curing of paint, new ¼-inch thick cloth-inserted gaskets shall be furnished and installed on both manways. CONTRACTOR shall also replace the “confined space” signage for both manways.
- P. Locking Access Hatches and Ladder Vandal Deterrent: The new roof access hatches and relocated exterior ladder vandal deterrent shall be locked at the completion of the Work using padlocks approved by the OWNER.
- Q. Electrode Holder: CONTRACTOR shall provide two (2) new 4-inch diameter flanged electrode holders in accordance with the Contract Drawings for the support of a level electrode system on the tank. Provide new 4-inch diameter blind flange gaskets with bolts, nuts and washers to replace the existing electrode holders and hand hole flanged holder opening. The location of the new level electrode holder shall be field verified in order to place it in close proximity to the interior access ladder.
 1. Note: CONTRACTOR shall measure the lengths of the electrode probes prior to removal and rehabilitation operations. The holders, controls and probes shall be protected during rehabilitation operations.

- R. Pressure Gauge: A new stainless steel pressure gauge with 4-inch minimum diameter dial calibrated to read pressure (in psi and feet) at no more than 2 ft intervals shall be installed on the tank as shown on the Contract Drawings.
- S. Sample Pipe Taps: The two (2) existing sample ports shall be plugged. The existing local sample port shall be replaced with a new sample tap located 36 inches off the tank floor/base plate (to comply with SAWS standards). See the Contract Documents for mounting details.
- T. Tie-offs: Tie-offs shall be furnished and installed in the locations indicated on the Contract Drawings.
- U. Weld Testing: All seal welds shall be mag-particle tested and butt seal welds shall be x-ray tested.
- V. Interior Roof Spaces: All interior spaces between the roof and rafters must be jacked or wedged in order to blast and recoat those areas.
- W. Exterior Coating System: Refer to specification 09871 – Exterior Coating System for Steel Storage Tanks.
- X. Interior Coating System: Refer to specification 09872 – Interior Coating System for Steel Storage Tanks.
- Y. Tank Floor Assessment: Perform metal integrity assessment of the tank bottom during the time that it is out of service. Prior to the inspection, the tank floor shall be cleaned, and pressure washed. Visual inspection of the top side of the tank floor shall be followed by scanning the underside using Magnetic Flux Exclusion (MFE) technology.

END OF SECTION

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SECTION 13216**FIBERGLASS REINFORCED PLASTIC TANK AND ACCESSORIES****PART 1 - GENERAL****1.01 DESCRIPTION****A. Scope of Work:**

1. This section covers the furnishing and installation of one (1) FRP tank for the bulk storage of hydrofluosilicic acid as shown on the Drawings and as specified herein.
2. Tanks furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the fabricator unless exceptions are noted by the Engineer.

B. Related Work Described Elsewhere:

1. Painting: Section 09900 and Section 09850.
2. Chemical Feed Systems: Section 11242.
3. Piping, Valves, and Appurtenances and Pipe Hangers and Supports are included in Division 15

1.02 QUALITY ASSURANCE**A. Governing Standards:** Except as modified or supplemented herein, all materials and construction methods shall comply with the applicable provisions of the following standards:

1. ASTM C582, "Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment".
2. ASME RTP-1, Reinforced Thermoset Plastic Corrosion Resistant Equipment.
3. The tanks shall meet the requirements of NSF Standard 61 for chemical storage vessels that contain liquids that will be added to potable water.
4. International Building Code.
5. Fabricator's quality Assurance Supervisor: Minimum of 3 years experience in the fabrication of fiberglass structures.
6. Designer: Registered Professional Engineer in Texas.

7. The tanks shall be furnished, coordinated, and tested by one supplier. The system shall be completely shop-assembled, and shop-tested prior to shipment.

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Complete drawings, details, and specifications covering the storage tanks, accessories and supports shall be submitted in accordance with Section 01300: Submittal Procedures.
2. The data shall include full information on basic materials and test data confirming the chemical resistance of the proposed resins to the intended tank contents.
3. The data shall also indicate the sizes of all major tank components including tank diameter, wall thickness, overall length, nozzle details and locations, supports and brackets, anchor bolt locations and details, and full information and details concerning field assembly and installation.
4. Fabricator's catalog information, descriptive literature, specifications, and identification of materials of construction. Include complete resin system information.
5. Detailed fabrication drawings.
6. Complete design calculations for tanks, supports, and appropriate accessories.
7. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.
8. Fabricator's detailed requirements for tank foundations.
9. Recommended bolt torques for all bolted FRP connections.
10. Recommendations for tank material selection and fabrication methods for services indicated on the Tank Data Sheets included at the end of the Detailed Specifications.
11. Certified test data on representative samples of standard laminate materials which verify that their physical properties meet the requirements and service conditions specified. Include verification of structural design parameters.
12. Complete catalog information, descriptive literature, specifications, and materials of construction for tank heating panels, temperature controllers, and other components of the tank heating system.

13. Power and control wiring diagrams for heating panel system, including terminals and numbers.
 14. Suggested spare parts list to maintain heating panel system for a period of 2 years. Include a list of any special tools required for checking testing, parts replacement, and maintenance.
 15. Final Configuration of Tank Appurtenances: The final locations of tank appurtenances including, but not limited to, nozzles, manways, pipe supports, anchor lugs, ladder, and handrail will be confirmed by the Engineer during review of Contractor's drawing submittals.
- B. Samples: Laminate sample representative of production quality of surface finish and visual imperfections.
- C. Quality Control Submittals:
1. Fabricator's Certificate of Compliance with fabrication requirements.
 2. Qualifications of fabricator's Quality Assurance Supervisor.
 3. Copy of the fabricator's Quality Assurance Program.
 4. Certification of Factory Testing. Submit factory test reports to the Engineer.
 5. Certification that the tank supports, and access nozzles have been coordinated with the actual equipment being furnished.
 6. Special shipping, storage and protection, and handling instructions.
 7. Fabricator's written/printed installation and tank support instructions.
 8. Manufacturer's Certificate of Proper Installation.
 9. ASME RTP-1 Certification.
- D. Contract Closeout submittals: Service records for repairs performed during construction.
- E. Additional Information
1. In the event that it is impossible to conform with certain details of the specifications due to different manufacturing techniques, describe completely all nonconforming aspects.
- F. Operating Instructions
1. Operating and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc., that are required to instruct

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

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

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. The tanks and components shall be adequately protected during transportation, in storage at the job site, and during subsequent installation and construction activities. Damaged units will be rejected and shall be replaced with new undamaged units.

1.05 WARRANTY

- A. FRP Tanks shall be provided with a two year warranty starting at the time of substantial completion.

PART 2 - PRODUCTS

2.01 GENERAL

Acceptable Manufacturers

- A. The tanks shall be manufactured by an established ASME RTP-1 certified manufacturer for fiberglass reinforced plastic vessels. The tanks shall be as manufactured by Diamond Fiberglass, Belco Manufacturing Company, or Augusta Fiberglass.
- B. Manufacturers shall have a minimum of 10 years of experience in the manufacture of FRP tanks of similar size and type as those for this project.

2.02 MATERIALS AND EQUIPMENT

- A. Basic materials shall be as follows:

Resin	Bisphenol-A polyester or vinyl ester Resins suitable for use with the specified chemicals.
Reinforcement	Glass fiber with a suitable coupling agent.
Surfacing Mat	Burlington Formed Fabrics "Nexus Veil", Nicofibers "Surmat 100".

Plastic Laminate	In conformity with the applicable governing standards.
Exposed Metal	No exposed metal allowed for fluoride.
Exposed Assembly and Bolts, Nuts, and Washers	ANSI Type 316 stainless steel. Hastelloy C for fluoride.
Protected Metal	Carbon steel, ASTM A36, with fiberglass reinforced plastic coating.

B. Performance and Design Requirements

1. Conditions of Service:

Table 1: Chemical Properties

Tank Number	
Chemical	Hydrofluosilicic Acid
Location	Outdoors
Concentration Percent by Weight	19 to 25
Chemical Specific Gravity	1.23
Max. Ambient & Liquid Temp., Degrees F	110
Min. Ambient & Liquid Temp., Degrees F	15/15
pH	No Data Available

2. Design Criteria:

- a. Each tank shall be designed to withstand the hydrostatic head which would result with the tank and fill line surcharged with the liquid chemical to 6 inches above the top of the tank.
- b. The tanks shall conform to the following requirements:

Table 2: Tank Design Requirements

Tank Number	
Chemical Stored	Hydrofluosilicic Acid
Orientation	Vertical

Equipment Tags	TNK-1
Number of Units	1
Nominal capacity, measured to invert of overflow pipe	1,000 gallon
Inner Tank Max diameter	6 ft
Height/Length (Sidewall)	6 ft
Tank Location	Outdoors

- c. Each exterior located tank shall be designed in accordance with the applicable design standards referenced herein. Design calculations shall be provided for each tank and shall be signed and sealed by a professional engineer registered in the State of Texas.

Wind & Seismic Loads: ASCE 7-10

Risk Category: 3

- d. Each exterior located tank shall have UV inhibitor coating.
- e. Tank head shall have a factory-applied non-skid coating.

C. Fabrication and Manufacture

1. Vertical Tanks:

- a. Vertical tanks shall be of the vertical type with flat outer bottoms for mounting on a concrete base as indicated on the Drawings integrally molded to the tank. Each tank shall contain an internal sloped floor to enhance draining.

2. Manufacture

- a. The tanks shall be hand lay-up, spray-up, or filament wound construction in accordance with the applicable governing standard. All tank shells shall be shop fabricated in a controlled environment by the manufacturer and no vertical seams shall be allowed. The finished laminate shall be constructed using a single generic type of thermoset resin throughout and shall not contain colorants, dyes, fillers, or pigments unless otherwise specified. Ultraviolet absorber shall be added to the resin used in the fabrication of tanks indicated on the drawings or specified to be suitable for installation in exposed, exterior locations.

- b. The inner surface layer of the tanks shall consist of two resin rich layers reinforced with surfacing mat and having a total combined thickness of not less than 110 mils.
 - d. Bracketed flat surfaces shall be provided on each tank for the installation of a nameplate, and a certification plate.
 - e. A Minimum of four (4) lifting lugs shall be provided on each tank as required for handling and installation.
 - f. FRP Tank manufacturer shall be responsible for providing any linings, resins, systems to make the tank compatible with the chemical it is used for.
3. Concrete Bases:
- a. The Contractor furnished concrete bases for the tanks shall be constructed in accordance with the provisions of Section 03300: Cast-in-Place Concrete and shall be level and smooth to the tolerances recommended by the tank fabricator.

2.03 ACCESSORIES

- A. Accessories shall be provided on each tank as indicated on the drawings and as specified herein.

Table 3: Tank Nozzle Schedule and Accessories

Tank Number	
Chemical Stored	Hydrofluosilicic Acid
Fill	3" Top
Outlet	3" Side @ Bottom
Overflow	3" Side @ Top
Vent	6" Top; as recommended by the manufacturer
Drain	On outlet
Manway	36" Top
Blower Connection	NA
Level Sensor	6" Top
Site Glass	2" side, Magnetic Flag
Access Ladder	Yes
Perimeter Top Handrail	Yes
Insulation	No
Heat Tracing	No
Mixer Nozzle	NA

B. Flanged Nozzles:

1. Nozzles for connecting piping and accessories shall be provided on each tank at the locations and of the sizes indicated on the drawings or specified herein.
2. Each nozzle shall be flanged, with flange diameter and drilling conforming to ANSI B16.5, Class 150. Nozzles shall extend at least 4 inches from outside face of tank to face of flange.
3. The top level sensor mounting flange shall be above the maximum liquid level recommended by the level sensor manufacturer. The length of the nozzle shall be as recommended by the level sensor manufacturer. The center line of the nozzle shall be at least 24 inches from the tank sidewall, fill nozzle, and other obstructions.
4. Flanged nozzles shall be fabricated of the same material as the tank and shall be gusseted to the tank or otherwise reinforced in accordance with the governing standard.
5. Overflow and Drains: Each tank shall be provided with an overflow and drain line of the size recommended by the manufacturer, but not smaller than specified in Table 3, to provide means for draining the tank and to prevent spills in the

- event of an overflow. Tank manufacturer shall provide FRP pipe support brackets for the pipe inside the tank.
6. Vents: The tanks shall be provided with a vent as shown on the Drawings and as specified herein, to prevent drawing a vacuum inside the tank during pumping or draining. Outside the vent shall be equipped with an insect screen of material compatible with the chemical stored.
 7. For fluoride, a fill pipe extension shall be provided from the tank dome to a point 12 inches above the tank bottom. Four 3/8-inch holes shall be drilled in the extension just below the tank dome to prevent a siphon condition.
 8. Each tank shall be furnished with top manway and cover and a side manway and cover where specified in Table 3. The manway shall be liquid tight for maximum loading conditions and suitable for the intended chemical use. Manways shall have a minimum diameter as specified in Table 3. Cover shall be fume tight furnished with EPDM or Viton full face gaskets. Hastelloy C-276 flange hardware shall be used in fluoride services. Boss flange type flush manways shall not be used. Tolerance on flatness shall be the same as for the flanges.
- C. Sight Glass: As indicated in Table 3, the fluoride tank shall be equipped with an external level monitor Magtech Magnetic Level Indicator, Style B as manufactured by Emerson, or equal. Connections shall be flanged and constructed of CPV
- D. Chamber shall be constructed of CPVC with CPVC coated Hastelloy C float and polycarbonate indicator viewing window. Indicator shall be in English units. Tanks indicated in Table 3 shall have reverse level float gauges. Reverse level float gauges shall consist of 4" perforated PVC pipe inside the tank, 2" clear UV resistant PVC pipe exiting and outside the tank, PVC roller pulleys, and polyethylene string, float and level indicator of a material compatible with process fluid. Tank manufacturer shall provide supports for the level monitor. Mounted on the tank adjacent to the sight gauge shall be a gauge board of corrosion-resistant construction calibrated with corrosion-resistant marking in 100-gallon increments.
- E. Nameplates: Each tank shall be provided with a nameplate to identify the use of the tank. The nameplates shall be of orange phenolic material with black engraved lettering one inch high and shall be mounted on the tank at a location acceptable to the Engineer.
- F. Certification Plates: A stainless steel certification plate shall be installed below each storage tank nameplate. The following data shall be included on the certification plate:
1. Name of tank fabricator.
 2. Date of manufacture.
 3. Product to be stored
 4. Maximum allowable concentration, specific gravity and temperature of the specified chemical solution that can be stored safely.

5. Mechanical properties of the laminate.
 6. Resin designation.
 7. Equipment identification number as listed herein.
- G. Lifting Lugs: Provide suitably attached for all tanks weighing over 100 pounds.
- H. Anchor Bolts: Type 316, stainless steel bolts, sized by fabricator and at least 1/2-inch in diameter, or as shown and as specified in Division 5.
- I. Anchor Lugs: Anchor lugs shall be provided and shall be designed to withstand all specified wind load conditions. No less than 8 anchor lugs shall be provided. Details of anchors shall be shown on fabrication Drawings. Anchor lugs shall be Type 316 stainless steel.
- J. Heating and Insulation:
1. If indicated in the schedule in Table 3, the tank manufacturer shall provide 2” polyurethane insulation covered with an exterior FRP skin of no less than 3/16" thick consisting of chop hoop construction.
 2. If heating is required by Table 3, the manufacturer shall install either heat tracing or heat panels designed to maintain 40 °F at outdoor ambient temperature of 15 °F. Design of heating system to be supplied as part of the submittal process.
- K. Ladders: If indicated in Table 3, each bulk storage tank shall be furnished with an external access ladder and access platform to facilitate access to the manway. Ladders shall meet applicable OSHA standards and the building code applicable to the project.
1. Ladders shall be FRP construction. Uncoated or exposed carbon steel parts or fasteners will not be acceptable. The ladders shall be supported on and anchored to the concrete base and bracketed to the tank shell as required.
 2. Ladders shall be provided with necessary assembly and mounting hardware. Mounts shall not penetrate tank wall. All mounting hardware shall be Hastelloy-C in hydrofluosilicic acid service, 316 SST is not acceptable.
 3. Safety cages shall be provided for tanks less than 20’ in height. For tanks 20’ and taller provide Fall Arrest System by DBI Sala and design ladder to take the load at the connection point of the fall arrest system.
 4. The ladder shall include safety rails across the top of the tank to the access manhole, attached to the ladder side rails, and anchored to the tank head as required.
 5. The ladders shall have a clear width of at least 16 inches, with rungs at least 3/4-inches in diameter and spaced not more than 12 inches apart and a clearance of at least 12 inches between the back of the ladder and the tank wall. Ladder shall extend beyond tank bottom to within 6 inches of concrete tank pad. Refer to

SAWS detail DD-900-16 Standard Tank Ladder Interior and Exterior for general dimensions

6. Safety rails and platform shall be fabricated of fiberglass reinforced plastic shapes and shall be fabricated and installed in accordance with OSHA regulations and the building code applicable to the project. Safety railings with 3 rails and kick plate or skirt-style handrail shall be provided around the perimeter of each manway opening, attached to the ladder side rails and anchored to the tank head as required.
 7. Vinyl ester resin shall be used in the fabrication of all FRP parts of the ladder.
 8. Ultra violet stabilizer: Add to the resin used in the wax coat for exterior surfaces in the type and amount recommended by the resin manufacturer.
 9. Acceptable Ladder Manufacturers: Fibergrate Corporation, Dallas, TX or approved equal.
- L. Handrail: Handrails shall be fabricated of fiberglass reinforced plastic shapes and shall be fabricated and installed in accordance with OSHA regulations and the building code applicable to the project. Safety railings with 3 rails and kick plate or skirt-style handrail shall be provided around the perimeter of the top dome of each tank.
- M. Pipe Supports: Provide pre-molded offset or stand off pipe support brackets for the attachment of pipe supports for support of vertical runs of piping from the outside of the tank in the locations shown on the drawings.
1. For the fluoride, provide an additional set of clips or strut for the electrical conduit for the level transmitter to line up with the level transmitter. Also provide a means of connecting a pipe support at one point on top of the tank about half way between the edge of the tank and the level transmitter.

2.04 QUALITY CONTROL

- A. Inspection of all products fabricated to this Specification is required prior to shipment unless specifically waived in writing by the Engineer. This shall include:
1. Visual inspection to the requirements of ASTM C582-87 and ASTM D2563-87.
 2. Barcol Hardness measurements per ASTM D2583-87.
 3. Acetone sensitivity test for all internal secondary bonds.
 4. Glass content by ignition loss on three cutouts per ASTM D2584.
 5. Hydrostatic Leak Test:
 - a. Perform on each tank.
 - b. Fill to top nozzle; allow to stand for 2 hours with no visible leakage.

- B. Repairs authorized by the Engineer shall be reinspected before final acceptance unless specifically waived.
- C. Identify and retain all cutouts. Engineer may select certain cutouts for testing for physical properties of the laminate.
- D. Factory Test Reports: Certify, by signature, results of the following:
 - a. Inspections.
 - b. Results of hydrostatic testing.
 - c. Test reports of physical properties of standard laminates.

PART 3 - EXECUTION

3.01 PREPARATION (NOT APPLICABLE)

3.02 INSTALLATION

- A. The tanks shall be installed by the Installation Contractor at the locations as indicated on the drawings. The tanks shall be installed in accordance with the fabricator's recommendations, the requirements of the applicable governing standard, and to the satisfaction of the Engineer, and made ready for the installation of piping and other appurtenances as indicated on the drawings and specified under other sections.

3.03 INSPECTION AND TESTING

- A. After completion of installation, the tanks shall be filled with water to the top access manhole opening by the installation contractor and allowed to stand full for a period of not less than 48 hours. During testing, flanged connections may be plugged by the installation of temporary blind flanges on the outside of the tank but shall not be blocked or plugged on the inside. All leaks or indications of leaks shall be repaired by the fabricator and made completely watertight. A leaking tank, upon repair, shall be retested to the satisfaction of the Engineer.

3.04 START-UP AND INSTRUCTION

- A. When installation has been completed and all connections have been made, all tank surfaces, interior and exterior, shall be thoroughly cleaned by the installation contractor as recommended by the fabricator and to the satisfaction of the Engineer. Abrasive cleaning agents shall not be used. The tank and wetted accessories shall be completely dried before being placed into service.
- B. Provide fabricator's representative at site in accordance with Section 01640: Manufacturer's Field Services for installation assistance, inspection and certification of proper installation and start-up assistance for specified component, subsystem, equipment, or system.

- C. Manufacturer's Authorized Representative: Present at Work site designated by the Contractor for the minimum person-days listed below, travel time excluded.
 - 1. Services to include but may not be limited to:
 - a. One (1) person-day for installation assistance, inspection, and certification of installation for tanks. If schedule permits, this may be done for all tanks in the same trip.
 - 2. Furnish assistance, inspection, and certification services at such times as requested by the Contractor.

END OF SECTION

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SECTION 13220**DISINFECTION OF WATER STORAGE TANKS****PART 1 – GENERAL****1.01 SECTION INCLUDES**

- A. Disinfection of water storage tank under this contract. Test water from the disinfected ground storage tank per regulatory standards to verify that water is acceptable. Repeat procedure if tests do not meet standards.

1.02 REFERENCES

- A. American Water Works Association (AWWA) Standards
 - 1. C652-02, Disinfection of Water-Storage Facilities
- B. Texas Commission of Environmental Quality (TCEQ) Standards

1.03 SEQUENCING AND SCHEDULING

- A. The interior wet coating shall be properly cured.
- B. The interior wet coating shall be washed with potable water.
- C. The Contractor shall flush and disinfect the tank.
- D. The Owner shall take and send in the samples to the laboratory for testing. The Owner shall pay for the testing of the initial set of samples. The CONTRACTOR shall pay for all subsequent samples and testing, if required.

1.03 CONTRACTOR RESPONSIBILITIES

- A. The CONTRACTOR responsibilities will include:
 - 1. Coordinating with SAWS to introduce water from existing pipelines.
 - 2. Coordinating to add sufficient disinfectant into the GST as needed to disinfect the GST.
 - 3. Select, provide, install, use, maintain, move, reuse, and remove up to 500 LF of temporary piping during disinfection and disposal operations.
 - 4. Direct valve and appurtenance operations needed to achieve and complete the disinfection process.
 - 5. Obtain all samples needed in accordance with regulatory requirements and these contract documents. Document and maintain sample chain of custody throughout the process.

1.04 SUBMITTALS

- A. A Disinfection Plan, to include procedures and plans for the disinfection and testing of the GST and related appurtenances. Sample site locations shall be identified. Plan shall be signed by the person responsible for performing and coordinating the work and shall be submitted to SAWS for approval.
- B. Type of disinfecting solution and method of preparation.
- C. Method of disposal for highly chlorinated disinfecting water.
- D. A water supply plan for disinfection. Confirm understanding of where and how water will be obtained, how much will be needed, how it will be accounted for and how connections will be made to fill and disinfect all pipeline segments.
- E. Submit proposed arrangement of temporary piping and appurtenances including pressure sustaining valves (if any), backflow prevention, and fittings if required.
- F. Certification that employees working with concentrated chlorine solutions or gas have received appropriate safety training.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Materials for disinfection of the tank shall be as listed in Section 4: Forms of Chlorine for Disinfection of AWWA C652-02.

PART 3 – EXECUTION

3.01 WASHING OF TANK INTERIOR WET SURFCES

- A. After proper curing of the interior wet paint and prior to disinfecting, the CONTRACTOR shall wash the interior wet surfaces with potable water. The CONTRACTOR shall supply an adequate flow of water with sufficient pressure to wash thoroughly all the interior surfaces, including those surfaces above the high water level. All debris and wash water shall be removed from the tank inlet/outlet pipe.

3.02 DISINFECTION OF THE TANK

- A. It is the Contractor's responsibility to flush and disinfect the tank and connection piping until two or more successive samples taken in a twenty four (24) hour period show that the samples are satisfactory as reported from the Owner's laboratory. Method 2 (Section 4.2) of AWWA C652-02 shall be used for the disinfection procedure. Samples shall be taken and tested by the Owner.

3.03 SAMPLING AND TESTING

- A. The Owner shall take and send in the samples to the laboratory, but shall assume no responsibility for the sampling technique or the care of the samples. The stored tank water shall comply with current State and United States EPA standards for organic, and biological contaminants as influenced by the operations of the Contractor. One tank of water for the disinfection shall be furnished by the Owner at no charge to the Contractor. Additional water shall be furnished at current municipal water rates charged by the Owner and shall be paid for by the CONTRACTOR.

END OF SECTION

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DIVISION 15

MECHANICAL

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SECTION 15000**MECHANICAL GENERAL REQUIREMENTS****PART 1 GENERAL****1.01 DESCRIPTION****A. Scope of Work:**

1. All equipment furnished and installed under this contract shall conform to the general stipulations set forth in this section except as otherwise specified in other sections.
2. Contractor shall coordinate all details of equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alternations in the Work required to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

B. General Design:

1. Contract Drawings and Specifications: The Contract Drawings and Specifications shall be considered as complementary, one to the other, so that materials and work indicated, called for, or implied by the one and not by the other shall be supplied and installed as though specifically called for by both. The Contract Drawings are to be considered diagrammatic, not necessarily showing in detail or to scale all of the equipment or minor items. In the event of discrepancies between the Contract Drawings and Specifications, or between either of these and any regulations or ordinances governing work of these specifications, the bidder shall notify the Engineer in ample time to permit revisions.

1.02 RELATED SECTIONS**A. The Following is a list of related sections. Other section may also apply.**

1. General Requirements: Division 1
2. Concrete: Division 3
3. Metals: Division 5
4. Finishes: Division 9
5. Equipment: Division 11
6. Special Construction: Division 13
7. Mechanical: Division 15
8. Electrical: Division 16

1.03 QUALITY ASSURANCE

- A. **Materials and Equipment:** Unless otherwise specified, all materials and equipment furnished for permanent installation in the work shall conform to applicable standards and specifications and shall be new, unused, and undamaged when installed or otherwise incorporated in the work. No such material or equipment shall be used by the Contractor for any purpose other than that intended or specified, unless such use is specifically authorized in writing by the Owner. No material shall be delivered to the work site prior acceptance of drawings and data by the Engineer.
- B. **Equivalent Materials and Equipment:**
1. Whenever a material or article is specified or described by using the name of a proprietary product or the name of a particular manufacturer or vendor, the specific item mentioned shall be understood as establishing the type, function, and quality desired. Other manufacturers' products will be accepted provided sufficient information is submitted to allow the Engineer to determine that the products proposed are equivalent to those named. Such items shall be submitted for review in accordance with Section 01300 – Submittals.
 2. Requests for review of equivalency will not be accepted from anyone except the Contractor and such requests will not be considered until after the contract has been awarded.
- C. **Governing Standards:** Equipment and appurtenances shall be designed in conformity with ANSI, ASME, ASTM, IEEE, NEMA, OSHA, AGMA, and other generally accepted applicable standards. They shall be of rugged construction and of sufficient strength to withstand all stresses which may occur during fabrication, testing, transportation, installation, and all conditions or operations. All bearings and moving parts shall be adequately protected against wear by bushings or other acceptable means. Provisions shall be made for adequate lubrication with readily accessible means.
- D. **Tolerances:** Machinery parts shall conform to the dimensions indicated on the drawings within allowable tolerances. Protruding members such as joints, corners, and gear covers shall be finished in appearance. All exposed welds shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.
- E. **Clearances:** Ample clearances shall be provided for inspection and adjustment. All equipment shall fit the allotted space and shall leave reasonable access room for servicing and repairs. Greater space and room required by substituted equipment shall be provided by the Contractor and at his expense.
- F. **Testing:**
1. When the equipment is specified to be factory tested, the results of the tests shall be submitted to the Engineer and approval of the test results shall be obtained before shipment of the equipment.
 2. When an item of equipment, including controls and instrumentation, has been completely erected, the Contractor shall notify the Engineer, who will designate

a time to make such tests as required, and operate the item to the satisfaction of the Contractor. All testing shall be done in the presence of the Contractor. "Completely erected" shall mean that the installation is erected, all necessary adjustments have been made, all required utility connections have been made, required lubricants and hydraulic fluid have been added and the unit has been cleaned and painted.

G. Pressure Test:

1. Contractor shall provide a blind flange with cap for pressure testing. After installation, all piping shall be pressure tested. Piping shall be tested in accordance with Section 15085 – Water Pipeline Testing or Section 15014 – Pressure Testing of Piping for water distribution piping.
2. All tests shall be made in the presence of and to the satisfaction of the Engineer and also, to the satisfaction of any local or state inspector having jurisdiction.
 - a. Provide not less than three (3) days notice to the Engineer and the authority having jurisdiction when it is proposed to make the tests.
 - b. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Engineer shall be retested in part or in whole as directed by the Engineer.
 - c. The piping systems may be tested in sections as the work progresses by no joint or portion of the system shall be left untested.
3. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.
4. All defects and leaks observed during the tests shall be corrected and made tight in an approved manner and the tests repeated until the system is proven tight.
5. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.
6. Provide test pumps, gauges, or other instruments and equipment required for the performance of all tests. Provide all temporary bracing, test plugs, additional restraint, and thrust blocking which may be required for test pressures above normal working pressures.
7. All tests shall be maintained for as long a time as required to detect all defects and leaks but not less than the duration specified for each type of pipe or piping system in this Division.

H. Failure of Test:

1. Defects: Any defects in the equipment, or deviations from the guarantees or requirements of the Specifications, shall be promptly corrected by the Contractor by replacements or otherwise. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligations under the Contract shall be final and conclusive. If the Contractor fails to correct any defects or deviations, or if the replaced equipment when tested shall fail again to meet the guarantees or specified requirements, the Owner, notwithstanding his having made partial payment for work and materials which have entered into the manufacturer for such equipment, may reject that equipment and order the Contractor to remove it from the premises at the Contractor's expense.
2. Rejection of Equipment: In case the Owner rejects a particular item of equipment, then the Contractor hereby agrees to repay to the Owner all sums of money paid to him to deliver to the Contractor a bill of sale of all his rights, title, and interest in and to the rejected equipment provided, however that the equipment shall not be removed from the premises until the Owner obtains from other sources other equipment to take the place of that rejected. The bill of sale shall not abrogate the Owner's right to recover damages for delays, losses or other conditions arising out of the basic Contract. The Owner hereby agrees to obtain the alternate equipment within a reasonable time and the Contractor agrees that the Owner may use the original equipment furnished by him without rental or other charge until the other equipment is obtained.

I. Responsibility During Tests: The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

J. Acceptance of Materials:

1. Only new materials and equipment shall be incorporated in the work. All materials and equipment furnished by the Contractor shall be subject to the inspection and acceptance of the Owner. No material shall be delivered to the work without prior submittal approval of the Engineer.
2. The Contractor shall submit to the Project Manager and Professional Engineer data relating to materials and equipment he proposes to furnish for the work. Such data shall be in sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the specifications.
3. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the work, the Contractor shall submit samples of materials for such special test as may be necessary to demonstrate that they conform to the specification. Such sample shall be furnished, stored, packed, and shipped as directed at the Contractor's expense. Except as otherwise noted, the Owner will make arrangements for and pay for tests.

4. The Contractor shall submit data and samples sufficiently early to permit consideration and acceptance before materials are necessary for incorporation in the work.

K. Safety Requirements:

1. In addition to the components shown and specified, all machinery and equipment shall be safeguarded in accordance with the safety features required by the current codes and regulations of ANSI, OSHA, and local industrial codes.
2. The Contractor shall provide for each V-belt drive or rotating shaft a protective guard which shall be securely bolted to the floor or apparatus. The guard shall completely enclose drives and pulleys and be constructed to comply with all safety requirements.
3. For double inlet fans, the belt guard shall be arranged so as not to restrict the air flow into the fan inlet. Guards shall not interfere with lubrication of equipment.

1.04 SUBMITTALS

- A. See Section 01300 – Submittals.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Packaging: All equipment shall be suitably packaged to facilitate handling and protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times.
- B. Protection: All machined surfaces and shafting shall be cleaned and protected from corrosion by the proper type and amount of coating necessary to assure protection during shipment and prior to installation. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage as specified in Sections 09900 – Paints and Coatings. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.
- C. Lubrication: Grease and lubricating oil shall be applied to all bearings and similar items as necessary to prevent damage during shipment and storage.
- D. Marking: Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.
- E. Fabricated sub-assemblies, if any, shall be shipped in convenient sections as permitted by carrier regulations and shall be properly match-marked for ease of field erection.
- F. Responsibility:

1. The Contractor shall be responsible for all material, equipment, and supplies sold and delivered to the site under this Contract until final inspection of the work and acceptance thereof by the Owner. In the event any such material, equipment, and supplies are lost, stolen, damaged, or destroyed prior to final inspection and acceptance, the Contractor shall replace same without additional cost to the Owner.
 2. Should the Contractor fail to take proper action on storage and handling of equipment supplied under this Contract within seven days after written notice to do so has been given, the Owner retains the right to correct all deficiencies noted in previously transmitted written notice and deduct the cost associated with these corrections from the Contractor's Contract. These costs may be comprised of expenditures for labor, equipment usage, administrative, clerical, engineering, and any other costs associated with making the necessary corrections.
- G. Delivery: The Contractor shall arrange deliveries of products in accordance with construction schedules and coordinate to avoid conflict with work and condition at the site.
1. The Contractor shall deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
 2. Immediately on delivery, the Contractor shall inspect shipments to assure compliance with requirements of Contract Documents and accepted submittals, and that products are properly protected and undamaged.
 3. Under no circumstances shall the Contractor deliver equipment to the site more than one month prior to installation without written authorization from the Engineer. Operation and maintenance data shall be submitted to the Engineer for review prior to shipment of equipment as described in Section 01730 – Operation and Maintenance Data.
- H. Storage and Protection of Products:
1. The Contractor shall furnish a covered, weather-protected storage structure providing a clean, dry noncorrosive environment for all mechanical equipment, valves, architectural items, electrical and instrumentation equipment, and special equipment to be incorporated into this project. Storage of equipment shall be in strict accordance with the "Instructions for Storage" of each equipment supplier and manufacturer including connection of space heaters, and placing of storage lubricants in equipment. Corroded, damaged, or deteriorated equipment and parts shall be replaced before acceptance of the project. Equipment and materials not properly stored will not be included in a payment estimate.
 - a. The Contractor shall store products subject to damage by the elements in weathertight enclosures.
 - b. The Contractor shall maintain temperature and humidity within the ranges required by manufacturer's instructions.

- c. The Contractor shall store fabricated products above the ground, on blocking or skids, to prevent soiling or staining. The Contractor shall cover products which are subject to deterioration with impervious sheet coverings and provide adequate ventilation to avoid condensation.
 - d. The Contractor shall store loose granular materials in a well drained area on solid surfaces to prevent mixing with foreign matter.
 2. All materials and equipment to be incorporated in the work shall be handled and stored by the Contractor before, during, and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting, and any injury, theft, or damage of any kind whatsoever to the material or equipment.
 3. Cement, sand, lime shall be stored under a roof and off the ground, and shall be kept completely dry at all times. All structural and miscellaneous steel and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt, or grease, and in a position to prevent accumulations of standing water, staining, chipping, or cracking. Brick, block, and similar masonry products shall be handled and stored in a manner to reduce breakage, chipping, cracking and peeling to a minimum.
 4. All materials which, in the opinion of the Engineer, have become damaged and are unfit for the use intended or specified, shall be promptly removed from the site of the work, and the Contractor shall receive no compensation for the damaged material or its removal.
 5. The Contractor shall arrange storage in a manner to provide easy access for inspection. The Contractor shall make periodic inspections of stored products to assure products are maintained under specified conditions, and free from damage or deterioration.
 6. Protection After Installation: The Contractor shall provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. The Contractor shall remove covering when no longer needed.
- I. Extended Storage Requirements For Equipment: Because of the long period allowed for construction, special attention shall be given to extended storage and handling of equipment onsite. As a minimum, the procedure specified herein shall be followed:
 1. If equipment will be stored onsite for more than one month prior to incorporation into the Work, the Contractor shall submit a written request to the Engineer outlining any special provision to be made to protect and maintain the equipment while it is being stored. All such provisions shall be acceptable to the Engineer. No equipment shall be stored onsite for more than one month without prior written authorization from the Engineer.
 2. All equipment having moving parts including gears, electric motors, and/or instruments shall be stored in a temperature and humidity controlled building accepted by the Engineer, until such time as the equipment is to be installed.

3. All equipment shall be stored fully lubricated with oil and grease unless otherwise instructed by the manufacturer.
4. Manufacturer's storage instructions shall be carefully studied by the Contractor and reviewed by him with the Manufacturer's Representative. These instructions shall be carefully followed and a written record of this review kept by the Contractor.
5. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, and operate loaded when possible, weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.
6. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. Mechanical equipment to be used in the work, if stored for longer than ninety days, shall have the bearings cleaned, flushed, and lubricated prior to testing and startup, at no extra cost to the Owner.
7. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested, and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective, and it shall be removed and replaced at the Contractor's expense.
8. A maintenance log shall be maintained by the Contractor outlining the schedule of maintenance required for each piece of equipment as well as the date on which the maintenance was actually performed and the initials of the individual performing the work. Submit a copy of the maintenance log monthly with the progress pay application.

1.06 WARRANTY AND GUARANTEES

- A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Section 01600 – Material and Equipment. The manufacturer's warranty period shall be concurrent with the Contractor's correction period for two (2) years after the time of completion and acceptance.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 290.44(a) of the Texas Administrative Code.

2.02 MATERIALS AND EQUIPMENT

- A. Fabrication and Manufacture:
 - 1. Workmanship and Materials:
 - a. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage or other failure. Materials shall be suitable for service conditions.
 - b. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and gages so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.
 - c. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch thick.
 - 2. Lubrication:
 - a. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrications systems shall not require attention during startup or shutdown and shall not waste lubricants.

- b. Lubricants of the type recommended by the equipment manufacturer shall be furnished by the Contractor in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Owner. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.
 - c. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.
3. Electric Motors: Unless otherwise specified, motors furnished with equipment shall be rated and constructed as specified in Division 16 – Electrical.
- a. Manufacturer's standard motor may be supplied on integrally constructed, packaged assemblies such as appliances, tools, unit heaters, and similar equipment specified by model number, in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.
4. Drive Units: The nominal input horsepower rating of each gear or speed reducer shall be at least equal to the nameplate horsepower of the drive motor. Drive units shall be designed for 24 hour continuous service.
- a. Gear Reducers:
 - i. Each gear reducer shall be a totally enclosed unit with oil or grease lubricated antifriction, rolling element bearings throughout.
 - ii. Helical, spiral bevel, combination bevel-helical, and worm gear reducers shall have a service factor of at least 1.50 based on the nameplate horsepower of the drive motor. Shaft-mounted and flange-mounted gear reducers shall be rated AGMA Class 11. Helical gear reducers shall have a gear strength rating to catalog rating of 1.5. Each gear reducer shall bear an AGMA nameplate.
 - iii. The thermal horsepower rating of each unit shall equal or exceed the nameplate horsepower of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100 F above the ambient air temperature in the vicinity of the unit and shall not exceed 200 F.
 - iv. Each grease lubricated bearing shall be installed in a bearing housing designed to facilitate periodic regreasing of the bearing by means of a manually operated grease gun. Each bearing housing shall be designed to evenly distribute new grease, to properly dispose of old grease, and to prevent overgreasing of the bearing. The use of permanently sealed, grease lubricated

- bearings will not be acceptable. An internal or external oil pump and appurtenances shall be provided if required to properly lubricate oil lubricated bearings. A dipstick or sight glass arranged to permit visual inspection of lubricant level shall be provided on each unit.
- v. Gear reducers which require the removal of parts or periodic disassembly of the unit for cleaning and manual regreasing of bearings will not be acceptable.
 - vi. Certification shall be furnished by the gear reducer manufacturer indicating that the intended application of each unit has been reviewed in detail by the manufacturer and that the unit provided is fully compatible with the conditions of installation and service.
- b. Variable Speed Drives: Each variable speed drive shall have a service factor of at least 1.75 at maximum speed based on the nameplate horsepower of the drive motor. A spare belt shall be provided with each variable speed drive unit employing a belt for speed change. Unless specifically permitted by the detailed equipment specifications, bracket type mounting will not be acceptable for variable speed drives.
- c. V-Belt Drives: Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 maximum speed based on the nameplate horsepower of the drive motor.
5. Safety Guards: All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage or heavier galvanized or aluminum-clad sheet steel or 1/2 inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.
6. Equipment Foundation Supports:
- a. All foundations, platforms and hangers required for the proper installation of equipment shall be furnished and installed by the Contractor.
 - b. Unless otherwise indicated or specified, all equipment shall be installed on reinforced concrete bases at least 6 inches high and shall conform to Section 03300 – Cast-in-Place Concrete. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection.

Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout as specified in Section 03300. All open equipment bases shall be filled with nonshrinking grout sloped to drain to the perimeter of the base.

- c. The Contractor shall furnish, install and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of equipment. These shall be of ample size and strength for the purpose intended.
- d. Equipment suppliers shall furnish suitable anchor bolts for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed. Anchor bolts shall comply with Division 5 – Metals and, unless otherwise specified, shall have a minimum diameter of 3/4 inch. Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete.
- e. Structural steel supports and miscellaneous steel required for supporting and/or hanging equipment and piping furnished under this Division shall be provided and installed by Contractor.
- f. All foundations, anchor pads, piers, thrust blocks, inertia blocks and structural steel supports shall be built to template and reinforced as required for loads imposed on them.
- g. The Contractor shall assume all responsibility for sizes, locations and design of all foundations, anchor pads, pier, thrust blocks, inertia blocks, curbs and structural steel supports.

7. Shop Painting:

- a. All steel and iron surfaces shall be protected by suitable paint or coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Exposed surfaces shall be finished smooth, thoroughly cleaned, and filled as necessary to provide a smooth uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with a high-grade oil resistant enamel suitable for coating in the field with an alkyd enamel. Coatings shall be suitable for the environment where the equipment is installed.
- b. Surfaces to be painted after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Unless otherwise specified, the shop primer for steel and iron surfaces shall be

- Cook "391-N-167 Barrier Coat", Koppers "No. 10 Inhibitive Primer", or equal.
- c. Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound, Houghton "Rust Veto 344", Rust-Oleum "R-9", or equal.
8. Nameplates: Contractor shall provide equipment identification nameplates for each item of equipment. Nameplates shall be 1/8-inch Type 304 stainless steel and shall be permanently fastened. Plates shall be fastened using round head metallic drive screws, or where metallic drive screws are impractical, with stainless steel pop rivets. Metallic drive screws shall be brass or stainless steel, Type V and No. 8 by 3/8-inch long. Names and/or equipment designations shall be engraved on the plates and the engraving painted with a primer and black paint system compatible with stainless steel. Contractor shall submit a list of proposed names and designations for review prior to fabrication of nameplates. At a minimum, each nameplate shall include equipment manufacturers name, year of manufacture, serial number and principal rating data.
9. Pipe Identification:
- a. Underground pipe and tube: Pipe and tube shall be located by laying 2-inch wide plastic tape continuously along the run of pipe or tube. Where possible, color of tape shall be consistent with the color of bands on interior pipe and as approved by the Engineer, or shall bear an imprinted identification of the line.
- i. Location: Tape shall be laid approximately 12 inches below ground surface and directly over pipe location.
- ii. Manufacturer: Tape shall be an inert plastic film highly resistant to alkaline, acids or other destructive chemical components likely to be encountered in soils and shall be Terra Tape as manufactured by Griffolyn Company, or underground warning tape by Seton Name Plate Corporation or equal. Pipe of PVC shall be protected with a detectable tape with a metallized foil core and shall be Terra Tape "D" or equal.
10. Valve Identification: On all valves, except shut-off valves located at a fixture or piece of equipment, the Contractor shall provide a coded and numbered tag attached with brass chain and/or brass "S" hooks.
- a. Tag Types:
- i. Tags for valves on pipe and tube lines conducting hot medium (steam, condensate, hot water, etc.) shall be brass or anodized aluminum.
- ii. Tags for all other valves shall be Type 304 stainless steel.
- iii. Square tags shall be used to indicate normally closed valves and round tags shall indicate normally open valves.

- b. Coding: In addition to the color coding, each tag shall be stamped or engraved with wording or abbreviations to indicate the line service. All color and letter coding shall be approved by the Engineer.
 - c. Valve Schedule: The Contractor shall provide a typewritten list of all tagged valves giving tag shape, letter code and number, the valve size, type, use and general location within building.
11. Noise Attenuation and Control:
- a. Unless otherwise specified, the maximum permissible noise level for a complete installed piece of equipment located within or outside a structure shall not exceed 85 dB at 3 feet. A complete piece of equipment includes the driver and driven equipment, plus any intermediate couplings, gears, and auxiliaries. All equipment provided herein that is specified to be factory and field tested shall be tested as specified herein for noise generation at the equipment manufacturer's expense.
 - b. Maximum permissible noise (sound pressure) levels shall be in decibels as read on the "A" weighting scale of a standard sound level meter (dB); all measurements shall be made in relation to a reference pressure of 0.0002 microbar. Measurements of emitted noise levels shall be made on a sound level meter meeting at least the Type 2 requirements set forth in ANSI S1.4, Specification for Sound Level Meters. The sound level meter shall be set on the "A" scale and to slow response. Unless otherwise specified for a particular piece of equipment, the point of measurement of sound level shall be made at the specified distance from any major surface along the entire perimeter and at midheight of the piece of equipment, or at the specified distance from an outer major surface encompassing the sound source including inlets or outlets.
12. Fire Hazard Rating:
- a. All piping, duct work, and equipment insulation, fastener, and jacketing materials shall have a fire hazard rating not to exceed 25 for flame spread, 50 for fuel contributed, and 50 for smoke developed. Rating shall be determined by ASTM Designation E84, "Surface Burning Characteristics of Building Materials". Corresponding ratings determined by Underwriters' Laboratories, Inc., UL-723, "Test Method for Fire Hazard Classification of Building Materials", will also be acceptable.
 - b. Flameproofing treatments will not be acceptable.
13. Heating, Ventilation and Domestic Plumbing Equipment:
- a. Interchangeability: In all design and purchasing, interchangeability of items of equipment, subassemblies, parts, motors, starters, relays, and

other items is essential. All similar items shall be of the same manufacturer, type, model, and dimensions.

2.03 ACCESSORIES

- A. Special Tools and Accessories: Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.04 SPARE PARTS

- A. Spare parts for certain equipment provided under Divisions 11, 13, 15, and 16 have been specified in the pertinent sections of the specifications. The Contractor shall collect and store all spare parts in an area to be designated by the Engineer. In addition, the Contractor shall furnish to the Engineer an inventory listing of all spare part, the equipment they are associated with, and the name and address of the supplier.
- B. Maintenance Materials:
 - 1. All grease, oil, and fuel required for testing of equipment shall be furnished with the respective equipment. The Owner shall be furnished with a year's supply of required lubricants including grease and oil of the type recommended by the manufacturer with each item of equipment supplied.
 - 2.. The Contractor shall be responsible for changing the oil in all drives and intermediate drives of each mechanical equipment after initial break-in of the equipment, which in no event shall be any longer than three weeks of operation.

2.05 QUALITY CONTROL

- A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Installation: Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary for proper results. When so specified, or when employees of Contractor or his subcontractors are not qualified, such personnel shall be field representatives of the manufacturer of the equipment or materials being installed.
1. The Contractor shall have on site sufficient proper construction equipment and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory assembled when practical.
 2. Equipment shall be erected in a neat and workmanlike manner on the foundations and supports at the locations and elevations shown on the Drawings, unless otherwise directed by the Engineer during installation.
 3. All equipment shall be installed in such a manner as to provide access for routine maintenance including lubrication.
 4. For equipment such as pumping units, which require field alignment and connections, the Contractor shall provide the services of the equipment manufacturer's qualified mechanic, millwright, machinist, or authorized representative, to align the pump and motor prior to making piping connections or anchoring the pump base.
 5. Equipment of a portable nature which require no installation shall be delivered to a location designated by the Owner.
- B. Tolerances: Precision gauges and levels shall be used in setting all equipment. All piping and equipment shall be perfectly aligned, horizontally and vertically. Tolerances for piping and equipment installation shall be 1/2 inch to 30 ft horizontal and vertically. All valves and operators shall be installed in the position shown on the Contract Drawings or as directed by the Engineer, if not shown.
- C. Alignment and Level: The equipment shall be brought to proper level by shims (1/4 inch maximum). After the machine has been leveled and aligned, the nuts on the anchor bolts shall be tightened to bind the machine firmly into place against the wedges or shims. Grouting shall be as specified in Section 03600.
- D. Grouting: The grout shall be tamped into position with a board, steel bar, or other tool. Tamping should not be so hard as to raise or otherwise displace the plate.
- E. Contact of Dissimilar Metals: Where the contact of dissimilar metal may cause electrolysis and where aluminum will contact concrete, mortar, or plaster, the contact surface of the metals shall be separated using not less than one coat of zinc chromate primer and one heavy coat of aluminum pigmented asphalt paint on each surface.

- F. Cutting and Patching: All cutting and patching necessary for the work shall be performed by the Contractor.
- G. Operation: All equipment installed under this Contract, including that furnished by Owner or others under separate contract, shall be placed into successful operation according to the written instructions of the manufacturer or the instructions of the manufacturer's field representative. All required adjustments, tests, operation checks, and other startup activity shall be provided.

3.02 INSPECTION AND TESTING

- A. Where the specifications require observation of performance tests by the Engineer, such tests shall comply with the quality assurance paragraph in this section.

3.03 START-UP AND INSTRUCTION

- A. Services Furnished Under This Contract:
 - 1. An experienced, competent, and authorized representative of the manufacturer of each item of equipment shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation. The manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.
 - 2. Each manufacturer's representative shall furnish to Engineer, Owner and Contractor, a letter of certification stating that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.
 - 3. All costs for field services shall be included in the contract amount.

END OF SECTION

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SECTION 15014**PRESSURE TESTING OF PIPING****PART 1 GENERAL****1.01 DESCRIPTION**

- A. Scope of Work: This section specifies the leakage testing requirements for all drains, chemical piping and service water, utility water and non-potable water piping.
- B. Related Work Described Elsewhere
 - 1. Process mechanical equipment are included under Division 11.
 - 2. Mechanical piping, valves, pipe hangers, accessories, and appurtenances are included under Division 15.

1.02 QUALITY ASSURANCE

- A. Test Pressures: Test pressures for the various services and types of piping shall be as shown on Sheet D-002. At a minimum, testing pressure shall be 1.5 times the working pressure.

1.03 SUBMITTALS

- A. Materials and Shop Drawings (Not Applicable)
- B. Additional Information:
 - 1. Testing Plan: Submit prior to testing and include at least the information that follows:
 - a. Testing dates.
 - b. Piping systems and section(s) to be tested.
 - c. Test type.
 - d. Method of isolation.
 - e. Calculation of maximum allowable leakage for piping section(s) to be tested.
 - 2. Certifications of Calibration: Testing equipment.
 - 3. Certified Test Report.
 - 4. Testing Records:
 - a. Provide a record of each piping installation during the testing. These records shall include:
 - i. Date of test.

- ii. Identification of pipeline tested or retested.
 - iii. Identification of pipeline material.
 - iv. Identification of pipe specification.
 - v. Test fluid.
 - vi. Test pressure.
 - vii. Remarks: Leaks identified (type and location), types of repairs, or corrections made.
 - viii. Certification by Contractor that the leakage rate measured conformed to the specifications.
 - ix. Signature of Owner's representative witnessing pipe test.
- b. Submit five (5) copies of the test records to the Engineer's representative upon completion of the testing.

PART 2 PRODUCTS

2.01 GENERAL

- A. Testing fluid shall be clean water for all piping except air service and shall be of such quality to prevent corrosion of materials in piping system for all hydrostatic tests. Air piping shall be tested using compressed air.

2.02 MATERIALS AND EQUIPMENT

- A. Provide pressure gauges, necessary bracing and restraint, test plugs, pipes, bulkheads, pumps, and meters to perform the hydrostatic and pneumatic testing.

PART 3 EXECUTION

3.01 PREPARATION

- A. Pipes shall be in place and anchored before commencing pressure testing.
- B. Conduct hydrostatic and pneumatic tests on exposed and aboveground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.
- C. Before conducting hydrostatic tests, flush pipes with water to remove dirt and debris. For pneumatic tests, blow air through the pipes.
- D. Test new pipelines which are to be connected to existing pipelines by isolating the new line from the existing line by means of pipe caps, special flanges, or blind flanges. After the new line has been successfully tested, remove caps or flanges and connect to the existing piping.
- E. Conduct hydrostatic tests on buried pipe after the trench has been completely backfilled. The pipe may be partially backfilled and the joints left exposed for inspection for an initial leakage test. Perform the final test, however, after completely backfilling and compacting the trench.

- F. Chlorine Piping: Test, dry, and clean in accordance with requirements of Chlorine Institute Pamphlet 6.
- G. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to ENGINEER.
- H. Items that do not require testing include: Piping between wet wells and wet well isolation valves, equipment seal drains, and tank atmospheric vents.
- I. Gravity Piping:
 - 1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
 - 2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to ENGINEER.
- J. Pressure Test:
 - 1. All tests shall be made in the presence of and to the satisfaction of the Program Manager/Engineer and Owner and also, to the satisfaction of any local or state inspector having jurisdiction.
 - a. Provide not less than three (3) days notice to the Owner, Engineer, and the authority having jurisdiction when it is proposed to make the tests.
 - b. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Engineer shall be retested in part or in whole as directed by the Engineer.
 - c. The piping systems may be tested in sections as the work progresses, but no joint or portion of the system shall be left untested.
 - 2. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.
 - 3. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.

3.02 INSTALLATION (Not Applicable)

3.03 INSPECTION AND TESTING

- A. Hydrostatic Testing of Aboveground or Exposed Piping: The maximum filling velocity shall be 0.25 feet per second, applied over full area of pipe. Open vents at high points of the piping system to purge air while the pipe is being filled. Subject the piping system to the test pressure indicated. Maintain the test pressure for a minimum of four (4) hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show no leakage or weeping. Correct leaks and retest until no leakage is obtained.

B. Hydrostatic Testing of Buried Piping:

1. Test after backfilling has been completed. Expel air from piping system during filling.
2. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after the concrete has been poured. When testing mortar-lined piping, fill the pipe to be tested with water and allow it to soak for at least 48 hours to absorb water before conducting the pressure test.
3. Apply and maintain the test pressure by means of a hydraulic force pump. Maintain the test pressure for a minimum duration of four (4) hours. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure during the four hours. This amount of water is the loss due to leakage in the piping system. The allowable leakage rate is defined by the formula.

$$L = \frac{SD(P)^{1/2}}{133,200}$$

in which:

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

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

C. Hydrostatic Test For Gravity Piping:

1. Testing Equipment Accuracy: Plus or minus 1/2 gallon of water leakage under specified conditions.
2. Maximum Allowable Leakage: 0.16 gallon per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.
3. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.
4. Exfiltration Test:
 - a. Hydrostatic Head:
 - i. At least 6 feet above maximum estimated groundwater level in section being tested.
 - ii. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.

5. Infiltration Test:
 - a. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.
6. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.
7. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

D. Test Pressure:

1. All pipe shall be tested at pressures shown on Sheet D-002. If not listed, at a minimum, testing pressure shall be 1.5 times the normal working pressure working pressure of the pipe.

END OF SECTION

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SECTION 15015**IDENTIFICATION FOR PROCESS PIPING AND VALVES****PART 1 - GENERAL****1.01 DESCRIPTION**

- A. Scope of Work: The work included under this Section consists of providing an identification system for piping systems and related equipment.
- B. Related Work Described Elsewhere:
 - 1. Painting and Coating: Section 09900

1.02 QUALITY ASSURANCE

- A. Standards: ANSI Standard A13.1, Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

- A. Submit manufacturer's descriptive literature, illustrations, specifications, and other pertinent data.
- B. Schedules:
 - 1. Provide a typewritten list of all tagged valves giving tag color, shape, letter code and number, the valve size, type, use, and general location.
 - 2. Provide a complete list of materials to be furnished and surfaces on which they will be used.
- C. Samples:
 - 1. Provide a sample of each type valve tag supplied.
 - 2. Provide a sample of each type of identification tape supplied.
 - 3. Provide manufacturer's color charts for color selection by Engineer.

1.04 PRODUCTS DELIVERY, STORAGE, AND HANDING

- A. Delivery of Materials: Except for locally mixed custom colors, deliver sealed containers with labels legible and intact.
- B. Storage of Materials:
 - 1. Store only acceptable project materials on project site.
 - 2. Store in suitable location.

3. Restrict storage to paint materials and related equipment.
4. Comply with health and fire regulations.

1.05 JOB CONDITIONS

- A. Environmental Requirements:
 1. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating systems can be applied.
 2. Do not apply finish in areas where dust is being generated.
- B. Protection: Cover or otherwise protect finished work of other trades and surfaces not to be painted.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials for painting shall conform to requirements of Section 09900: Painting.
- B. Materials selected for coating systems for each type surface shall be the product of a single manufacturer.
- C. Aboveground piping shall be identified by self-adhesive pipe markers equal to those manufactured by W. H. Brady Company or equal.
 1. Markers shall be of wording and color as shown on Sheet D-1001.
 2. Lettering shall be:
 - a) 2 1/4-inches high for pipes 3 inches diameter and larger.
 - b) 1 1/8-inches high for pipes less than 3 inches diameter.
 3. Flow arrows shall be:
 - a) 2 1/4-inches by 6 inches for pipes 3 inches diameter and larger.
 - b) 1 1/8-inches by 3 inches for pipes less than 3 inches diameter.
- D. Buried piping shall be identified by identification tape installed over the centerline of the pipelines.
 1. Identification Tape for Steel or Iron Pipe: Identification tape shall be manufactured of inert polyethylene film so as to be highly resistant to alkalis, acids, or other destructive agents found in soil, and shall have a minimum thickness of 4 mils. Tape width shall be 6 inches and shall have background color specified below, imprinted with black letters. Imprint shall

be as specified below and shall repeat itself a minimum of once every 2 feet for entire length of tape. Tape shall be Terra Tape Standard 250, or approved equal.

2. Identification Tape for Plastic or Non-Magnetic Pipe: Identification tape shall be manufactured of reinforced polyethylene film with a minimum overall thickness of 4 mils and shall have a 0.35 mil thick magnetic metallic foil core. The tape shall be highly resistant to alkalis, acids, and other destructive agents found in soil. Tape width shall be 3 inches and shall have background color specified below, imprinted with black letters. Imprint shall be as specified below and shall repeat itself a minimum of once every 2 feet for entire length of tape. Tape shall be TerraTape Sentry Line 1350, or approved equal.

3. Tape background colors and imprints shall be as follows:

<u>Imprint</u>	<u>Background Color</u>
"Caution Electrical Line Buried Below:	Red
"Caution Water Line Buried Below"	Blue

4. Identification tape shall be "Terra Tape" as manufactured by Reef Industries, Inc., Houston, TX; Allen Systems, Inc., Wheaton, IL; or approved equal.

E. Aboveground Valve Identifications: A coded and numbered tag attached with stainless steel chain and/or "S" hooks shall be provided on all valves.

1. Tag Types: Tags for valves on pipe shall be stainless steel or anodized aluminum. Colors for aluminum tags shall, where possible, match the color code of the pipe line on which installed. Square tags shall be used to indicate normally closed valves and round tags shall indicate normally open valves.

2. Coding: In addition to the color coding, each tag shall be stamped or engraved with wording or abbreviations to indicate the valve service and number. All color and letter coding shall be approved by the Engineer.

F. Buried valves shall have valve boxes protected by a concrete pad. The concrete pad for the valve box cover shall have a 3-inch diameter, bronze disc embedded in the surface as shown on the Drawings. The bronze disc shall have the following information neatly stamped on it:

1. Size of valve, inches
2. Type of valve:
 - a) GV - Gate Valve
 - b) BFV - Butterfly Valve
 - c) BV – Ball Valve
3. Number of turns to fully open

4. Direction to open

PART 3 - EXECUTION

3.01 COLOR CODING FOR PIPES AND EQUIPMENT

- A. Piping color codes, and code labels for pipe identification shall conform to Sheet D-002.
- B. General Notes and Guidelines:
 1. Pipelines, equipment, or other items which are not listed here shall be assigned a color by the Owner and shall be treated as an integral part of the Contract. Color coding shall consist of color code painting and identification of all exposed conduits, through lines and pipelines for the transport of gases, liquids, or semi-liquids including all accessories such as valves, insulated pipe coverings, fittings, junction boxes, bus bars, connectors and any operating accessories which are integral to a whole functional mechanical pipe and electrical conduit systems.
 2. All moving parts, drive assemblies, and covers for moving parts which are potential hazards shall be Safety Orange.
 3. All safety equipment shall be painted in accordance with OSHA standards.
 4. All inline equipment and appurtenances not assigned another color shall be painted the same base color as the piping. The pipe system shall be painted with the pipe color up to, but not including, the flanges attached to pumps and mechanical equipment assigned another color.
 5. All pipe hangers and pipe support floor standards shall be painted, unless specified otherwise due to material of construction.
- C. All hangers and pipe support floor and accessories stands shall be painted to match their piping. The system shall be painted up to, but not including, the face of flanges or the flexible conduit connected to electrical equipment. Structural members used solely for pipe hangers or supports shall be painted to match their piping. Where the contact of dissimilar metals may cause electrolysis and where aluminum will contact concrete, mortar or plaster, the contact surface of the metals shall be coated in accordance with Section 09900.
- D. All systems which are an integral part of the equipment, that is originating from the equipment and returning to the same piece of equipment, shall be painted between and up to, but not including, the face of flanges or connections on the equipment.
- E. All insulated surfaces, unless otherwise specified, shall be given one coat of glue sizing, one prime coat and one finish coat.
- F. System code lettering and arrows shall conform to the requirements of ANSI A 13.1 marked on piping as follows:

1. Legends shall be of the following color for the respective pipe color:

	<u>Key to Classification of Predominant Colors For Piping</u>	<u>Color of Letters, if not otherwise specified</u>
(F) Fire Protection:	Red	White
(D) Dangerous:	Yellow	Black
	Orange	Black
	White	Black
	Brown	White
(S) Safe:	Green	Black
	Black	White
	Light Gray	Black
	Dark Gray	White
	Aluminum	Black
(P) Protective:	Blue	White

2. Markers shall be placed no more than 20 feet apart with at least one marker on every straight run and additional markers at turns and where pipe passes through walls.
3. An arrow indicating direction of flow shall be placed adjacent to each marker.

3.02 FABRICATED EQUIPMENT

- A. Unless otherwise indicated or specifically approved, all fabricated equipment shall be shop primed and finished. See Section 09900 - Painting.
- B. The Contractor shall be responsible for and take whatever steps are necessary to properly protect the shop prime and finish coats against damage from weather or any other cause.
- C. Where specified in other sections of these specifications for mechanical equipment, the Contractor shall apply field coat or coats of paint in accordance with Section 09900. If shop finish coat is unsatisfactory due to poor adhesion or other problems with primer or finish coats, coatings shall be removed and replaced by sandblasting, priming and finishing in accordance with Section 09900 and this Section.
- D. Wherever fabricated equipment is required to be sandblasted, the Contractor shall protect all motors, drives, bearings, gears, etc., from the entry of grit. Any equipment found to contain grit shall be promptly and thoroughly cleaned. Equipment contaminated by grit in critical areas, such as bearings, gears, seals, etc., shall be replaced at no cost to the Owner.

3.03 INSTALLATION OF IDENTIFICATION TAPE

- A. Identification tape shall be installed for all buried piping in accordance with the

manufacturer's installation instructions and as specified herein.

- B. Identification tape for piping shall be installed at two (2) locations:
 - 1. One (1) foot below finished grade along centerline of pipe, and;
 - 2. Directly on top of the pipe.

3.04 BURIED VALVES

- A. In paved or concrete areas, tops of valve box covers shall be set flush with pavement or concrete top. In concrete areas, valve boxes shall be embedded. Following paving operations, a 24 inch square shall be neatly cut in the pavement around the box and the paving removed. The top of the box shall then be adjusted to the proper elevation and a 24 inch square by 6 inch thick concrete pad poured around the box cover. Concrete pads in traffic areas shall be reinforced with No. 4 reinforcement bars as shown on the Drawings. Concrete for the pad shall be 3,000 psi compressive strength.
- B. In unpaved areas, tops of valve box covers shall be set 0.20-foot above finished grade. After the top of the box is set to the proper elevation, a 24 inch square by 6 inch thick concrete pad shall be poured around the box cover. Concrete for the pad shall be 3,000 psi compressive strength.
- C. The bronze, valve identification disc shall be embedded in the concrete pad.

TABLE 15015

COLOR CODES AND ABBREVIATIONS

Service	Mark	Conduit, Pipe, and Valve Color Code	Letter and Flow Arrow Color
PROCESS PIPING			
Potable Water	PW	Light Blue	White
MISC. PIPING			
Drain	DR	Dark Gray	White

END OF SECTION

SECTION 15055**STEEL PIPE (AWWA C200 MODIFIED)****PART 1 GENERAL****1.01 DESCRIPTION**

- A. This Section will govern the installation of steel pipe, six (6) inches in diameter and larger, complete in place. Steel pipe shall be installed to the applicable provisions of the SAWS' Standard Specifications for Water Works Construction and/or conforming to AWWA C200. Specials shall be provided as specified in Section 15056 Steel Pipe Fabricated Specials.
- B. A single Pipe Manufacturer shall be responsible for furnishing all the fusion bonded epoxy-lined and polyurethane-coated steel pipe and smaller diameter appurtenant steel pipe. Manufacture of steel pipe and specials shall be under the direction and management of one steel PIPE Manufacturer only. This does not prevent a separate supplier from manufacturing specials or fittings; however, all Work shall be the responsibility of one manufacturer of the water piping. The responsibility of the Pipe Manufacturer shall include, at a minimum:
1. Certify all pipe, fittings and specials are being manufactured in full accordance with the Contract Documents.
 2. Manage the design and fabrication of the pipe and specials.
 3. Prepare and submit all submittal information and shop drawings.
 4. Make any corrections that may be required to the submittal information and shop drawings.
- C. All steel pipe shall be coated and lined as indicated below with welded joints.
1. Interior Lining:
 - a) All piping shall be fusion bonded epoxy.
 2. Exterior Coating:
 - a) Buried steel water pipe shall be polyurethane coated.
 - b) Above ground steel water pipe shall be coated with an epoxy primer and polyurethane top coat.
- D. As part of the CONTRACTOR's Bid Documents, the Contractor shall submit the submit the following manufacturer information. Verification of items below will be conducted as part of the Bid Document review process for steel pipe and the CONTRACTOR'S preliminary schedule. Qualifications shall include the following:
1. Years of Experience. Submit written verification that the Pipe Manufacturer has been producing ANSI/AWWA C200 pipe with similar coatings and linings as

indicated herein and similar design pressure as this project for a minimum of five (5) years.

2. Project Experience. Submit written verification that the Pipe Manufacturer has provided pipe for at least three (3) similar type projects of similar size, with wall thickness of 0.25" or greater. Submit reference names, telephone numbers, and description of projects for pipe conforming to ANSI/AWWA C200 and this requirement. Descriptions for applicable projects shall include, but not be limited to, length, diameter, wall thickness, lining and coating, steel metallurgy, location of facility where pipe was manufactured/fabricated and key plant personnel involved with the Work.
3. Certifications. Submit written verification that the Pipe Manufacturer is certified by either the Steel Plate Fabricator's Association (SPFA) Quality Assurance Program or International Organization for Standardization (ISO) 9001.
4. Personnel Qualifications. Submit names and qualifications of current plant personnel to be used to manufacturer/fabricate pipe for the Work and the experienced manufacturer's representative proposed for onsite observation. Manufacturer's representative shall be as specified in Section 01300 – Submittals.
5. Submit written verification from the Pipe Manufacturer demonstrating compliance with the production and delivery schedule of the pipe as indicated in the Contractor's preliminary schedule.

1.02 RELATED SECTIONS

- A. The following is a list of related sections. Other sections may also apply.
 1. Section 01300 – Submittals
 2. Section 01640 – Manufacturer's Field Services
 3. Section 02220 – Earthwork
 4. Section 09911 – Polyurethane Coating for Steel Pipe
 5. Section 15056 – Steel Pipe Fabricated Specials
 6. Section 15085 – Water Pipeline Testing

1.03 REFERENCES

- A. The following is a list of related standards. Other standards may also apply.
 1. AWWA C200: Steel Water Pipe 6 inches and larger
 2. AWWA C203: Coal-Tar Protective Coatings and Linings for Steel Water Pipelines – Enamel and Tape – Hot Applied

3. AWWA C205: Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe – 4 in and Larger – Shop Applied.
4. AWWA C206: Field Welding of Steel Water Pipe
5. AWWA C207: Steel Pipe Flanges for Waterworks Service – Sizes 4 inch through 144 inches
6. AWWA C208: Dimensions for Fabricated Steel Water Pipe Fittings
7. AWWA C213: Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipes.
8. AWWA C216: Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
9. AWWA C222: Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
10. AWWA M11: Steel Water Pipe – A Guide for Design and Installation

1.04 ABBREVIATIONS

- A. DR: Dimension Ratio
- B. NPS: Nominal Pipe Size followed by the size designation

1.05 QUALIFICATIONS

- A. Fabricator shall be ISO-9001 or SPFA certified with five years' experience in the manufacture of steel pipe, fittings, and coatings specified. All pipe, coatings, linings, and fittings shall be fabricated by one company at one facility for quality control purposes.

1.06 SUBMITTALS

- A. Contractor shall submit all certified affidavits of compliance for each portion of work for which Contractor is requesting payment before acceptance of such payment will be made. Performing and paying for sampling and testing as necessary for the certified affidavits of compliance are the Contractor's responsibility. The following certified affidavits of compliance are required for all pipe and other products or materials furnished under this Section, as specified in AWWA C200 and in accordance with Section 01300 – Submittals.
 1. List cross-referencing pipe mark numbers with pipe sequence numbers, heat numbers and can numbers.
 2. Hydrostatic test reports.

3. Results of production weld tests.
 4. A Certified Test Report from the polyurethane coating manufacturer indicating that the coatings were applied in accordance with manufacturer's requirements and in accordance with this Section and Section 09911 – Polyurethane Coating for Steel Pipe on all pipe, fittings and joints made in the factory and in the field.
 5. Coating applicator shall submit a typical QA/QC inspection form during the submittal process.
 6. The Coating applicator shall submit daily inspection reports within one week of the inspection date to the Owner.
 7. Pipe temperature complies with Contract Documents prior to placing backfill material and prior to and during welding temperature control joints.
 8. All welds were performed in conformance with these Contract Documents.
 9. Provide certification stating that the instructions and requirements of the lining and coating materials manufacturer will be followed and that the lining and coating materials manufacturer is acceptable to the Pipe Manufacturer.
- B. Drawings, specifications, and other data showing complete details of the design, fabrication, construction, field locations and elevations, and installation of pipe, fittings, specials and connections, together with complete data covering all materials proposed for use shall be submitted to the Owner for review, approval, or other appropriate action prior to beginning pipe laying operations. All submittals shall be in accordance with the provisions of Section 01300 - Submittals. The drawings and data shall include but not be limited to the following for each size and class of pipe:
1. Shop drawings, complete with material, grade, and pressure class for all pipe, fittings and couplings for all joints, coatings, and appurtenances will be submitted. Detailed catalog and engineering data sheets and product delivery schedules shall be submitted for all components.
 2. Complete erection drawings for all buried and exposed piping shall be submitted. The drawings shall show and identify the pipe, pipe joint lengths, fittings, couplings, joint harnesses, restrained joint lengths, wall sleeves in vaults, wall castings for vaults, miscellaneous supports, and other miscellaneous details as required.
 3. Drawings showing the location and details of bulkheads for hydrostatic testing of the pipeline and details for removal of test bulkheads and repair of the lining.
 4. Erection procedures for installing all piping. The procedures shall cover in detail, the preparation and making of push-on, mechanical, flanged, or welded couplings; measures to ensure the integrity of the interior pipe lining and the exterior protective coating; the method of backing up and sealing the annular spaces in pipe sleeves; and the installation and adjustment of supports.
 5. Protective coating schedules that show shop and field surface preparations, materials, methods of application, dry thickness, and tests for coating defects.

6. Procedures for testing the piping and arrangements for obtaining and disposing of the water for the tests shall be fully described. Details of bulkheads, flanges, or caps for the testing shall be included in the submittal.
 7. Production schedule for manufacturing/fabricating pipe for the Work as part of the Contractor's schedule.
 8. Joint and pipe wall construction details which indicate the type and thickness of cylinders; the position, type, all size and area of wire or other reinforcements; coating and lining holdbacks; manufacturing tolerances; maximum angular joint deflection limitations; and all other pertinent information required for the manufacture and installation of the product. Joint details and design calculations shall be submitted for all welded joint types, including beveled ends for alignment conformance and deep butt strap joints required for control of temperature stresses as applicable. The pipe manufacturer shall submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In absence of a history of field performance, the results of a test program shall be submitted.
 9. Pipe design criteria shall include, but shall not be limited to, minimum pipe diameter, minimum pipe wall thickness, pressures, external loads, yield strength, allowable fiber stress, longitudinal stress for restraint, temperature changes, lining and coating materials, and other factors used for pipe design.
 10. A table shall be provided that includes the following information: E', K, soil weight, deflection lag factor, external load(s), and percent deflection from minimum to maximum cover depth shown in the Steel Pipe Schedule in one foot increments covering each size and class of pipe. Two (2) tables shall be submitted for each size and class of pipe, one with live loads and one without live loads.
 11. Detail drawings indicating the type, number and other pertinent details of the slings, stulling, and other methods proposed for pipe support and handling during manufacturing, transport, and installation. Submit documentation confirming that the handling and support system has been designed and sealed by a registered professional engineer, licensed in the State of Texas. The recommended methods of handling and placement of the pipe shall be submitted to the Owner as a record copy prior to transporting of any pipe to the project site. All pipe handling equipment and methods shall be acceptable to the Owner.
 12. For record copy, submit detailed drawings indicating loading and shipping procedures that are designed to minimize damage to coating.
 13. Pipe Manufacturer to provide AutoCAD drawings of the pipe plan and profile layout sheets showing each joint of pipe and all appurtenances to the same coordinate system as used on the Drawings.
- C. Submit copies of the method that the Contractor proposes to use for measuring deflection of pipe joints to the Engineer and Owner for review. Submit copies of agreed written method for taking pipe deflection measurements with measurements made no sooner than five (5) days and no later than 21 days after backfilling operations are complete.
- D. Product Data: Submit manufacturer's catalog information on pipe material and fittings.

- E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for pipe sizing methods and calculations used.
- F. Design calculations:
 - 1. Wall thicknesses for external loading, special loading and internal pressure to be signed and sealed by a registered professional engineer in the State of Texas.
- G. Ground Profile and Utility Locations.
 - 1. Prior to preparation of line layouts Contractor shall verify the existing ground profile and the location and depth of all underground utilities using centerline stakes set by the Contractor at no less than 100 feet intervals.
 - 2. Ground profile and utility locate information shall be provided to the Owner through the submittal process. Any plans sheets that are modified due to adjustments in pipeline profile shall be reissued to the Contractor.
- H. Welding Information. Submit the following prior to performing any Work:
 - 1. Full and complete information regarding location, type, size and extent of all welds with reference called out for Welding Procedure Specifications (WPS) numbers shall be shown on the Shop Drawings. The Shop Drawings shall distinguish between shop and field welds. Shop Drawings shall indicate by welding symbols or sketches the details of the welded joints and the preparation of parent material required to make them.
 - 2. Written welding procedures for shop and field welds including Welding Procedure Specifications (WPS) and Procedure Qualification Records (PQR).
 - 3. Written nondestructive testing (NDT) procedure specifications and NDT personnel qualifications.
 - 4. Credentials of the Contractor's certified welding inspectors and quality control specialist for review prior to starting any welding in the shop or field.
 - 5. Welding map showing the sequence of welds for all field welds.
 - 6. Written weld repair procedure for each type of shop and field weld proposed for use on the project.
 - 7. Written rod control procedure for shop and field operations demonstrating how the Contractor intends to maintain rods in good condition throughout the Work.
 - 8. Submit shop drawings and welding information together as a complete package. Welding Procedure shall be approved by the Engineer and Owner before welding of joints begin.
 - 9. Submit the following as the work is performed:
 - a. Certified Test Reports for the NDT data for each shop-welded and field-welded joint. This data shall include all testing on each weld joint,

including re-examination of repaired welds, using visual, radiographic, magnetic particles, dye penetrant examination, ultrasonic or air test examination methods specified. Test data shall be reviewed and signed by the welding inspector.

- b. Certified Test Reports for daily welder logs for field and shop welding. Logs shall list all welders to be used for the Work, the welding process, position, welder stamp number, certification date and certification status for each welder, test documentation, and Welder Procedure Specification.

I. Control of Temperature Stresses:

1. Submit plan and installation instructions to avoid the accumulation of expansion and contraction to minimize temperature stresses in the pipe wall during installation. The plan and installation instructions shall include the sequencing of events during and after installation, including backfilling and welding, use of a lengthened bell, and other methods to control temperature stresses in the pipeline.
2. Submit the proposed sequencing of events or special techniques to minimize distortion of the steel as may result from shop welding procedures. Submit a plan for monitoring pipeline temperatures.

J. Qualification Statement:

1. Submit qualifications for manufacturer, installer, and licensed professional.
2. Submit manufacturer's approval of installer.

1.07 QUALITY CONTROL AND ASSURANCE

A. Inspection. All pipe, linings, coatings, welds and related work shall be subject to inspection at the place of manufacture and/or the place the Work is performed in accordance with the provisions of ANSI/AWWA C200 as supplemented by the requirements herein. The Contractor shall notify the OWNER in writing not less than 14 calendar days prior to the start of any phase of the pipe manufacture, welding, lining, coating, testing or field operations. The Contractor may provide access to manufacturers' site visits in accordance with the Contractors Quality Control Plan. The Pipe Manufacturer will be required to present and demonstrate compliance with all manufacturer specifications required in this project. Personnel at the plant involved in this Project shall be in attendance. All aspects of pipe manufacture will be reviewed: welding, lining, polyurethane coating, testing, handling, and loading and shipping.

1. The Contractor shall provide a certified welding inspector(s) (CWI) for all field welding as specified in ANSI/AWWA C206 and the Pipe Manufacturer shall provide a certified welding inspector(s) (CWI) for all shop welding as specified in ANSI/AWWA C200. The CWI shall visually inspect 100 percent of all welds, verify proper procedures are being followed using qualified welders and supervise CONTRACTOR'S NDT. The welding inspector(s) shall submit written certification that all welds were performed in conformance with these Contract

Documents in accordance with Contractor's QC Plan. All shop weld tests shall be reviewed and signed by the inspector(s).

2. All pipe and fittings will be inspected prior to unloading and upon delivery to project site. Any pipe not fully meeting these specifications will not be paid for as material on site until it is repaired to within these specifications.

B. Onsite Observation.

1. Polyurethane Coating Manufacturer. The Pipe Manufacturer shall provide services of the coating Manufacturer's representative and a representative from the Heat Shrink Joint Manufacturer for the initial installation to advise Contractor and Owner regarding installation, including but not limited to, handling and storage, cleaning and inspecting, coating repairs, field applied coating, heat shrink installation procedures and general construction methods and how they may affect the pipe coating. The Manufacturer's Representative shall be required to return if, in the opinion of the Owner, the coating or the Contractor's construction methods do not comply with Contract Documents. Cost for the Manufacturer's Representatives to return to the site shall be at no additional cost to the Owner.

- C. Welder Qualifications. All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the Welding Procedure Specification submitted and materials to be used. Welders shall be qualified by the Contractor under the provisions of ANSI/AWS D1.1 or ASME BPVC for shop welds and ANSI/AWS D1.1 for field welds. All welders shall have been certified within the last six months or shall provide a welding continuity log. All welders shall be certified to weld in all positions.

- D. Shop Tests. Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of ANSI/AWWA C200, as applicable. The Contractor shall be responsible for performing and paying for said material tests. The Owner shall have the right to witness all testing conducted by the Contractor; provided that the Contractor's schedule is not delayed for the convenience of the Owner. In addition to those tests specifically required, the OWNER may request additional samples of any material including mixed concrete and lining and coating samples for testing by the Owner. The additional samples shall be furnished as part of the Work.

1. Weld Tests. Shop Nondestructive Testing (NDT) shall be performed for various weld categories in accordance with the requirements of ANSI/AWWA C200 and as specified herein. Testing shall include submitting written documentation of procedures per Section V ASME BPVC, and acceptable criteria shall be in accordance with Section VIII of the ASME BPVC.
 - a) Fillet Welds. Examine 100 percent of fillet welds using the magnetic particle inspection method.
 - b) In all hand welding, the metal shall be deposited in successive layers. The WPS shall describe the minimum weld to be placed in each pass. Each pass except the final one, whether in butt or fillet welds, shall be thoroughly cleaned to remove dirt, slag, or flux before the succeeding bead is applied. Each pass shall be thoroughly fused into the plates at each

- side of the welding groove or fillet and shall not be permitted to pile up in the center of the weld. Undercutting along the side shall not be permitted.
- c) Welds shall be free from pin holes, non-metallic inclusions, air pockets, undercutting and/or any other defects.
 - d) Welds. PIPE MANUFACTURER'S certified welding inspector shall visually examine 100 percent of all welds.
 - e) In addition to weld tests, doubler pads shall be air tested as stated in ANSI/AWWA C206.
 - f) In addition to the tests required in ANSI/AWWA C200, magnetic particle weld tests on steel cylinders shall be conducted one time for each 5,000 feet of production welds and at any other times there is a change in the grade of steel, welding procedure, or welding equipment. Additionally, at least one set of tests per operator per work shift shall be performed.
 - g) Spiral weld seams shall be tested by the visible penetrant method of ASTM E 165 - Methods for Liquid Penetrant Inspection or magnetic particle inspection method of ASME Section VIII, Division 1, Appendix VI, for a minimum distance of 12 inches from each end of each joint after the spigot and bell are formed. Defects shall be repaired.
 - h) Coil splices shall be tested by the ultrasonic method in conformance with ASME Boiler and pressure vessel Cod, Section VIII, Pressure Vessels.
2. Hydrostatic Tests. After the joint configuration is completed and prior to lining, each steel cylinder shall be shop tested and certified to a pressure of at least 75 percent of the yield strength of the pipe steel cylinder. Test pressure shall be maintained for a minimum of 2 minutes. Factory hydrostatic tests shall be submitted as Certified Test Reports.
 3. Charpy Tests. Steel greater than or equal to 1/4-inch thickness used in production manufacturing of pipe and specials shall be tested for notch toughness using Charpy V-Notch tests in accordance with ASTM A370 - Test Methods and Definitions for Mechanical Testing of Steel Products. The test acceptance for full size specimens (10 mm by 10 mm size) shall be 25 feet-pounds at a test temperature of 30 degrees F; tests shall include three impact specimens and shall be conducted in the direction transverse to the final direction of rolling. Steel for pipe and specials shall be qualified for notch toughness with Charpy tests as indicated for the specified steel.
 - a) Plate. Charpy tests shall be conducted on each plate as required in ASTM A20. Plates that do not qualify shall not be used in production of the pipe.
 - b) Coils. Test Outside diameter wrap of two coils per heat lot.
 4. Shop Fit Test. To ensure that lap and bell and spigot joints may be fully assembled, that excessive annular space between spigots and bells does not exist, and that the pipe meets the requirements of ANSI/AWWA C200, the pipe

fabricator shall perform a shop fit test on a minimum of five joints of each pipe size and joint type used. The joints to be tested shall be selected by the OWNER based on pipe measurements. The shop fit test shall join the pipe ends in the shop with the proposed adjacent pipe end. The pipe ends shall be match marked after shop assembly. Record the actual annular space, with the data to include as a minimum:

- a) Maximum space at any point.
- b) Minimum space at any point.
- c) Space at 90-degree intervals - top, bottom and spring line on both sides.

E. Field Tests. The following field tests shall be required. Field testing shall not damage factory applied coating system.

1. Welded Joint Tests. Contractor's certified welding inspector shall perform a magnetic particle test and visually inspect all welds. All field-welded joints shall be tested by the Contractor using the magnetic particle inspection procedure conforming to the requirements of ANSI/ASTM E 709 "Standard Guide for Magnetic Particle Testing" and ASTM E 1444 "Standard Practice for Magnetic Particle Testing" unless otherwise specified. Additionally, butt straps shall be air tested with low pressure from a threaded fitting between the welds as specified in Section 15056 - Steel Pipe Fabricated Specials (ANSI/AWWA C200, Modified).
2. Holiday Tests. Holiday tests shall be performed as specified in Section 09910 – Polyurethane Coating for Steel Pipe and shall be done prior to shipment. Provide certification for test results.
3. Mortar Coating Thickness Tests. Tests shall be performed on cylinders, specials, joints, and repairs. The Contractor shall furnish inspection devices that are calibrated and in good working condition for measurement of mortar coating thicknesses. These inspection devices shall be purchased by the Contractor and provided to Owner for approval prior to any delivery of pipe.
4. Pipe shall be measured for deflection at 25-foot intervals unless otherwise required by Owner. Monthly deflection report shall be submitted for the Engineer and Owner's review.
5. Hydrostatic pressure and leakage testing shall be as specified in Section 15085 – Water Pipeline Testing.
6. Coating thickness tests shall be performed on cylinders, specials, joints, and repairs. These inspection devices shall be as required as specified in Section 099101 – Polyurethane Coating for Steel Pipe.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. All water main piping shall be handled at all times with equipment designed to prevent damage to the interior and exterior coatings.

- B. When making shipments, all chains, cables and hold-down equipment shall be carefully padded where in contact with the pipe. Unloading from trucks shall be done with care using slings and cables that will not harm the pipe and no pipe will be allowed to fall.
- C. Gaskets will be stored in containers or wrappers to protect them from ozone and other atmospheric deterioration.
- D. Pipe shall not be stored on rocks, gravel or other hard materials that might damage the coating. Pipe shall not be laid on asphalt without suitable padding at all contact points.
- E. Stockpiled pipes shall be secured to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.
- F. Any pipe damaged during handling, transporting, storage or installation shall be repaired or replaced. Repairs must meet the approval of the Pipe Manufacturer, Engineer and Owner.
- G. Pipe shall be inspected by the Contractor at the project site for damage. Any damage to the pipe, lining, or coating shall be repaired as directed if, in the opinion of the Engineer or Owner, a satisfactory repair can be made; otherwise, the damaged section shall be replaced at the sole expense of the Contractor.
- H. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating.

1.09 EXISTING CONDITIONS

- A. Field measurements: Verify field measurements prior to fabrication. Indicate field measurements on shop drawings.
- B. Contractor shall field verify any existing piping to be replaced in the yard to determine the actual O.D and depths. Based on the O.D., appropriate transitions needs to be provided to mate with the valves, flanges, etc. utilized in the field and the transition flanges fabricated to AWWA C200.

PART 2 PRODUCTS

2.01 GENERAL

- A. The following pipe materials will be authorized for use in this project in the sizes shown below and as indicated in the Plans:
 - 1. Steel Pipe – Pipe diameters equal to 6” and greater
- B. Potable water main pipe, fittings, couplings, and appurtenant items shall be new, free from defects or contamination, and wherever possible, shall be the standard product of the manufacturer. All buried potable water main pipe shall be connected together using mechanical or push-on joints, except as otherwise specified. All potable water main pipes shall be manufactured in the USA.
- C. Repair of Defects. Patching inserts, overlays or pounding out of dents will not be permitted. Repair of notches or lamination on second ends shall not be permitted.

Damaged ends shall be removed as a cylinder, and the end properly prepared. Distorted or flattened lengths shall be rejected. A buckled section shall be replaced as a cylinder.

- D. Steel piping shall have a pressure classification of at least 150 psi unless otherwise shown in the Plans. The pipe weight and classification shall be clearly indicated on the bell of each pipe section. In addition, all potable water main pipes shall be designed to withstand the service conditions shown in Table 1 – Design Service Conditions.

Table 1
Design Service Conditions

Service Parameter	Design Condition
(a) Maximum depth of cover	As shown in plans
(c) Maximum interior working pressure	As indicated on the piping schedule
(d) Field test pressure	Per sheet D-002
(e) Maximum vacuum pressure	-10 pounds per square inch
(f) Surge pressure	Maximum Surge Pressure to be 150% of the operating pressure
(h) Fluid temperature	70 degrees (F) with $\Delta t = 30$ degrees F
(i) Soil unit weight	120 pounds per cubic foot

- E. The pipe shall be of the diameter as shown on Drawings. Unless indicated otherwise, the inside diameter shall be considered the finished diameter after lining.
- F. Pipe Wall Thickness. The pipe wall thickness shall be in accordance with ANSI/AWWA M11, except with a minimum wall thickness of 0.25", with zero minus tolerances or unless otherwise noted on the drawings. Pipe wall thickness shall be constant for the entire length of pipe section. In restrained lengths, the steel cylinder area shall not be progressively reduced from the point of maximum thrust to the end of the restrained length. The lining shall not be used in the pipe wall stiffness calculations. For pipe diameters up to 12-inches, the Contractor may substitute steel pipe ASTM A53 "Welded and Seamless Steel Pipe" with a thickness known as Schedule 40 (standard weight).
- G. Design (Working) Pressure. Unless otherwise indicated, the working (maximum steady state) and field hydrostatic test pressures shall be as indicated on the Drawings. The transient pressure (maximum total unsteady state) shall be 1.5 times the working pressure. Design in accordance with ANSI/AWWA C200 except that the design stress (using a safety factor of 2.0 to yield strength) shall not be greater than 21,000 psi at design working pressure nor shall the design stress (using a safety factor of 1.5 to yield strength) be greater than 75 percent of 42,000 psi or 31,500 psi for 42,000 psi steel pipe at design transient pressure. In restrained lengths, design hoop stresses shall not exceed 21,000 psi.
- H. External Grout Pressure. The pipe in the tunnel and steel casing shall be designed for an external grout pressure of 15 psi. The stiffness of the mortar lining shall not be considered in the design.

- I. Modulus of Soil Reaction. Design calculations which require a modulus of soil reaction (E') shall assume an E' of 1500 psi for trench backfill.
- J. Bedding Constant. The bedding constant, K shall be 0.10.

2.02 WELDED STEEL PIPE AND FITTINGS

- A. Except as otherwise noted, steel pipe, fittings and specials shall be made of carbon steel plate conforming to ASTM A572 grade 42 or ASTM A36 with modified minimum yield strength of 42,000 psi and minimum tensile strength of 60,000 psi, or coil conforming to ASTM A1018 SS Grade 40 with minimum yield strength of 42,000 psi and minimum tensile strength of 60,000 psi or the chemical and physical requirements of ASTM A139 grade C, fabricated in accordance with AWWA C200. Steel made of Grade 45 or higher will not be allowed. When using spiral seams, coil splices shall be a minimum of two feet away from the ends of the pipe cylinder. Forming bells by rolling will not be allowed. The thickness shall be designed for 66 percent of minimum yield stress at hydrostatic test pressure. Alternatively, pipe diameters up to 12-inches in diameter, shall conform to the requirements of ASTM A53, Type E or S, or ASTM A106, Grade B.
- B. Steel plates or coils shall be fine grained, fully killed, and manufactured using a continuous casting process. The steel shall also meet the maximum carbon equivalent of 0.45, as measured by AWS D1.1, Annex XI.
- C. Joints shall be lap welded, butt-welded, flanged, or shouldered in accordance with AWWA C606, Type D (non-buried only), where required on the plans. To facilitate installation, field welded or mechanically coupled joints may be provided, but shall be kept to a minimum and their location shall be acceptable to the Engineer.
- D. Welded Joints.
 - 1. Field welded joints shall not be used in pipe smaller than 30 inches, except in locations where the interior coating can be satisfactorily repaired and inspected. In buried locations, field weld joints on pipe 30 inches in diameter and larger in accordance with AWWA C206. For pipe smaller than 30 inches, provide bell and spigot joints with rubber gaskets per AWWA C200 when joint restraint is not required, or sleeve type couplings that are harnessed when joint restraint is required. Field welded joints for 36 inch diameter and larger shall be single lap-welded joints except in thrust restraint areas the first joint at either side of the thrust point shall be double lap-welded (welded from inside and outside). Flanges shall only be used in buried piping for connections to valves and other appurtenances. Provide a harnessed flanged coupling adaptor to one side of all flanged valves and appurtenances.
- E. Fittings and Specials. Whether or not indicated on the drawings, reinforcement for fittings and specials shall be designed by the pipe manufacturer in accordance with AWWA M11.
 - 1. Specials shall include, but are not limited to fittings, closure pieces, bends, elbows, reducers, tees, wyes, bifurcations, crosses, outlets, manifolds, nozzles, steel pipe wall sleeves, bulkheads and other specials, piping and appurtenances

- fabricated from steel plate, sheet or coils as required to provide the Work, complete. Specials shall also include piping above ground or inside structures.
2. Specials shall be properly reinforced to withstand the internal pressure, both circumferential and longitudinal, and external loading conditions. Fittings and specials shall be equal to adjoining pipe in pressure and external loading design strength. Wall thickness for reducing sections shall not be less than the required thickness for the larger ends.
 3. Fittings shall be fabricated from carbon steel in accordance with AWWA C208. Elbows shall have a maximum 22.5 degree miter section angle and a minimum of 3 sections. Wyes, tees, crosses, and outlets shall be reinforced in accordance with AWWA M11.
- F. Flanges shall be in accordance with AWWA C207 Class D for operating pressures to 175 psi on 4 inch through 12 inch diameter, and operating pressures to 150 psi on diameters over 12 inches. Flanges shall be in accordance with AWWA C207 Class E for operating pressures up to 275 psi or Class F for pressures up to 300 psi. Drilling matches ANSI B 16.5 Class 250. Shop lining and coating shall be continuous to the end of pipe or back of flange. All flanges shall be welded slip on with no screw on flanges allowed.
1. Bolts for flanges located indoors and in enclosed vaults and structures shall be carbon steel, ASTM A307, Grade B for class B and D flanges and nuts shall be ASTM A563, Grade A heavy hex. Bolts for Class E and F flanges shall be ASTM A193 grade B7 and nuts shall be ASTM A194, grade 2 H, heavy hex.
- G. Pipe Deflection. The requirements of Section 02200 EARTHWORK govern for the excavation and backfilling of trenches for laying steel pipe, fittings, and specials. Conformance with pipe deflection requirements shall be as set forth below.
1. Average allowable pipe deflection is limited to 2% for polyurethane and tape coated steel pipe. In no case shall a single measurement in any direction exceed 1.5 times the average allowable deflection. These measurements include the allowable tolerance for lining thickness.
 2. Deflection measurements shall be made by the CONTRACTOR in the presence of the OWNER's representative. Method for taking measurements shall be agreed to by the OWNER and CONTRACTOR in writing prior to installing the first joint of pipe.
 3. Average deflection shall be determined by averaging the pipe's measured vertical deflection as indicated below. Locations where measurements are taken shall be clearly marked on the interior of the pipe.
 - a. For pipe joints 36 feet in length or less, measurements shall be taken at two locations, 1/4-distance from each pipe end.
 - b. For pipe joints longer than 36 feet, measurements shall be taken at three locations including 1/4-distance from each pipe end and at the pipe midpoint.

4. If the average measured deflection at any joint or any single measurement fails to meet specifications, the entire joint shall be reworked in accordance with the manufacturer's recommendations and as directed by the ENGINEER at no additional cost to the OWNER. This may include uncovering the pipe and recompaction of the pipe bedding, and repair of coating.
 5. Installed pipe joints will also be examined for flat spots and internal lining stress cracks by the OWNER's representative. A flat spot is anything flat enough to cause lining damage. Lining damage shall be repaired in accordance with the manufacturer's recommendations and as directed by the OWNER at no additional cost to the OWNER. Repair of flat spots may include uncovering the pipe and re-compaction of the pipe bedding, and repair of the coating.
 6. Where pipe has been reworked to comply with the deflection requirements, CONTRACTOR shall re-measure for deflection no earlier than seven days after the repaired pipe is backfilled. OWNER's representative will re-inspect for flat spots at this time.
 7. No pipe installation shall be accepted until the entire installation is in compliance with the above deflection requirements.
 8. All costs associated with measuring for pipe deflection and any repairs or rework associated with meeting these requirements shall be borne by the CONTRACTOR.
- H. Bolts for buried and submerged flanges and flanges located outdoors above ground or in open vaults shall be Type 316 SS conforming to ASTM A193, Grade B8M, Class 1 for class B and D flanges with ASTM A194, grade 8M nuts. For Class E and F flanges the bolts shall be ASTM A194 grade 2H nuts with bolt and nuts to be zinc plated in accordance with ASTM B633.
- I. Gaskets shall be 1/8-inch thick, cloth-inserted rubber corrosive acid and alkali free for potable water and sewage service conforming to ANSI B16.21 and AWWA C207.
1. Gaskets shall be Garlock 3000, John Crane Co. Style 7777 or approved Equal.
 2. Gaskets for potable water service shall be certified as suitable for chlorinated and chloraminated potable water; a certificate of gasket suitability shall be submitted. Flat faced flanges shall require full-face gaskets. Raised faced flanges shall require flat ring gaskets.
- J. Small Branch Connections.
1. Branch connections less than 1-inch. A 1-inch outlet shall be provided and reducing bushings used as needed.
 2. Branch connections 2½ inch and smaller shall be made with welding fittings with threaded outlets.
 3. Branch connections sized 3 through 12 inches shall be made with pipe nipples or by welding fittings with welded outlets. Pipe nipples and welding fittings shall

- be welded to the pipe shell and reinforced as needed to meet design and testing requirements.
4. Small branch connections shall be located to not interfere with joints, supports, or other appurtenances and shall be provided with caps or plugs to protect the threads during shipping and handling.
- L. Exterior steel surfaces for buried pipe and fittings shall polyurethane coated.
1. Polyurethane Coating. The coating system for straight line pipe and fittings shall be in accordance with ANSI/AWWA C222, field joints shall be in accordance with ANSI/AWWA C216 as modified by Section 09911 - Polyurethane Coating.
- M. Interior surface of all steel pipe, fittings and specials shall be cleaned and lined in the shop with Fusion-Bonded Epoxy coating, NSF 61 certified and conform to AWWA Standard C213.
- N. Provide epoxy lining for the interior of the existing Ground Storage Tank 24" overflow pipe and shall be in accordance with AWWA C210 (Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines). Interior epoxy lining shall be applied and inspected prior to installation of the pipe. Epoxy lining shall be Tnemec 140 Pota Pox. Lining system shall be NSF 61 approved. Total interior lining system shall be a minimum of 14 miles DFT.
- O. Shop Inspection and Testing. Except as otherwise indicated or acceptable to the Engineer, all materials and work shall be inspected and tested by the pipe manufacturer in accordance with AWWA C200. All costs in connection with such inspections shall be borne by the CONTRACTOR. Copies of all test reports shall be submitted in accordance with Section 01300 – Submittals.
1. The Owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to comply with the specified requirements.
- N. Insulated Flanges. Insulated flanges shall be as specified in Section 13110 – Cathodic Protection.
- O. Dielectric Fittings and Dielectric Couplings: Provide between dissimilar metals and between old and new steel pipes.
- P. Temperature Control Joint Design. Where restrained joints are used, a special longer bell or butt strap joint (temperature control joint) shall be provided at a maximum spacing of 250 feet to account for movement of the installed pipe due to temperature changes. The PIPE MANUFACTURER shall determine joint depth requirement based on anticipated temperature change. The joint shall have a rust inhibitive primer. The pipe shall be homed to mid-way of the joint to allow either expansion or contraction to occur. The PIPE MANUFACTURER shall determine the length required for the longer bell or butt strap as defined by the CONTRACTOR's pipe laying procedures and the location of the special joint.

PART 3 EXECUTION

3.01 GENERAL

- A. Care and Handling of Materials: All materials shall be carefully handled in all steps of fabrication, storing, loading, and transporting, unloading, storing at the site, and installation, using the means and following the procedures submitted with the approved shop drawings. Pipe slings used during handling and tie-down straps during transit shall not be less than 4-inch wide flat fiber or plastic straps. During storage and in transit, pipe (8-inch diameter and larger) shall be rested on saddles or on another support system approved by the OWNER, which will ensure freedom from damage of the barrel, interior lining, and exterior coating. A minimum of three saddles will be used during transit.
- B. Installation: All potable water main pipe shall be installed in accordance with the drawings and procedures submitted with the approved shop drawings. The interior of the pipe, fittings and couplings shall be kept clean and free from contamination during installation. All pipes shall be carefully placed and supported at the proper lines and grades and where practical shall be sloped to permit complete drainage. Piping runs shown on the plans shall be followed as closely as possible. If relocation is required, they shall be approved by the Owner.
- C. Verification of Dimensions: All dimensions essential to the correct locations of the pipe, or fit of piping at equipment and valves, or to the proper orientation of pipe sleeves and wall castings, or to the avoidance of obstructions or conflict with other improvements, shall be accurately determined by the CONTRACTOR prior to the fabrication of the piping involved. All required changes from the nominal location shown on the drawings shall be made by the CONTRACTOR and shall be included as a part of the work.
- D. Installation: All potable water main pipe, fittings, couplings, and appurtenant items shall be in proper alignment. Assembly and installation shall not result in placing any undue alignment strains or stresses on any flanges or couplings. When connecting flanged joints care shall be taken in bolting together joints to avoid placing restraint on the opposite end of the piece, which would prevent pressure from being evenly and uniformly applied to the flanged gasket. The pipe or fitting must be free to move in any direction during the installation of bolts. Bolts shall be gradually tightened in a crisscross pattern, to ensure a uniform rate of gasket compression around the entire flange.
- E. Mechanical couplings shall be carefully installed in accordance with the manufacturer's recommendations. A space of at least $\frac{1}{4}$ -inch, but not more than $\frac{3}{4}$ -inch, shall be left between the pipe ends. Pipe and coupling surfaces in contact with the gaskets shall be clean and free from dirt and other foreign matter during assembly. All assembly bolts shall be uniformly tightened so the coupling is free from leaks, and all parts of the coupling are square and symmetrical with the pipe. Wrenches used in bolting shall be of a type and size recommended by the coupling manufacturer.

3.02 BURIED PIPING

- A. Installation: All buried pipe, 30 inches and larger shall be welded steel unless otherwise specifically shown in the drawings. In thrust restrained areas the first joint at either side of the thrust point (e.g., Fitting greater than 5 degrees, tees, crosses, dead ends, valves, etc.) shall be double lap welded from inside and outside. Buried pipe less than 30 inches shall be steel with sleeve type couplings, harnessed when joint restraint is required, or bell and spigot joints with rubber gaskets. Buried piping shall be installed according to

the lines and grades shown in the plans. All trenching, bedding, and backfilling shall conform to the requirements specified in Section 02200 - Earthwork. Other requirements include:

1. Open ends of the pipe shall be secured when the work is not in progress.
 2. Piping shall be installed when trench and weather conditions are suitable. No pipe shall be placed in standing water, and the responsibility for diverting drainage and de-watering all trenches, including meeting all safety requirements shall be borne by the CONTRACTOR.
 3. All pipe in place shall be approved by the Owner as to line, grade, bedding, and proper joint construction prior to backfilling.
- B. Joints: Care shall be taken to keep pipe in correct alignment when making joints. The fitting of piping to valves, wall castings, and other appurtenances shall be worked out in advance of installation to ensure correct orientation of the mating ends and bedding of approach piping. Other requirements include:
1. The maximum deflection in bell and spigot potable water main pipe joints shall not exceed 75 percent of the manufacturer's recommendations.
 2. All underground pipe shall be restrained in accordance with SAWS standard 95-10, latest edition.
 3. Bolts and other exterior surfaces of buried joints, rods, and couplings shall be given a 20 mil coating of KOPR-KOTE High Temp Anti-Seize or approved equal.
 4. When interior joints are protected with mortar, the procedure for mortar placement shall be as follows. Prior to the placing of mortar, any dirt or trash which has collected in the joint shall be cleaned out and the surfaces of the joint space shall be moistened with water by spraying or brushing with a wet brush. The inside joint recess at the bell end of 33-inch and smaller pipe shall be filled immediately prior to placing the pipe together by buttering the bell recess with mortar. After the joint is engaged, the joint mortar of pipe 18-inch in diameter and smaller shall be smoothed and cleaned with a swab, and the joint mortar of pipe larger than 18-inch pipe shall be finished off smooth by hand trowel. The inside joint recess of pipe larger than 33-inch shall be filled with mortar and finished smooth after the joint is engaged. Careful inspection shall be made of each joint to insure a smooth, continuous interior surface.
 5. When the exterior joints are protected with mortar, the procedure for mortar placement shall be as follows:
 - a. A grout band shall be placed around the pipe and positioned to straddle the joint recess. The band shall be of sufficient length to essentially encircle the pipe and shall be secured in such a manner that joint mortar will be contained with little or no leakage.
 - b. For raised-bell (lined cylinder C301) pipe, there shall be no additional bedding or backfill material placed on either side of the pipe until after the mortar band is filled and the mortar has mechanically stiffened. For all other (flush bell) concrete pressure pipe, bedding and backfill may be

- placed and consolidated to approximately three-fourths the height of the pipe before the band is filled to provide support for the band to contain the weight of the mortar.
- c. The band shall be completely filled with mortar in one operation by filling from one side only until the mortar rises on the opposite side, and then rodded or agitated on both sides of the pipe alternately to settle the mortar. The mortar shall then not be agitated for at least 15 minutes to allow excess water to seep through the grout band and to allow the mortar to mechanically stiffen. After this period more mortar shall be added, if necessary, to fill the joint completely.
 - d. The gap at the top of the joint band shall be protected from penetration of backfill into the mortar either by allowing the mortar to stiffen, or by capping with a stiff mortar mix, or by covering with a structurally protective material. The band shall not be removed from the joint.
 - e. The mortar used at joints shall consist of one part Portland cement to no more than 3 parts clean sand mixed with water. Interior joint mortar shall be mixed with as little water as possible so the mortar will be very stiff but workable. Exterior joint mortar shall be mixed with water until it has the consistency of thick cream. During periods of cold weather the joint mortar shall be adequately protected from freezing.
- C. Restraint: All push-on and mechanical joint tees, Y-branches, bends, and plugs which are installed in buried piping shall be provided with suitable anchors, joint harness, or other acceptable means for preventing movement of the pipe caused by internal pressure. Thrust blocking shall not be used alone, a restrained joint pipe system must be used which adequately resists thrust. Shop drawings will include a sealed thrust resistance design and a restraint length calculation for restraints at the pipe joints prepared by a registered professional engineer licensed in the State of Texas.
- D. Cover: Unless otherwise shown, all potable water piping shall have a minimum cover of 4 feet.
- E. Polyethylene Tube Encasement: All buried steel pipe shall be encased in polyethylene tubing. Installation procedures for polyethylene tube encasement are as follows:
1. Installation of polyethylene tube encasement for pipe and fittings shall be in accordance with Method A of ANSI A21.5 and as specified herein.
 2. Each pipe joint shall be covered with a 4.0 mil thick polyethylene sleeve that is 4 feet longer than the pipe joint. The sleeve shall cover the entire length of the pipe joint, lap over 2 feet on each end of the adjoining pipe joints and be secured with a minimum of 2 circumferential turns of pressure sensitive tape every 5 feet.
 3. Excess material should be neatly drawn up and around the pipe barrel, folded into an overlap on top of the pipe and held in place by means of pressure sensitive tape.
 4. After assembling the joint, the polyethylene tube from the previously installed pipe shall be pulled over the joint and secured to the pipe barrel. The polyethylene tube from the new joint is then pulled over the first joint and

secured with polyvinyl pressure sensitive tape that conforms to AWWA C209 and Federal Specification L-T-1512A, to create a double seal.

5. Fittings shall also be wrapped in 4 mil polyethylene film with a minimum of 1 foot overlap on each end.
6. Any damaged areas in the polyethylene film shall be repaired by covering the area with a sheet of polyethylene film large enough to lap over the damaged area 1 foot in any direction. This patch shall be securely taped to the original polyethylene tube. All edges of the patch are to be taped with polyvinyl pressure sensitive tape. Backfill shall be carefully placed to avoid damage to the polyethylene tubing.

3.03 ABOVE GROUND PIPING

- A. Installation: All above ground piping shall be welded steel pipe unless otherwise specified in the plans. All piping shall be installed in accordance with the erection drawings and the erection procedure submitted with the approved shop drawings. Horizontal piping shall be run parallel to building walls and shall be level, except where otherwise shown. Parallel lines shall be grouped on the same horizontal or vertical plane wherever possible. Vertical piping shall be plumb and the entire piping configuration shall provide adequate clearances for painting and maintenance. Piping shall clear obstructions, preserve headroom, and keep openings and passageways clear. If structural difficulties or other work prevent the running of pipes or the setting of equipment at the point indicated on the drawings, the necessary minor deviations therefrom, as determined by the CONTRACTOR and approved by the Owner, will be allowed. All changes will be shown on the record drawings.
- B. Joint Installation: Installation of joints and couplings shall conform to the following:
 1. Joints and couplings shall be made in accordance with the specified requirements made part of the erection procedure submitted by the CONTRACTOR and approved by the Owner. The minimum distance between the harness clips for flexible couplings shall be a minimum of two (2) times the dresser length plus 12 inches.
 2. Pipe threads shall be made in accordance with the requirements of ANSI B2.1, and shall be cut full and free from torn or ragged surfaces. No more than 3 threads on the pipe at any joint shall remain exposed after installation. Threaded joints shall be established with Teflon tape or joint compound applied to the male ends only. The use of thread cement or caulking will not be permitted.
 3. Flanged joints shall be made with gaskets centered in the joint. Bolts, studs, and nuts shall be lubricated with graphite or oil so that the nuts can be turned by hand. Care shall be taken to prevent excessive initial tension to the bolt and studs so that the tension applied is as nearly uniform as possible. The rust preventative compound applied to the faces before shipment shall be removed before installation.
 4. Mechanical coupling type joints of the sleeve, grooved mechanical, split sleeve, and flanged coupling adapter types shall be made in accordance with the manufacturer's printed instructions.

- C. Pipe Sleeves: All piping which will pass through walls and slabs shall be provided with pipe sleeves with the annular space sealed or with wall castings. The CONTRACTOR shall provide the wall sleeves and castings for insertion into the concrete work and shall verify their correct setting prior to concrete placement. Sealing of the wall sleeves shall be made with mechanical link seals, appropriately sized for the through-pipe. Installation of the link seal shall be made in accordance with recommendations of the manufacturer.
- D. All above ground piping and valves shall be exterior coated as detailed in Section 09900 – Painting and Coatings.

END OF SECTION

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SECTION 15056**STEEL PIPE FABRICATED SPECIALS
(ANSI/AWWA C200, MODIFIED)****PART 1 GENERAL****1.01 DESCRIPTION**

- A. The CONTRACTOR shall provide fittings, closure pieces, bends, elbows, reducers, tees, wyes, bifurcations, crosses, outlets, manifolds, nozzles, steel pipe wall sleeves, bulkheads, other specials, piping and appurtenances fabricated from steel plate, sheet, or coils and pipe above ground, inside structures complete in place, and pipe encased in concrete, in accordance with ANSI/AWWA C200, C208 and AWWA Manual M11 as modified by the Contract Documents. Steel pipe shall be provided as required in Section 15055 – STEEL PIPE (AWWA C200 MODIFIED).
- B. The manufacturer of the steel pipe shall be made responsible for furnishing all the specials. Manufacture of steel pipe and specials shall be as specified in Section 15055 – STEEL PIPE, (AWWA C200 MODIFIED).
- C. As part of the CONTRACTOR's Bid Documents, submit the qualifications for the specials manufacturer/fabricator. Qualifications of the specials manufacturer/ fabricator shall be as specified in Section 15055 – STEEL PIPE, (AWWA C200 MODIFIED).
- D. Fabrication. All specials shall be fabricated in the shop. No field fabrication of specials will be allowed unless specifically accepted by the OWNER. Approval will be based on clear demonstration by the manufacturer/fabricator that the manufacturer/fabricator has the appropriate equipment to mobilize to construct the specials in accordance with these Contract Documents for shop fabrication, including holding the appropriate tolerances, and performing the indicated testing.

1.02 RELATED WORK

- A. Section 01330 Submittals
- B. Section 01400 Quality Control
- C. Section 02200 Earthwork
- D. Section 03300 Cast-In-Place Concrete
- E. Section 09900 Painting and Coatings
- F. Section 09911 Polyurethane Coating
- G. Section 13110 Cathodic Protection
- H. Section 15055 Steel Pipe (AWWA C200 Modified)

I. Section 15085 WATER PIPELINE TESTING

1.03 SUBMITTALS

- A. Certified Affidavits of Compliance. The CONTRACTOR shall submit certified affidavits of compliance for all steel pipe fabricated specials and other products or materials furnished under this Section. The requirements of Section 15055 – STEEL PIPE (AWWA C200 MODIFIED) shall apply.
- B. Shop Drawings. The CONTRACTOR shall submit shop drawings and line layout diagrams of all steel pipe fabricated specials, in accordance with Section 01330 – SUBMITTALS. All submittals required for steel pipe and related work as listed in 15055– STEEL PIPE, (AWWA C200 MODIFIED) shall also be required for specials including the following:
1. Shop drawings shall indicate the type, size and location of all reinforcement pieces.
 2. Detailed design drawings shall also be submitted for reinforced fittings and shall include developed plans or cut-out patterns, dimensioning of all fabricated pieces and welding requirements. The CONTRACTOR shall provide such detailed information for all reinforced fittings.
 3. Design criteria shall be submitted to the OWNER for review prior to manufacture of steel pipe fabricated specials.
 4. Pipe Manufacturer’s Qualifications. Furnish a copy of pipe manufacturer’s certification by Steel Plate Fabricator’s Association (SPFA), International Organization for Standardization (ISO) 9001 or Lloyd’s Register Quality Assurance Limited (LRQA) and documentation of manufacturer’s experience in fabricating ANSI/AWWA C200 pipe.

1.04 QUALITY CONTROL AND ASSURANCE

- A. Inspection. All specials shall be subject to inspection at the place of manufacture/fabrication as specified in Section 15055 STEEL PIPE, (AWWA C200 MODIFIED). A certified welding inspector shall be provided for shop fabrication work and shall have the responsibilities outlined in Section 15055 STEEL PIPE, (AWWA C200 MODIFIED).
- B. Onsite Observation. Onsite observation shall be as specified in Section 15055 STEEL PIPE, (AWWA C200 MODIFIED).
- C. Welder Qualifications and Welding Procedure Specifications (WPS). All welder performance qualifications and WPS shall be in accordance with Section 15055 STEEL PIPE, (AWWA C200 MODIFIED).
- D. Shop Tests. The CONTRACTOR shall be responsible for performing and paying for material shop tests. The OWNER shall have the right to witness all testing conducted by the CONTRACTOR, provided that the CONTRACTOR’S schedule is not delayed for the convenience of the OWNER. In addition to those tests specifically required, the OWNER may request additional samples of any material including mixed concrete and lining and coating samples for testing by the OWNER. The additional samples shall be

furnished as part of the work. Testing shall be performed before joints have been coated or lined.

1. Weld Tests. All welds shall be non-destructive tested at the special fabricator's facility as specified below for various weld categories. Testing shall include submitting written documentation of procedures per Section V, and acceptance criteria shall be in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code (BPVC).
 - a. Butt Joint Welds. Spot radiographically examine pipe in accordance with paragraph UW-52 of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1, or they shall be 100 percent ultrasonically examined.
 - b. Fillet Welds. Examine 100 percent of all fillet welds using the magnetic particle or dye penetrant inspection method.
 - c. Groove Welds. Ultrasonically examine 100 percent of all groove welds that cannot be readily radiographically spot examined.
 - d. Welds on pipe seams for previously successfully tested straight pipe do not need to be retested.
 - e. All Welds. Pipe manufacturer's certified welding inspector shall 100 percent visually examine each pass of all welds as a minimum.
 - f. Butt strap joints shall have an inside and outside weld and shall be air tested. Air test shall be low pressure from a 1/4-inch threaded fitting between the welds. Air test pressure shall be 15 psi for 10 minutes with no loss of air pressure.
 2. Hydrostatic or Weld Tests. If specials have been fabricated from untested straight pipe, they shall be either tested per section 1.04, D. 1. or hydrostatically tested with a pressure equal to 1-1/2 times the design working pressure shown on the Drawings. If specials have been fabricated from successfully tested straight pipe, no additional hydrostatic test is required unless otherwise indicated. In no case shall shop test pressure be less than 150 psi. All fittings with crotch plates shall be either tested per section 1.04, D.1. or hydrostatically tested as indicated regardless of whether or not the straight pipe sections used were previously tested. For crotch plate reinforcement, postweld heat treatment will be required if the reinforcing members are thicker than 1.25 inches in conformance with Table UCS-56 of paragraph UCS-56 of ASME Code; for crotch plate thicknesses between 1.25 and 1.5 inches postweld heat treatment will not be required if preheat is applied at a minimum temperature of 200° F during welding.
- E. Field Testing. Field testing shall conform to the requirements of Section 15085 WATER PIPELINE TESTING.

PART 2 PRODUCTS

2.01 GENERAL

- A. Markings. Markings shall be as specified in 15055 STEEL PIPE, MORTAR-LINED (AWWA C200 MODIFIED). In addition, a mark indicating the true vertical axis of the special shall be placed on the top and bottom of the special
- B. Specials. Specials shall include, but are not limited to fittings, closure pieces, bends, elbows, reducers, tees, wyes, bifurcations, crosses, outlets, manifolds, nozzles, steel pipe wall sleeves, bulkheads and other specials, piping and appurtenances fabricated from steel plate, sheet, or coils and pipe above ground, inside structures complete in place, and pipe encased in concrete as required to provide the work complete.

2.02 MATERIALS

- A. Steel. Steel for specials shall conform to the requirements of Section 15055 STEEL PIPE, (AWWA C200 MODIFIED).
- B. Lining. Specials shall be lined using the same materials for straight pipe as specified in Section 02571 STEEL PIPE, MORTAR-LINED (AWWA C200 MODIFIED).
- C. Coating. Specials shall be coated as specified in Section 09911 POLYURETHANE COATING.
- D. Access Manholes. Access manholes with covers shall be as shown on Drawings, installed during fabrication and not in the field. No temporary utility access penetrations shall be allowed. All threaded outlets shall be forged steel suitable for 3,000 psi service and shall be as manufactured by Vogt or equal.
- E. Outlets, Tees, Wyes and Crosses.
 - 1. Outlets 12-inch and smaller shall be fabricated from ASTM A53, Type E or S, Grade B, standard weight steel pipe in the standard outside diameters, i.e., 12-3/4-inch, 10-3/4-inch, 8-5/8-inch, 6-5/8-inch and 4-1/2-inch. Unless otherwise shown, wall thickness and collar reinforcing shall be designed by the pipe manufacturer as specified. Collars shall be manufactured with the same steel as specified for the mainline piping.
 - 2. In lieu of collar reinforcement, pipe or specials with outlets may be fabricated in their entirety of steel plate having a thickness equal to the sum of the pipe wall plus the required reinforcement.
 - 3. Fittings shall be manufactured with crotch plate reinforcements as shown on the Drawings or as required by design procedures in AWWA Manual M11, whichever requirements are more stringent.
- F. Closures and Correction Pieces. Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing indicated. The locations of correction pieces and closure assemblies shall be shown on the pipe layout drawings and shall be subject to the OWNER's review. Any change in location or number of said items shall be accepted by the OWNER. Closure pieces shall be welded inside and out at each joint.

2.03 DESIGN OF SPECIALS AND FITTINGS

- A. General. The specials shall be of the diameter and wall thickness shown on the Drawings, or in accordance with these Contract Documents. Where not otherwise shown, reinforcement for fittings shall be designed by the pipe manufacturer in accordance with AWWA Manual M11. Shop welding shall conform to the applicable provisions of the ASME BPVC. Except as otherwise provided herein, specials shall be fabricated from materials in full conformance with the requirements of Section 15055 STEEL PIPE, (AWWA C200, MODIFIED), ANSI/AWWA C200, and the dimensions of ANSI/AWWA C208.
- B. The minimum thickness of plate for pipe from which specials are to be fabricated shall be the thickness of adjacent mainline pipe, the thickness shown on the Drawings, or whichever is thicker.
- C. Design Pressure. All fittings and specials shall be properly reinforced to withstand the internal working and transient pressure, both circumferential and longitudinal, and external loading conditions. Specials and fittings shall be equal to adjoining pipe in pressure and external loading design strength.
- D. Bevels and Miters. Unless otherwise shown, the minimum radius of elbows shall be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11-1/4 degrees. Moderate deflections and long radius curves shall be designed using beveled joint rings. The maximum total allowable angle for beveled joints shall be 3 degrees per pipe joint. Miters shall be provided on the bell ends. Mitering of the spigot ends will not be permitted.
- E. Deflection at Joints. Minor field adjustments can be made by pulling standard joints. The maximum allowable angle for pulled joints shall be as specified in 15055, STEEL PIPE, (AWWA C200 MODIFIED) or the angle which results from a 3/4-inch pull out from normal joint closure, whichever is less.
- F. All horizontal deflections or fabricated angles shall fall on the horizontal alignment, as shown on the Drawings. All vertical deflections shall fall on the vertical alignment, and the pipe angle point locations shall match the locations shown on the Drawings.
- G. Joints. All joints and related work for field assembly of the pipe and specials shall conform to Section 15055, STEEL PIPE, (AWWA C200 MODIFIED). All shop joints shall be complete penetration butt-welds unless otherwise shown.
- H. Steel Welding Fittings. Steel welding fittings for pipe spools and fittings 24 inches in diameter and smaller shall be in accordance with ANSI/ASME B16.9 conforming to ASTM A234. Taper pipe wall at welds at 4:1 for connection to pipe of different wall thicknesses. The CONTRACTOR shall be fully responsible for coordinating the difference in diameter convention between these specials and ANSI/AWWA C200/C208 pipe and fittings to provide complete piping systems as shown.
- I. Ends for Mechanical Type Couplings. Except as otherwise shown, where mechanical-type couplings are shown, the ends of pipe shall be shoulder banded with Type C collared ends using double fillet welds. Where pipe 12-inches in diameter and smaller is

furnished in standard schedule thicknesses and where the wall thickness equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved.

- J. Where welded test heads or bulkheads are used, extra length shall be provided to each opening of the special. After removal of each test head, the special shall be trimmed back to the design points with all finished plate edges ground smooth, straight, and prepared for the field joint.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide all specials, bolts, nuts, gaskets, jointing materials and all other appurtenances as indicated to provide a complete and workable installation. Where pipe support details are indicated, the supports shall conform thereto and shall be placed as indicated; provided that the support for all exposed piping shall be complete and adequate regardless of whether or not supporting devices are specifically indicated. Where indicated, welded joints shall be provided. Unless otherwise indicated, all specials shall be installed in full conformance with Section 15055, STEEL PIPE, (AWWA C200 MODIFIED). At no additional cost to the OWNER, CONTRACTOR shall install temporary bulkheads as necessary to secure the pipe at night and when pipe laying operations are not being performed. Temporary bulkheads shall be waterproof.
- B. Lining and Coating. Specials shall have the same lining and coating as the adjoining pipe. Specials shall be lined and coated using the same thickness, application and curing of lining indicated for straight pipe in accordance with the applicable AWWA or ASTM Standards, as modified in Section 15055 STEEL PIPE, (AWWA C200 MODIFIED), Section 09911 – POLYURETHANE COATING, or by any other applicable sections in these Specifications with the following provisions.
 - 1. Specials that cannot be lined centrifugally or with field lining equipment shall be lined by hand. In such case, the lining shall be reinforced with welded wire fabric positioned approximately in the center of the lining and in accordance with the requirements of ANSI/AWWA C205 for lining specials.
 - 2. Specials that cannot be mechanically coated shall be coated by hand-application. Coating applied in this manner shall provide protection equal to that specified for the pipe. Fittings may be fabricated from pipe that has been mechanically lined or coated. Areas of coating that have been damaged by such fabrication shall be removed and reapplied by hand-applications.
 - 3. Unless otherwise indicated, the exterior surfaces of pipe or fittings passing through a structure wall shall be tape or polyurethane coated from the center of the wall or wall flange to the end of the underground portion of pipe or fitting.
 - 4. Pipe above ground or in structures shall be shop primed and field coated as specified in Section 09900, PAINTING AND COATINGS.
 - 5. Portions of wall sleeves that penetrate into structures and will be embedded in concrete shall be shop-lined and coated in accordance with requirements for submerged conditions as specified in Section 09900, PAINTING AND COATINGS.

- C. Handling and Storage. Specials handling and storage shall be as specified in Section 15055, STEEL PIPE, (AWWA C200 MODIFIED).
- D. Holiday Testing. Specials shall be tested for holidays as specified in Section 15055, STEEL PIPE, (AWWA C200 MODIFIED) and Section 09910 POLYURETHANE COATING.
- E. Protection of Specials. At all times when the work of installing pipe is not in progress, the pipe shall be protected as specified in Section 15055, STEEL PIPE, (AWWA C200 MODIFIED).
- F. Pipe Cleanup. Maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the OWNER as specified in Section 02571, STEEL PIPE, MORTAR-LINED (AWWA C200 MODIFIED).
- G. Field Welding. Field welding shall conform to ANSI/AWS D1.1 and ANSI/AWWA C206.
- H. Markings. Markings shall be as specified in Section 15055, STEEL PIPE, (AWWA C200 MODIFIED).
- I. Take all necessary precautions to prevent the pipe from floating due to water entering the trench from any source. The CONTRACTOR shall assume full responsibility for any damage due to this cause, and shall at its own expense replace the pipe to its specified condition and grade if it is displaced due to floating. Maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the OWNER.

3.02 INSTALLATION OF FABRICATED SPECIALS, AND CONCRETE-ENCASED PIPE WITHIN STRUCTURES

- A. Trenches shall be kept dry in accordance with Section 02200, EARTHWORK when the pipe special is laid. The pipe and specials shall be laid to the line and grade indicated as specified in Section 15055 – STEEL PIPE, (AWWA C200 MODIFIED) and shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointing, the bedding shall be checked for firmness and uniformity of surface. Steel pipe encased in concrete within structures shall be hydrostatically tested in conformance with Section 15085, WATER PIPELINE TESTING, prior to encasement.
- B. The pipe shall be appropriately supported in the proper position prior to placing steel reinforcement or concrete.
- C. Steel reinforcement shall be constructed around the pipe and supported in a manner that does not touch the pipe or provide any metallic contact with the pipe. Steel reinforcement shall conform to the requirements of Section 03300, CAST-IN-PLACE CONCRETE.

- D. Place concrete for encasement as shown on the Drawings. Construction joints shall be located in the encasement to limit the size of each placement in order to avoid cold joints and to prevent floatation of the pipeline.
- E. Cathodic protection for fabricated specials and concrete encased pipe within structures shall conform to the requirements of Section 13110, CATHODIC PROTECTION SYSTEM.

END OF SECTION

SECTION 15058

DUCTILE IRON PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Ductile iron pipe and fittings.
 - 2. Accessories.

- B. Related Requirements:
 - 1. Section 15080 - Disinfection of Water Systems
 - 2. Section 15085 - Water Pipeline Testing

1.02 REFERENCE STANDARDS

- A. American Society of Mechanical Engineers:
 - 1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
 - 2. ASME B31.3 - Process Piping Design.

- B. ASTM International:
 - 1. ASTM A48 - Standard Specification for Gray Iron Castings.

- C. American Water Works Association:
 - 1. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
 - 2. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - 3. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.
 - 4. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

5. AWWA C150/A21.50 - Thickness Design of Ductile-Iron Pipe.
 6. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.
 7. AWWA C153/A21.53 - Ductile-Iron Compact Fittings.
 8. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.
- D. The Society for Protective Coatings:
1. SSPC-SP 6/NACE No. 3 - Commercial Blast Cleaning.

1.03 SUBMITTALS

- A. Shop Drawings Submittals **will not** be provided to the Owner unless a deviation from the Construction Drawings or the specifications is proposed. The supplier will provide the purchaser with submittals. The Purchaser will determine if the Design Engineer and/or Owner need to review submittals for compliance.
- B. Supplier shall indicate layout of piping systems, including equipment, critical dimensions, sizes, and materials lists.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Submit Coating Manufacturer's Technical Representative's Report.

1.04 QUALITY ASSURANCE

- A. Qualifications:
1. Lining manufacturers: For piping specified to receive epoxy lining, use only a lining manufacturer having a minimum of 5 years' experience supplying this type of product to the wastewater and water industry.
 2. Welded on outlets: The pipe manufacturer shall have a minimum of 5 years' experience in the fabrication and testing of outlets of similar size and configuration similar to those used on the Project.
- B. Pre-installation meeting:
1. Coating manufacturer's Technical Representative shall attend pre-activity conferences, and to make periodic visits to factory or shop to inspect surface preparation of pipe, fittings, and accessories; and to inspect

application of linings to interior and coating to exterior of pipe, fittings, and accessories.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's packaging, including handling instructions.
- B. Inspection: Accept piping and appurtenances on-Site. Inspect for damage.
- C. Store piping and appurtenances according to manufacturer's instructions.
- D. Protect piping and appurtenances from oxidation by storing off the ground.

1.07 INSPECTION

- A. The Design Engineer reserves the right to inspect materials, production, or testing of pipe at the manufacturer's plant.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE AND FITTINGS

- A. This specification covers 3” through 64” ductile-iron pipe, centrifugally cast, for water or other liquids, with push-on or mechanical joints. All pipe furnished shall be in conformance with ANSI/AWWA Standard C151/A21.51.91, or latest revision thereof.

1. General Requirements:

- a. All pipe shall conform to the following pressure classes, based upon Type 3 bedding conditions, a depth of bury of 6 feet, and a working pressure of 150 pounds per square inch:

3” through 12” 350 psi

16” and 20” 250 psi

24"	200 psi
30" through 64"	150 psi

- b. Dimensions and tolerances for each nominal pipe size shall be in accordance with Table 51.5 (push-on) or Table 51.5 (mechanical joint) of AWWA Standard C151 for pipe with a nominal laying length of 20 feet.
 - c. All pipes shall have an interior lining applied in accordance with ANSI/AWWA C104/A21.4 cement mortar lining. Sludge piping from the plate settlers shall have an interior glass lining in accordance with AWWA standards.
 - d. Exterior coating for buried pipe shall consist of a nominal one-mil thick asphaltic material applied to the outside of the pipe as described in Section 51.8 of AWWA C151, plus polyethylene tube encasement except ductile iron pipe within a steel casing does not require a polyethylene tube.
 - e. Exterior Coating for Exposed Piping: Piping Located above ground or in vaults or structures shall be coated per Section 09900 – Painting and Coating.
 - f. All rubber joint gaskets utilized on ductile-iron pipe shall be in conformance with ANSI/AWWA C111/A21.11 Standard, latest revision.
 - g. Each length of pipe furnished shall bear identification markings in conformance with Sec. 51.10 of AWWA Standard C151.
 - h. The manufacturer shall take adequate measures during pipe production to assure compliance with AWWA C151 by performing quality-control tests and maintaining results of those tests as outlined in Sec 51.14 of that Standard.
2. Fittings: For use on ductile iron bell, mechanical, or push on joint, unless shown otherwise on Drawings or Standard Details.
- a. Size, dimensions, and tolerances: AWWA C110 or AWWA C153.
 - b. Mechanical joint solid sleeves: AWWA C110 or AWWA C153.
 - c. Unless shown otherwise, furnish fittings 3 inch through 24 inch diameter having minimum pressure rating of 350 psi, and furnish fittings larger than
 - d. 24 inch diameter having minimum pressure rating of 250 psi.
 - e. Restrain system: All DIP pipe and fittings shall be restrained in accordance with SAWS standard 95-10, latest edition.
 - f. Coatings: Manufacturer shall provide patch kits for minor repair of coating during installation.
 1. Exterior: Asphalt coated outside: AWWA C111.

2. Interior: Lined with double thickness cement and seal coated: AWWA C104 and C111.
 3. Or, exterior and interior: Fusion bond epoxy coated: AWWA C116.
- g. Approved manufacturers: Only domestic DIP shall be provided.
1. American Cast Iron Pipe Co.
 2. Clow Water Systems Company, (Division of McWane Incorporated).
 3. Griffin Pipe Products Co.
 4. Tyler Pipe Industries, Inc.
 5. Union Foundry Company
 6. United States Pipe and Foundry Co.
 7. C&B Piping

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field dimensions are as indicated on Drawings and Shop Drawings.
- B. Inspect existing flanges for nonstandard bolt hole configurations or design, and verify that new pipe and flange mate properly.

3.02 PREPARATION

- A. Thoroughly clean pipe and fittings before installation.
- B. Surface Preparation:
 1. Touch up shop-primed surfaces with primer as specified in Section 09900 - Painting and Coating.
 2. Solvent-clean surfaces that are not shop primed.

3.03 INSTALLATION

- A. Exposed Service:
 1. Run piping straight along alignment indicated on Drawings and procedure submitted with the approved Shop Drawings with minimum number of joints.

2. Install according to ASME B31.3.
 3. Fittings:
 - a. Clean gasket seats thoroughly, and wipe gaskets clean prior to installation.
 - b. Install fittings according to manufacturer's instructions.
 - c. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer's recommendations.
 4. Provide required upstream and downstream clearances from devices as indicated.
- B. Make taps to ductile iron piping only with service saddle, tapping boss of a fitting or valve body, or equipment casting.
- C. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.
- D. Finish primed surfaces according to Section 09900 - Painting and Coating.
- E. Provide cathodic protection as indicated on Drawings for buried ferrous piping systems.
- F. Installation: All water main pipe shall be installed in accordance with the drawings and procedures submitted with the shop drawings. The interior of the pipe, fittings and couplings shall be kept clean and free from contamination during installation. All pipes shall be carefully placed and supported at the proper lines and grades and where practical shall be sloped to permit complete drainage. Piping runs shown on the plans shall be followed as closely as possible. If relocation is required, they shall be approved by the Design Engineer.
- G. Installation: All water main pipe, fittings, couplings, and appurtenant items shall be in proper alignment. Assembly and installation shall not result in placing any undue alignment strains or stresses on any flanges or couplings. When connecting flanged joints care shall be taken in bolting together joints to avoid placing restraint on the opposite end of the piece, which would prevent pressure from being evenly and uniformly applied to the flanged gasket. The pipe or fitting must be free to move in any direction during the installation of bolts. Bolts shall be gradually tightened in a crisscross pattern, to ensure a uniform rate of gasket compression around the entire flange.
- H. Connections to Existing Piping. Connections between new work and existing piping shall be made suitable fittings for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions

which will least interfere with service to customers and as authorized by the Design Engineer. Special care shall be taken to prevent contamination when dewatering and making connections with potable water piping. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then disinfected.

3.04 FIELD QUALITY CONTROL

- A. Inspect for damage to pipe lining or coating, or other defects that may be detrimental as determined by the Design Engineer. Repair damaged piping, or provide new undamaged pipe.
- B. Pressure Testing per Specification Section 15085 Water Pipeline Testing.
- C. After installation, inspect for proper supports and interferences.

3.05 CLEANING

- A. Keep pipe interior clean as installation progresses.
- B. Clean pipe interior of soil, grit, loose mortar, and other debris after pipe installation.

END OF SECTION

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SECTION 15062**CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS****PART 1- GENERAL****1.01 DESCRIPTION****A. Scope of Work:**

1. Furnish all labor, materials, equipment and incidentals required, and install and test in the locations and of the size as shown on the Drawings and specified herein Schedule 80 Chlorinated Polyvinyl Chloride (CPVC) piping, fittings and appurtenances.
2. All plastic pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the contractor.

B. Related Work Described Elsewhere:

1. Section 09900 – Painting and Coating
2. Section 15011 – Pipe Hangers and Supports for Process Piping
3. Section 15014 – Pressure Testing of Pipe
4. Section 15015 – Identification for Process Piping and Valves
5. Section 15141 – Couplings, Connectors and Adapters

C. General Design (Not Applicable)**1.02 QUALITY ASSURANCE****A. CPVC pipe, fittings and appurtenances shall meet the following standards:**

- | | | |
|----|-----------------------|--|
| 1. | Pipe | ASTM D1784/ASTM F441, Type IV, Grade I, CPVC 4120, Schedule 80, Cell Classification 23447-A, bearing NSF seal. |
| 2. | Fittings | ASTM D2464 or D2467, Cell Classification 23447-A, bearing NSF seal. |
| 3. | Flanges | Diameter and drilling shall conform to ANSI B16.5, Class 150. |
| 4. | Flange Bolts and Nuts | Flange bolts and nuts shall conform to ASTM F593 and F594 respectively. |

- | | | |
|----|----------------------------|---|
| 5. | Flat Washers | Shall be of the same material as the bolts. |
| 6. | Flange Gaskets | Full face, 1/8 inch thick, chemical-resistant elastometric material suitable for the specified service. |
| 7. | Solvent Cement ASTM D2564. | |
| 8. | Primer | ASTM F656. |
| 9. | Expansion Joints | Edlon "Thermo-molded TFE", Resistoflex "Style R6905". |

1.03 SUBMITTALS

A. Materials and Shop Drawings:

1. Shop drawings shall be submitted to the Engineer for approval in accordance with the General Requirements and Section 01300. All products within this specification shall be combined into a single submittal which shall include at least the following:
 - a. Dimensioning and the technical specification for all piping, fittings, and appurtenances to be furnished.
 - b. Letter of Certification from the National Sanitation Foundation International (NSF) stating compliance with Standard 14 and Standard 61.
 - c. Letter from the Manufacturer verifying chemical compatibility of all products to be used in chemical feed systems.

B. Additional Information:

1. Submit to the Engineer, for approval, samples of all materials specified herein, along with the manufacturer's descriptive literature, illustrations, specifications, installation instructions and related information.

C. Operating Instructions (Not Applicable)

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Pipe and fittings shall be handled and stored in a manner which will ensure installation in sound, undamaged condition. Handling methods and equipment used shall prevent damage to pipe. Bare cables, chains, or metal bars shall not be used. Pipe shall be stored off the ground on wide padded skids.

1.05 WARRANTY AND GUARANTEES

- A. Provide equipment warranty in accordance with Section 01400: Quality Control.

PART 2 - PRODUCTS**2.01 GENERAL**

- A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water, in accordance with Rule 290.44(a) of the Texas Administrative Code.

2.02 MATERIALS AND EQUIPMENT

- A. Piping for buried service:
1. Pipe and fittings:
 - a. Pipe and fittings shall be gasketed style utilizing twin gasket coupling or single gasket bell and spigot unless otherwise shown on the Drawings or specified in other Sections in this Division.
 - b. All chemical piping using Schedule 80 CPVC shall be solvent welded.
 - c. Pipe lengths: Laying length of 20 feet or as shown on the Drawings.
 2. Joints:
 - a. Provide rubber gaskets in sufficient quantity to allow for loss.
 - b. Provide couplings of the same quality as the pipe that will maintain tight joints when subjected to the same hydrostatic tests designated for the pipe.
 3. Adapters: When applicable, provide adapters for connecting chlorinated polyvinyl chloride pipe to pipes constructed from other material.
- B. Piping for exposed service:
1. Pipe and fittings:
 - a. Solvent weld type unless otherwise shown on the Drawings or specified in other Sections in the Division.
 - b. Chemical piping, fittings and components: Schedule 80 CPVC, normal impact unless otherwise shown on the Drawings or specified in other Sections in this Division.

2. Joints:
 - a. Solvent weld using solvent supplied or approved by pipe manufacturer.
 - b. Threaded and screwed joints: Permitted only on Schedule 80 and heavier pipe.
 - c. Couplings and fittings: Minimum schedule and pressure rating as the pipe.
 3. Provide suitable adapters for connections to equipment and other piping systems.
- C. Solvent Cement:
1. CPVC solvent cement shall be in compliance with ASTM D 2564.
 2. Solvent cement shall be specified by compatibility based on pipe service and size.
 3. For CPVC pipe in chemical service, provide IPS Corp Type 724 cement or another cement certified by the manufacturer for the proposed chemical service. Manufacturer to provide certification with submittal.
- D. Flanges:
1. The Contractor shall provide flanges on CPVC piping to connect to flanged valves, fittings, or equipment and as shown in the Drawings. Flanges shall match the connecting flanges on the adjacent fitting, valve or piece of equipment and must meet the test pressure of the piping system as specified in Section 15014: Pressure Testing of Piping.
 2. Except for higher pressure flange connections that may be required as noted above, flanges shall meet ANSI B16.5 and be rated for an internal pressure of 150 psi at 73-degrees F.
 3. Flange hardware (bolts, nuts, and washers) for CPVC flanges shall be Type 316 stainless steel in accordance with ASTM F593 and F594, respectively, and shall be furnished with a bright electropolished finish. Flange hardware for CPVC flanges on Hydrofluosilicic Acid and Sulfuric Acid chemical piping and at injection nozzles on process piping shall be Hastelloy C-276. Bolt length shall be provided such that bolts will project 1/8 to 3/8 inch beyond the outer face of the nut.
 4. For chemical feed piping systems, the gasket material shall be selected by the gasket manufacturer based on the chemical concentrations as specified in Divisions 11 and 13.

2.03 ACCESSORIES (Not Applicable)

2.04 SPARE PARTS

- A. All special tools, solvents, lubricants, and cements required for normal installation shall be furnished with the pipe.

2.05 QUALITY CONTROL

- A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION (Not Applicable)

3.02 INSTALLATION

- A. Install CPVC pipe where shown on the Drawings and in strict accordance with the manufacturer's technical data and printed instructions.
- B. Joints for Schedule 80 CPVC pipe and fittings shall be solvent welded or threaded. All joints shall be made watertight. All pipe cutting, threading and jointing procedures for solvent welded and threaded CPVC pipe joints shall be in strict accordance with the pipe and fitting manufacturer's printed installation instructions. Thread lubricant for threaded joints shall be Teflon tape only. In making solvent welded connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth, if necessary and apply solvent cement of proper grade.
- C. Installation of valves and fittings shall be strictly in accordance with the manufacturer's instructions. Particular care shall be taken not to over-stress threaded connections at sleeves. In making solvent weld connections the solvent shall not be spilled on valves or allowed to run from joints.
- D. All piping shall have sufficient number of unions to allow convenient removal and shall be as approved by the Engineer.
- E. Where plastic passes through wall sleeves, joints shall be sealed with a mechanical seal equal to Link-seal.
- F. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and the Contractor shall verify their locations from approved piping layout Drawings and the structural Drawings. Pipe Supports for Process Piping are specified in Section 15011.
- G. Jointing:
 - 1. Clean each pipe length, coupling and fitting of all debris and dirt before installation.

2. Do not use pipe length if there are any cuts, abrasions, or defects on the surface of the pipe.
3. Provide and use coupling pullers for joining the pipe when required.
4. Shove home each length of pipe against the pipe previously laid and hold securely in position.
5. Do not pull or cramp joints.

H. Fabrication:

1. Cutting:
 - a. Use a hand saw or pipe cutter with blades (not rollers).
 - b. Examine all cut ends for possible cracks caused by cutting.
2. Connecting:
 - a. Solvent weld connections are recommended by the manufacturer.
 - b. Connect pipe and fittings only when temperature is above the minimum recommended by the manufacturer.
 - c. Threaded adapters shall be connected only with plastic male into metal female.

3.03 INSPECTION AND TESTING

- A. All CPVC pipe shall be pressure tested in accordance with Section 15014: Pressure Testing of Piping.

3.04 START-UP AND INSTRUCTION (Not Applicable)

END OF SECTION

SECTION 15063**POLYVINYL CHLORIDE (PVC)
PIPE AND FITTINGS, SCHEDULE TYPE****PART 1 - GENERAL****1.01 DESCRIPTION****A. Scope of Work:**

1. Furnish all labor, materials, equipment and incidentals required, and install and test in the locations as shown on the Drawings, the Schedule 80 polyvinyl chloride piping, fittings and appurtenances specified herein.
2. Schedule 80 PVC piping shall be used on all small diameter PVC piping systems (4 inches and smaller in diameter) which includes, but are not limited to, chlorine solution, non-potable water, potable water, other chemical feeds and PVC pipe used for conduit/sleeve applications.
3. Polyvinyl chloride (PVC) gravity sewer pipe and fittings shall be in accordance with ASTM D 3034 for piping NPS 15 and smaller, and to ASTM F 679 for piping NPS 19 and larger diameter.
4. All plastic pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the contractor.

B. Related Work Described Elsewhere:

1. Section 09900 – Painting and Coating
2. Section 15014 – Pressure Testing of Piping
3. Section 15015 – Identification for Process Piping and Valves
4. Section 15140 – Pipe Supports for Process Piping
5. Section 15141 – Couplings and Connectors

1.02 REFERENCES**A. ASTM Internation (ASTM):**

1. D 1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
2. D 1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
3. D 2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
4. D 2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
5. D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride)

(PVC) Plastic Piping Systems.

6. D 2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
7. F 645 - Standard Guide for Selection, Design and Installation of Thermoplastic Water-Pressure Piping Systems.

B. NSF International (NSF):

1. 61 – Drinking Water System Components – Health Effects

1.03 QUALITY ASSURANCE

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

1.04 SUBMITTALS

A. Materials and Shop Drawings:

1. Shop drawings shall be submitted to the Engineer for approval in accordance with the General Conditions and Section 01300. All products within this specification shall be combined into a single submittal which shall include at least the following:
 - a. Dimensioning and the technical specification for all piping, fittings, and appurtenances to be furnished.
 - b. Letter of Certification from the National Sanitation Foundation International (NSF) stating compliance with Standard 14 and Standard 61.
 - c. Letter from the Manufacturer verifying chemical compatibility of all products to be used in chemical feed systems.

B. Additional Information:

1. Submit to the Engineer, for approval, samples of all materials specified herein, along with the manufacturer's Certificates of Inspection, descriptive literature, illustrations, specifications, installation instructions and related information.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. PVC pipe shall be delivered to the site in unbroken bundles packaged in such manner as to provide protection against damage. When possible, pipe should be stored at the job site in the unit packages until ready for use. Packaged units shall be handled using a forklift or a spreader bar with fabric straps. Packaged units shall not be stacked at the job site higher than two units high.
- B. When it is necessary to store PVC pipe for more than 30 days, exposure to direct sunlight shall be prevented by covering the pipe with an opaque material. Adequate air circulation

above and around the pipe shall be provided as required to prevent excessive heat accumulation. PVC pipe shall not be stored close to heat sources or hot objects such as heaters, fires, boilers or engine exhaust. Pipe gaskets shall be protected from excessive exposure to heat, direct sunlight, ozone, oil and grease. The interior and all sealing surfaces of pipe, fittings and other appurtenances shall be kept clean and free of dirt and foreign matter.

- C. Care shall be taken in handling and laying pipe and fittings to avoid severe impact blows, crushing, abrasion damage, gouging or cutting. Pipe shall be lowered, not dropped, from trucks or into trenches. All cracked, damaged or defective pipe and fittings, or any length of pipe having a gouge, scratch or other permanent indentation of more than 10 percent of the wall thickness in depth, shall be rejected and removed at once from the work and replaced with new acceptable pipe at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All materials that come into contact with the water being treated or the finished water shall be NSF Standard 61 certified for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating NSF Standard 61 for the materials used in products that come into contact with the water.

2.02 MATERIALS AND EQUIPMENT

A. PVC Pipe:

- 1. Pipe shall be made of polyvinyl chloride, Schedule 80 pipe, conforming to ASTM D1785. Schedule 80 pipe shall have solvent welded joints. Threaded connections are permissible when connecting to valves or other equipment where solvent weld connections are not an option. In no cases is connection of PVC female threads to metal male threads allowable. Female threads shall be special reinforced with stainless steel collars. Male threads shall be reinforced with stainless steel insert.

C. Fittings:

- 1. Fittings for Schedule 80 pipe 4 inches and smaller in diameter shall be socket type, solvent welded in conformance with ASTM D 2467. When permitted, threaded joints shall be in conformance with ASTM D 2464. Solvent welded and threaded joints shall be watertight. Chlorine gas vacuum feed lines and chlorine solution lines shall have solvent welded fittings. Female threads shall be special reinforced with stainless steel collars. Male threads shall be reinforced with stainless steel insert.
- 2. Fittings for Schedule 80 pipe greater than 4 inches in diameter shall be socket type, solvent welded in conformance with ASTM D 2467. Fittings shall be a 1-piece injection molded design. Use of low pressure fabricated PVC fittings will not be permitted.

C. Solvent Cement:

- 1. PVC solvent cement shall be in compliance with ASTM D 2564.

2. Solvent cement shall be specified by compatibility based on pipe service and size. Large diameter joints shall be solvent welded with slow setting solvent cement.
 3. Manufacturer to provide certification with submittal.
 4. All PVC chemical feed piping joints are to be solvent welded using CPVC solvent cement.
- D. Flanges:
1. Slip-on flanges shall be provided to connect to flanged valves, fittings, or equipment. Flanges shall match the connecting flanges on the adjacent fitting, valve or piece of equipment and must meet the test pressure of the piping system as specified in Section 15014.
 2. Flange hardware (bolts, nuts, and washers) for PVC flanges shall be Type 316 stainless steel in accordance with ASTM F593 and F594, respectively. Flange hardware for PVC flanges on Sulfuric Acid piping shall be Hastelloy C-276. The length such that, after installation, bolts will project 1/8 to 3/8 inch beyond the outer face of the nut. Flat Washers shall be of the same material as the bolts.
 3. Flange gaskets shall be EPDM for water service.
- E. PVC Gravity Sewer Piping
1. Polyvinyl chloride (PVC) gravity sewer pipe and fittings: In accordance with ASTM D 3034 for piping NPS 15 and smaller diameter, and to ASTM F 679 for piping NPS 18 and larger diameter:
 - a. Referenced standards apply as complemented and modified in this Section.
 - b. Fittings: Supplied by the pipe manufacturer.
 2. PVC compounds: Class Number 12454-C, in accordance with ASTM D 1784:
 - a. Stabilizers, antioxidants, lubricants, colorants, and other additives and fillers: Not to exceed 10 parts by weight per 100 of PVC resin in the compound.
 3. Pipe NPS 15 and smaller diameter: Wall thickness SDR 26:
 - a. Joints: Push-on joints in accordance with ASTM D 3212.
 4. Pipe NPS 18 and larger diameter:
 - a. PVC compound: Cell classification 12454-C in accordance with ASTM D 1784.
 - b. Minimum wall thickness: Thickness T-1 in accordance with Table 1 in ASTM F 679.

- c. Joints: Integral bell gasketed joints in accordance with ASTM F 679.
 - d. Bell: Fabricated from pipe sections, thickness of the wall of the bell equivalent to the pipe wall thickness.
 - e. Gasket ring: Locked into the bell.
 - f. Spigot end of the pipe: Marked by the manufacturer to identify the final in-place position of the spigot in the bell.
5. Fittings, including wyes, tees, elbow caps, plug adapters, and manhole waterstops: Same wall thickness as the pipe:
- a. Fittings: Factory molded with joints and gaskets equal to those of the pipe.
6. Gasket: EPDM in accordance with ASTM D 3212 or ASTM F 477:
- a. Keep rubber gasket in place during pipe joining.
7. Gasket for connection to manhole: Stainless steel clamp with gasket or similar device to seal the penetration.

2.03 SPARE PARTS

- A. All special tools, solvents, lubricants, and cements required for normal installation shall be furnished with the pipe

2.04 QUALITY CONTROL

- A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install PVC pipe where shown on the Drawings and in strict accordance with the manufacturer's technical data and printed instructions.
- B. Joints for Schedule 80 PVC pipe and fittings shall be solvent welded, flanged, or threaded. All joints shall be made watertight. All pipe cutting, threading and jointing procedures for solvent welded and threaded PVC pipe joints shall be in strict accordance with the pipe and fittings manufacturer's printed installation instructions. Thread lubricant for threaded joints shall be Teflon tape only. In making solvent welded connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth, if necessary and apply solvent cement of proper grade.
- C. Installation of valves and fittings shall be strictly in accordance with the manufacturer's instructions. Particular care shall be taken not to over-stress threaded connections at sleeves. In making solvent weld connections the solvent shall not be spilled on valves or allowed to run from joints.

- D. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and the Contractor shall verify their locations from approved piping layout Drawings and the structural Drawings. Pipe hangers and supports are specified in Section 15126
- E. Field Painting:
1. Pipe normally exposed to sunlight shall be painted and marked as specified in Section 09900.
- F. Joining:
1. Join pipe in strict accordance with manufacturer's instructions for joining pipe. Pay special attention to proper methods for solvent welding pipe, especially with larger pipe diameters.
 2. Clean each pipe length, coupling and fitting of all debris and dirt before installation.
 3. Do not use pipe length if there are any cuts, abrasions, or defects on the surface of the pipe.
 4. Provide and use coupling pullers for joining the pipe when required.
 5. Shove home each length of pipe against the pipe previously laid and hold securely in position.
 6. Do not pull or cramp joints.
- F. Fabrication:
1. Cutting:
 - a. Use a hand saw or pipe cutter with blades (not rollers).
 - b. Examine all cut ends for possible cracks caused by cutting.
 2. Connecting:
 - a. Solvent weld connections as recommended by the manufacturer.
 - b. Connect pipe and fittings only when temperature is above the minimum recommended by the manufacturer.
 - c. Threaded adapters shall be connected only with plastic male into metal female. Do not thread metal threads into plastic female threads.
 - d. Flange pipe with appropriate adaptors for to connect to flanged valves, tank nozzles and equipment.

3.03 INSPECTION AND TESTING

- A. All PVC piping shall be hydrostatically pressure tested and flushed in accordance with the requirements in Section 15014: Pressure Testing of Piping.

END OF SECTION

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SECTION 15067**STAINLESS STEEL PIPE AND FITTINGS****PART 1 - GENERAL****1.01 DESCRIPTION**

- A. Scope of Work: Furnish all labor, materials, equipment and incidentals required to supply, store, install, clean, and test all stainless-steel pipe and fittings where shown on the Drawings and as specified herein.
- B. Stainless steel piping and fittings where indicated on the Drawings shall be furnished with a pickled and passivated finish.
- C. Related Work Described Elsewhere:
 - 1. Couplings and Connectors: Section 15141.

1.02 QUALITY ASSURANCE

- A. All stainless-steel pipe, fittings and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The manufacturer shall be qualified to perform work in accordance with the ASME Code Standards and shall hold one or all of the following ASME accredited code stamps (“U”, “S”, “PP”). The stainless-steel pipe, fittings and appurtenances shall be fabricated and installed in accordance with the best practices and methods and shall comply with these Specifications.
- B. Stainless steel pipe and fittings shall be supplied by Aerex Industries, Inc., Ft. Pierce, Florida, Felker Brothers Corporation, Marshfield, Wisconsin, or Douglas Brothers, Portland, Maine. Qualified fabricators that are not listed above and/or that do not hold either of the listed ASME accredited code stamps (“U”, “S”, “PP”) will be considered upon successful demonstration of similar project experience and welder qualifications as specified herein.
- C. Welder Qualifications: All welding shall be done by welders, welding operators, and tackers fully qualified in accordance with ASME Sect. IX and have adequate experience in the methods and materials to be used. All field welding shall be per the pipe manufacturer’s written instructions and procedures unless otherwise approved by the ENGINEER.

1.03 SUBMITTALS

- A. Materials and Shop Drawings: CONTRACTOR shall submit shop drawings of pipe and fittings in accordance with Section 01300 and the following supplemental requirements as applicable.

1. Certified dimensional drawings of all valves, fittings, and appurtenances.
 2. Joint and pipe/fitting wall construction details which indicate the type and thickness of pipe, manufacturing tolerances, and all other pertinent information required for the manufacture of the product.
 3. Fittings and specials details such as elbows, wyes, tees, outlets, connections, test bulkheads, and nozzles or other specials where shown on the drawings which indicate amount and position of all reinforcement. All fittings and specials shall be properly reinforced utilizing wall thickness to withstand the internal pressure, both circumferential and longitudinal. Calculations shall be submitted proving complete compliance with ASME B31.3 for all extruded reducing outlet tees.
 4. Process piping layout and marking diagrams which indicate the specific number of each pipe and fitting and the location of each pipe and the direction of each fitting in the completed line.
 5. Full and complete information regarding location, type, size, and extent of all welds shall be shown on the shop drawings. The shop drawings shall distinguish between shop and field welds. Shop drawings shall indicate by welding symbols or sketches the details of the welded joints and include the applicable WPS and PQR. Submit Weld Procedure Specifications (WPS) along with applicable supporting Procedure Qualification Records (PQR) and Welder Qualification Records.
 6. Complete piping design pressure calculations shall be submitted to the ENGINEER. The calculations shall be in conformance with the ASME B31.3 standards and the requirements specified herein.
- B. Additional Information:
1. Submit materials list showing material of pipe and fittings with ASTM reference and grade.
- C. Operating Instructions (Not Applicable)

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. The equipment provided under this section shall be shipped, handled and stored in accordance with the manufacturer's written instructions, and in accordance with Section 01600: Material and Equipment.

1.05 WARRANTY AND GUARANTEES

- A. Provide equipment warranty in accordance with Section 01600: Project Requirements.

PART 2 - PRODUCTS**2.01 GENERAL**

- A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water.
- B. Stainless steel piping shall be pickled and passivated following fabrication.

2.02 MATERIALS AND EQUIPMENT

- A. Materials:
 - 1. Stainless Steel Pipe and Fittings (100 - 300 psi working pressure at 120°F maximum).
 - a. All stainless steel pipe and fittings shall be fabricated from Type 316L extra low carbon grade austenitic stainless steel sheet and plate.
 - i. Pipe shall conform to ASTM A-312 and be die-formed or rolled true to dimension and round within the applicable ANSI Standard. The two edges of sheet shall be brought to line so as not to leave a shoulder on the inside of the pipe.
 - ii. Pipes shall be straight within the applicable ANSI Standard for ASTM-A-312 welded pipe.
 - iii. Ends of pipe and fittings shall be true and perpendicular to the longitudinal axis with the edges deburred.
 - iv. Fittings shall conform to ASTM A-403-WP in accordance with B16.9.
 - v. Longitudinal seams on pipe and fittings shall be welded by the GTAW, PAW, FCAW, SAW, or the SMAW methods. Filler metal, if utilized, shall be of same composition or superior to the pipe and fittings material.
 - vi. Weld deposit at the seams shall have a slight crown on both sides of the weld and no cracks or crevices shall be allowed. Excessive weld deposits, slag, weld spatter and projections into interior of pipe shall be removed by grinding. The interior welds shall be smooth, even and shall not have an internal bead higher than 1/16 inch.
 - vii. All pieces shall be marked indicating wall thickness/schedule, grade of stainless steel, and ASTM Standard.

- b. The stainless steel piping wall dimensions shall be designed for the hydrostatic test pressures as required in Section 15014: Pressure Testing of Piping, and shall be at a minimum Schedule 10S. The required Schedule Gauge or Plate and Wall Thickness are to be indicated in the manufacturer's shop drawings and verified by ASME B31.3 calculations. Calculations for wall thickness shall be based on the minimum wall thickness due to manufacturing tolerances, joint efficiencies, and a safety factors as permitted by ASME B31.3.
- c. Fittings: Fittings shall be butt weld type per ASTM-A-403WP and manufactured in accordance with ANSI B16.9. All fittings shall be of the same pressure rating and grade material as the pipe. Elbows shall be long radius Long radius; i.e., centerline to end of elbow equals 1.5 times the nominal pipe size, unless otherwise approved by the ENGINEER. All elbows up to 24-inch diameter shall be smooth flow. All short radius, special radius, and reducing elbows and long radius elbows greater than 24-inch diameter shall be of mitered construction with at least (5) miter sections for 90-degree bends, (3) mitered sections for 45 and 60 degree bends, and (2) mitered sections for 30 degree and smaller bends. Reducers shall be straight tapered, cone type.
 - i. Fittings three inches and smaller shall be threaded conforming to ASTM-A-182 forged, Class 3000# and manufactured to ANSI B16.11.
 - ii. Fittings for buried or submerged pipe larger than three inches shall be butt-welded, conforming to ASTM-A-403WP, same pressure rating and material as the pipe and manufactured to ANSI B16.9.
 - iii. Fittings for above ground or exposed pipe larger than three inches shall be butt-welded except when flanged or coupled, as shown on the drawings, conforming to ASTM A 403 WP, same pressure rating and grade material as the pipe and manufactured to ANSI B16.9. Tees shall have no welds in the throat area and the crotch shall be reinforced with long radius design to eliminate sharp corners. Extruded branch outlets may be used in place of reducing outlet tees when properly designed and manufactured per ASME B31.3 to meet the applicable operating, design, and test pressures as specified herein.
 - iv. Drain & Instrumentation Branches:
 - (1) Outlets of size three inches and smaller in piping 4 inches and larger shall be of the Threadolet type, per AWWA Manual M11 (1964 edition), Figure 19.24. Outlets shall be 3,000 pound WOG stainless steel per ASTM A 182, or ASTM A 403. Threads shall comply with ANSI B2.01. Outlets shall be Bonny Forge Co.

"Threadolet," Allied Piping Products Co. "Brachlet," or equal.

- (2) For outlets three inches and smaller in piping smaller than four inches, use a threaded tee in accordance with c.i. above.
- (3) For outlets larger than three inches, use a tee conforming to ASTM-A-403WP, in accordance with c.iii. above and with a flanged outlet or as shown on the Drawings.

d. Joints:

- i. Joints for pipes three inches and smaller shall be threaded or socket welded, same material as the pipe, 3,000 pound WOG, conforming to ANSI B16.11.
- ii. Joints for buried or submerged pipe larger than three inches shall be butt-welded.
- iii. Joints for aboveground or exposed pipe larger than three inches shall be butt-welded except where flanges or grooved end joints are shown on the Drawings.

e. Flanges:

- i. Provide weld-neck flanges conforming to ANSI B16.5 for piping three inches and smaller to connect to flanged valves, fittings, or equipment. Provide slip-on flanges for piping larger than three inches. Provide blind flanges at dead end connections and where shown on the Drawings. Flanges shall be Class 150 per ANSI B16.5 unless a higher pressure rating is required. Material for weld-neck, slip-on, and blind flanges shall conform to ASTM-A-182, Grade F316L. Flanges and blind flanges shall match the connecting flanges on the adjacent fitting, valve or piece of equipment. Stainless steel flanges in sizes greater than 24-inches shall be AWWA Class E hubbed flanges. Ring flanges will not be acceptable.
- ii. Determine the pressure class of flange and blind flanges based on the test pressure specified in Section 15014: Pressure Testing of Piping.
- iii. Where a raised face steel flange connects to a flat face flange, remove the raised face on the steel flange.

- f. Field welding of stainless steel piping will not be permitted unless approved by the ENGINEER in the shop drawing submittal. Proposed field welded joints in all other areas of the project must be submitted to the ENGINEER for approval in advance of such work. All field welding

shall be performed by welders certified in accordance to ASME Section IX. Welding processes utilized shall be as specified herein.

- g. Pipe ends shall be prepared for either mechanical or flexible couplings where shown on the Drawings.
- h. Pipe and fittings shall be cleaned acid pickled after manufacture in accordance with 3.01 of this specification.
- i. Dead Ends of pipe runs shall have butt-welded ASME Code dished heads designed to meet the test pressures specified in Section 15014.
- j. Mechanical couplings at equipment connections shall be in accordance with the requirements of Section 15000: Mechanical - General Requirements, as modified by this Section. Gaskets shall be suitable for the service conditions. The pipe ends shall be roll grooved to the coupling manufacturer's specifications for piping size 6-inches and under. Where roll grooving is not sufficient for the specified pressure, the pipe shall have heavy wall machine grooved pipe nipples or machined ring collars fully welded to the pipe or fitting. Nipples shall be taper bored to the I.D. of the adjoining pipe to allow full weld penetration. Collars shall be welded on both sides to the piping. Nipples and collars shall be of the same alloy as the piping.

2. Stainless Steel Tubing and Fittings

- a. Pipe and fittings to sample panels, 1-inch and smaller, shall incorporate seamless Type 316 stainless steel tubing and shall maximize the use of non-threaded fittings where possible. Tubing systems shall be pressure rated for a minimum of 1,000 psi and shall conform to ASTM A276.
 - i. Approved fittings include Swagelok VCR or VCO series, Ham-Let Let-Lok series, or ENGINEER-approved equal. Gaskets shall be made of stainless steel or Buna N. All pressure ratings shall comply with calculations in accordance with ASME Code for Pressure Piping B31.3, Process Piping, and ASME B31.1, Power Piping. For 316 SS fittings and gaskets, temperature rating shall be 1000°F (537°C).
 - ii. Pressure relief valves shall be constructed of Type 316 SS with screw type adjustment and shall have an operating range of 30 - 150 psi. Pressure relief valves shall be manufactured by Jesco or approved equal.
 - iii. Ball valves shall be two-way vented with quarter turn actuation, pressure rated for a minimum of 1,000 psi. Models include Swagelok 60 series, Hamlet 700 series, or approved equal.

- iv. When threaded fittings are used, unions shall be provided within 2 feet on each threaded end unless there are other connections which permit easy removal of the fitting.
- v. Pipe and fittings larger than 1-inch shall be threaded stainless steel piping and fittings as specified herein.

2.03 ACCESSORIES

A. Bolts and Nuts for Flanges:

- 1. Bolts and nuts for flanges shall be Type 316 stainless steel, hex heavy bolt head and nut dimensions conforming to ASTM A 193, Grade B8M, for bolts and ASTM A 194, Grade 8M, for nuts. Bolts, nuts, and washers shall be furnished with a bright electropolished finish. Absolutely no surface corrosion of any type will be considered as acceptable for the installed stainless steel hardware.
- 2. Provide washer for each nut. Washers shall be of the same material as the nuts.

B. Gaskets for Flanges:

- 1. Provide full-face gaskets for flat faced flanges. Provide ring gaskets for raised face flanges.
- 2. Air Service (High Temperature): Gaskets shall be composed of asbestos with rubber binder, 1/8-inch thick, Johns-Manville No. 60, John Crane Co. "Granite", or ENGINEER-approved equal.
- 3. Water Service
 - a. Gaskets for water service shall be tested and certified by NSF 61.
 - b. High Pressure Service (150 - 450 psi at 120-Degrees F): Gaskets for high pressure service shall be Garlok Style 3505 (Gylon) high performance restructured PTFE material with glass microspheres.
 - c. Low Pressure Service (25 - 150 psi at 120-Degrees F): Gaskets for low pressure service shall be Garlok Style 3760-U synthetic fiber sheet with a proprietary rubber binder for raised face flanges and Garlok Style 98206 EPDM sheet gasket material with Sulfur Cure (85 durometer) for flat face flanges.

2.04 SPARE PARTS (Not Applicable)

2.05 QUALITY CONTROL

- A. CONTRACTOR shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.

- B. Piping subcontractor shall submit a list of welders who will work on this project along with a welder's current certification (less than one year old) and two (2) sample weld coupons. Only approved welders will be allowed to work on this project.
- C. The weld should be made as rapidly as possible, with the least amount of generated heat.
- D. At random, CONTRACTOR shall visually examine via x-ray approximately 10 percent of all welds.
- E. All shop welds shall be visually inspected by the fabricator's quality control division. Each weld shall be marked with an inspection stamp, certifying that the weld is acceptable.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Descaling, Cleaning, and Passivation:
 - 1. Following final fabrication, all stainless steel pipe spools and fittings shall be cleaned and descaled in accordance with the requirements of ASTM A-380. Descaling shall include immersion in an appropriate pickling solution for the type and grade of material being treated. Caution shall be taken to avoid over-pickling. The type of acid used, acid concentration, solution temperature, and contact time shall be consistent with industry standards for such work. In addition to pickling, piping and fittings shall be scrubbed and washed until discoloration and possible iron, picked up from manufacturing process, is removed. Pickling and passivation of individual pipe lengths and fittings will not be considered equal to pickling and passivation of the finished product(s) following fabrication.
 - 2. After chemical descaling, surfaces shall be thoroughly rinsed to remove residual chemicals. Surfaces shall not be permitted to dry between successive steps of the acid descaling and rinsing procedure. Following the final rinse, thorough air drying shall be performed.
- B. Handling and Storage
 - 1. Extreme care shall be used to avoid the contact of any ferrous materials with the stainless steel piping. All saws, drills, files, wire brushes, etc. shall be used for stainless steel piping only. Pipe storage and fabrication racks shall be non ferrous or stainless steel or rubber lined. Nylon slings or straps shall be used for handling stainless steel piping. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls. After installation, the CONTRACTOR shall wash and rinse all foreign matter from the piping surface. If rusting of embedded iron occurs, the CONTRACTOR shall pickle the affected surface with Oakite Deoxidizer SS or equal, scrub with stainless steel brushes and rinse clean.

2. The use of chains, hooks, or other equipment which might injure the pipe will not be permitted. All other pipe handling equipment and methods shall be acceptable to the ENGINEER.
3. All fabricated piping shall have openings plugged and flanges screened for storage and/or transport after fabrication.
4. CONTRACTOR shall be fully liable for the cost of replacement or repair of pipe which is damaged, including any cosmetic damage to electropolished piping.

3.02 INSTALLATION

- A. Stainless steel piping shall be installed true to alignment and rigidly supported.
- B. After installation, completed pipelines shall be washed clean with steam or hot water to remove any foreign material picked up during transportation.
- C. Field Welded Piping: Field welding will not be permitted . CONTRACTOR shall use flange joints or couplings at assembly joints as approved by the ENGINEER. At other locations where permitted, field joint welding shall be in accordance with the ASME B31.3 standards. The strength of the weld shall develop the strength of the pipe. All field welds shall be descaled and passivated with pickling paste, scrubbed with stainless wire brushes and rinsed until clean.
- D. Installation Threaded Piping: Ream, clean and remove burrs from threaded straddling the pipe's horizontal and vertical centerline. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.
- E. Fabrication, Assembly and Erection of Welded Piping:
 1. Beveled ends for butt-welding shall conform to ANSI B16.25. Remove slag by chipping or grinding. Surfaces shall be clean of paint, oil, rust, scale, slag, and other material detrimental to welding.
 2. Fabrication shall comply with ANSI B31.3, Chapter V.
 3. Use the GTAW process only for all stainless steel welded butt joints in accordance with the specifications.
 4. Welding preparation shall comply with ANSI B31.3, paragraph 327.3. Limitations on imperfections in welds shall conform to the requirements in ANSI B31.3, Tables 327.4.1A and 327.4.1a, and paragraph 327.4 for visual examination. Identify welds in accordance with ANSI B31.3, paragraph 327.4.
 5. Clean each layer of deposited weld metal prior to depositing the next layer of weld metal, including the final pass, by a power-driven wire brush on the same material.
 6. Welding electrodes shall comply with AWS A5.4. Bare wire shall comply with AWS AS.9.

7. Where field welds are permitted, the CONTRACTOR shall install the stainless steel piping system with the minimal number of field welded joints as is possible. Field welding shall be in conformance with procedures detailed in the mechanical specifications. All installed stainless steel pipe shall be closed to the atmosphere after connections of pipe, valves or equipment with a nitrogen purge and bagged ends. Provide temporary enclosures as required to complete the piping installation in a clean environment. This area shall remain clean and dust free. If the area is not maintained adequately, the fabrication and welding work will not be accepted.
8. Mark each weld (field and manufacturing facility) with symbol identifying welder and date of weld.

3.03 INSPECTION AND TESTING

- A. All stainless-steel pipe shall be pressure tested in accordance with Section 15085: Water Pipeline Testing.

END OF SECTION

SECTION 15076**DOUBLE WALL CONTAINMENT PIPING****PART 1 - GENERAL****1.01 DESCRIPTION**

- A. Scope of Work:
1. Furnish all labor, materials, equipment and incidentals required, and install and test the double wall containment piping, fittings and appurtenances specified herein.
 2. Double wall containment piping systems are required for the hydrofluosilicic acid feed piping and containment drains. The double wall containment piping shall be used when the piping is in contact with the ground, located in the trenches or overhead, or any other location indicated on the drawings.
- B. Related Work Described Elsewhere:
1. Section 09900 – Painting and Coating
 2. Section 15015 – Identification for Process Piping and Valves
 3. Section 15140 – Pipe Supports for Process Piping
 4. Section 15085 – Water Pipeline Testing
- C. General Design:
1. Double wall containment piping shall be installed in the locations as shown on the Drawings. All plastic pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the Contractor.
 2. Double wall containment pipe for hydrofluosilicic acid feed piping shall be made of Schedule 80 polyvinyl chloride (PVC) with black Perfluoroalkoxy (PFA) tubing conforming to this specification.
 3. Double wall chemical containment floor drains and drain piping shall be installed from the chemical feed rooms to their respective bulk storage containment areas as shown in the Drawings. Double containment drain piping shall be of schedule 80 CPVC construction for hydrofluosilicic acid conforming to this specification.

1.02 QUALITY ASSURANCE

- A. All Schedule 80 CPVC and black PFA tubing double containment piping including fittings and appurtenances shall be furnished by a manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications.
- B. Solvent welder shall be qualified in accordance with Chapter VII of the ASME B31.3-93 Code, Part 9, Paragraph A328.
- C. Piping shall be marked with nominal size, type, class, schedule or pressure rating, manufacturer and all markings required by applicable ASTM and AWWA standards.
- D. CPVC Schedule Type Piping shall be Schedule 80 unless otherwise indicated on the Drawings. Pipe and fittings shall be extruded from Type I, Grade I, Class 12454-B material in accordance with ASTM D 1784.

1.03 SUBMITTALS

- A. Materials and Shop Drawings:
 - 1. Shop drawings shall be submitted to the Engineer for approval in accordance with the General Requirements and Section 01300 and shall include dimensioning and the technical specification for all piping to be furnished.
- B. Additional Information:
 - 1. Submit to the Engineer, for approval, samples of all materials specified herein, along with the manufacturer's Certificates of Inspection, descriptive literature, illustrations, specifications, installation instructions and related information.
- C. Operating Instructions (Not Applicable)

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. PVC containment pipe and PFA carrier tubing shall be delivered to the site in unbroken bundles packaged in such manner as to provide protection against damage. When possible, pipe should be stored at the job site in the unit packages until ready for use. Packaged units shall be handled using a fork lift or a spreader bar with fabric straps. Packaged units shall not be stacked at the job site higher than two units high.
- B. When it is necessary to store PVC containment pipe and PFA tubing for more than 30 days, exposure to direct sunlight shall be prevented by covering the pipe with an opaque material. Adequate air circulation above and around the pipe shall be provided as required to prevent excessive heat accumulation. Double wall containment pipe shall not be stored close to heat sources or hot objects such as heaters, fires, boilers or engine exhaust. Pipe gaskets shall be protected from excessive exposure to heat, direct sunlight, ozone, oil and grease. The interior and all sealing surfaces of pipe, fittings and other appurtenances shall be kept clean and free of dirt and foreign matter.

- C. Care shall be taken in handling and laying pipe and fittings to avoid severe impact blows, crushing, abrasion damage, gouging or cutting. Pipe shall be lowered, not dropped, from trucks or into trenches. All cracked, damaged or defective pipe and fittings, or any length of pipe having a gouge, scratch or other permanent indentation of more than 10 percent of the wall thickness in depth, shall be rejected and removed at once from the work and replaced with new acceptable pipe at no additional cost to the Owner.

1.05 WARRANTY AND GUARANTEES

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

PART 2 - PRODUCTS

2.01 GENERAL

- A. All double wall containment piping system components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

2.02 MATERIALS AND EQUIPMENT

- A. PFA Tubing and Fittings:
 - 1. Materials:
 - a. Small Bore PFA Tubing: Carrier pipe shall be of flexible virgin PFA tubing, suitable for flaring and available in continuous lengths of 25, 50, 100, 250, and 1,000 feet.
 - b. PFA Tubing shall be black.
 - c. PFA tubing wall thickness shall be as follows:
 - i. For NS 1/4-inch, 0.047-inches.
 - ii. For NS 3/8-inch, 0.062-inches.
 - iii. For NS 1/2-inch, 0.062-inches.
 - iv. For NS 3/4-inch, 0.062-inches.
 - v. For NS 1-inch, 0.062-inches.
 - 2. Pressure ratings for PFA tubing shall be as follows:
 - i. For 1/2-inch (hydrofluosilicic acid), no less than 230 psi.
 - 3. Fittings: PFA tubing fittings shall be flare-type (no threads exposed to fluid).
 - 4. Manufacturers: Tubing shall be manufactured by Chemline Plastics Unlimited or engineer approved equal. Fittings shall be manufactured by FlareLINK by Fit-LINE, Inc., or engineer approved equal.

B. PVC Tubing**1. Materials:**

- a. Tubing shall be NSF 61 listed.
- b. Provide PVC tubing with nylon braid reinforcement embedded in the wall of the tubing with smooth inside bore and smooth outside.
- c. Minimum operating pressure shall be 200 psi for tubing 3/4 inch and smaller, 150 psi for 1 inch, 100 psi for 1-1/4 and 1-1/2 inches, and 75 psi for 2 inches. Burst pressure shall be at least 4.0 times the specified operating pressure.
- d. Products: Kuriyama “Kuri-Tech Clearbraid K3130 Series BF Heavy Wall PVC Food and Beverage Hose”, Ryan-Herco “Herco-Braid Heavy Duty Food Grade Clear PVC Tubing”.

2. Fittings:

- a. Join tubing to pipe with a single-barb male adapter fitting. Secure tubing to the fitting with a stainless steel hose clamp. Connect tubing sections by means of single or multi-barb thermoplastic couplings with titanium hose clamps. Use single barb PVC fittings for ½ inch tubing and smaller and multiple barb PVC fittings for larger tubing.

C. Double Containment Drain Piping:**1. Materials:**

- a. Chemical containment drain piping shall be a prefabricated double containment piping system with 4-inch diameter primary drain piping with 6-inch diameter secondary containment piping. Each contained piping system shall consist of Schedule 80 PVC primary piping system supported within a Schedule 80 PVC secondary containment housing for polymer and sodium hypochlorite and schedule 80 CPVC primary piping system supported within a Schedule 80 CPVC secondary containment housing for hydrofluosilicic acid.

2. Fittings:

- a. All primary fittings shall be schedule 80 CPVC according to ASTM F-439 specifications for hydrofluosilicic acid. All secondary containment fittings shall be schedule 80 CPVC according to ASTM F-439.

3. The double containment piping system shall be a Guardian prefabricated system as manufactured by IPEX, or equal.

D. PVC Containment Piping:

1. Materials:
 - a. Pipe shall be made of polyvinyl chloride, Schedule 80, conforming to ASTM D1784-92.
 2. Fittings:
 - a. Fittings for Schedule 80 pipe shall be socket type, solvent welded in conformance with ASTM D2467. Solvent welded joints shall be watertight.
 3. Solvent Cement:
 - a. PVC solvent cement shall be in compliance with ASTM D2564.
- E. Double Containment (Hard) Piping
1. Materials:
 - a. Chemical containment hard piping shall be a prefabricated double containment piping system with sizes as shown on the drawings. Each contained piping system shall consist of schedule 80 CPVC primary piping system supported within a Schedule 80 CPVC secondary containment housing for hydrofluosilicic acid.
 2. Fittings:
 - a. All primary fittings shall be schedule 80 CPVC according to ASTM F-439 specifications for hydrofluosilicic acid. All secondary containment fittings shall be schedule 80 CPVC according to ASTM F-439.
 3. The double containment piping system shall be a Guardian prefabricated system as manufactured by IPEX, or equal.

2.03 ACCESSORIES

- A. Leak Detection System
1. Install in strict accordance with the system manufacturer's instructions and recommendations. Leak detection shall be installed with a sensor located in each Chemical Containment Pull Box sump, with all pipe sloping to the Chemical Containment Pull Boxes. The leak detection system shall sound an alarm when a leak event occurs.
 2. Signal wires from the leak detection sensor shall terminate in an adjacent terminal cabinet and shall then be connected to the local leak detection output panel. Contact with any aqueous chemical shall result in an audible alarm and a LED indication at the leak detection output panel. The local output panel shall be housed in a NEMA 4X enclosure. The leak detection output panel shall be

located directly outside the chemical feed pumping facility where the pipe first penetrates the ground surface. For any miscellaneous control component data see Divisions 16 – Electrical and 17 – Instrumentation. The output relays shall be capable of interfacing with the plant PCS.

B. Centering Devices

1. Centering and support carrier pipe within the containment pipe with centering devices. Locate not less than every 9 feet or within 24 inches of the termination of the containment pipe on all fabricated pieces.
2. Install centering devices such that the system maintains free drainage.

2.04 SPARE PARTS

- A. All special tools, solvents, lubricants, and cements required for normal installation shall be furnished with the pipe.

2.05 QUALITY CONTROL

- A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install double wall containment pipe where shown on the Drawings and in strict accordance with the manufacturer's technical data and printed instructions.
2. All piping shall have sufficient number of unions to allow convenient removal and shall be as approved by the Engineer.
3. All valves and equipment shall be supported independently from the pipe. Anchor valves such that the turning moment resulting from their operation will not be transmitted to the pipe.

B. Installation of PVC Piping, Schedule Type:

1. Joints for double wall containment pipe and fittings shall be solvent welded. All joints shall be made watertight. All pipe cutting and jointing procedures for solvent welded pipe joints shall be in strict accordance with the pipe and fittings manufacturer's printed installation instructions. In making solvent welded connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth, if necessary and apply solvent cement of proper grade.

2. Installation of valves and fittings shall be strictly in accordance with the manufacturer's instructions. In making solvent weld connections the solvent shall not be spilled on valves or allowed to run from joints.
3. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and the Contractor shall verify their locations from approved piping layout Drawings and the structural Drawings.

C. Installation of Flexible Non-Metallic Tubing and Fittings:

1. Install small bore flexible tubing in accordance with manufacturer's printed instructions, in neat straight lines, supported at close enough intervals to avoid sagging, and in continuous runs wherever possible.
2. Bundle tubing in groups of parallel tubes within protective sheath.
3. Tubes within protective sheath may be color coded, but protect tubing other than black outside the sheath by wrapping with black plastic electrician's tape.
4. For buried tubing in chemical service, tubing shall be installed in Schedule 80 PVC carrier pipe to serve as double containment. Requirements are as follows:
 - i. Carrier pipe shall utilize long radius elbows to facilitate pulling of tubing.
 - ii. Carrier pipe system shall run through H-20 precast vault structures in the yard, watertight (cast with waterstops), and no smaller than 4-feet by 4-feet by 4-feet deep, unless otherwise shown on the drawings, with an H-20 rated access hatch.
 - iii. Leak detection sensor shall be Flowline Switch-Tek Optic Leak detection switch, Model L010-2305, or equal. Sensor shall be installed in the Chemical Containment Pull Box sump using a side-mount bracket.
 - iv. Drain valves (Type BV320) for each carrier pipe shall also be installed in the vault to allow for draining of accumulated chemicals.
 - v. Tubing shall be coiled inside each box to account for expansion and contraction. Coil radius shall be kept larger than the tubing manufacturer's recommended minimum radius.

D. Field Painting:

1. Pipe normally exposed to view shall be painted and marked as specified in Section 15015 – Identification for Process Piping and Valves.

3.02 INSPECTION AND TESTING

- A. All PVC piping shall be hydrostatically pressure tested and flushed in accordance with the requirements in Section 15014 – Pressure Testing of Piping.
- B. Following installation and testing:
 - 1. Flush clean the carrier and containment piping system.
 - 2. Purge the annular space of moisture with clean, dry air.

3.03 START-UP AND INSTRUCTION

- A. Provide manufacturer’s representative to assist with the unloading of the double wall containment piping system, system tests, containment pipe joint closure, installation and testing of the leak detection system, and training of owner’s personnel in the operation and maintenance of the leak detection system. Manufacturer’s representative shall complete a Manufacturer’s Certificate of Proper Installation. Inspection and examination practices shall be according to ASME B31.3-93 for normal fluid service.

END OF SECTION

SECTION 15080**DISINFECTION OF WATER SYSTEMS****PART 1 GENERAL**

- A. This specification indicates requirements of the program disinfection plan and communicates associated responsibilities of the CONTRACTOR.

1.01 PIPELINE AND PROGRAM DISINFECTION PLAN

- A. Disinfect the facilities conveying potable water to comply with the standards for potable water of the regulatory agency of jurisdiction. Potable water is defined as any water that has been filtered, disinfected or otherwise treated to the meet regulatory standards.
- B. Disinfect piping systems that are used to convey water, solutions, or chemicals to the potable water facilities.
- C. Test water from the disinfected system per regulatory standards to verify that water is acceptable. Repeat procedure if tests do not meet standards.

1.02 CONTRACTOR REPONSIBILITIES

- A. The CONTRACTOR responsibilities will include:
 - 1. Coordinating with SAWS to introduce water from existing pipelines.
 - 2. Coordinating to add sufficient disinfectant into the pipeline at that point and along the pipeline as needed to disinfect using the slug method.
 - 3. Select, provide, install, use, maintain, move, reuse, and remove up to 500 LF of temporary piping during disinfection and disposal operations.
 - 4. Direct valve and appurtenance operations needed to achieve and complete the disinfection process.
 - 5. Obtain all samples needed in accordance with regulatory requirements and these contract documents. Document and maintain sample chain of custody throughout the process.
 - 6. Direct valve operations and maintain pressure on the pipeline throughout and residual disinfectant to maintain potable water status of the pipeline upon receipt of passed bacteriological test results.

1.03 REFERENCES

The following is a list of standards which may be referenced in this section:

- A. American Water Works Association (AWWA):

1. B300, Hypochlorites
 2. B301, Liquid Chlorine
 3. B303, Sodium Chlorite
 4. C651, Disinfecting Water Mains, Dechlorination
 5. C652, Disinfection of Water Storage Facilities
- B. Standard Methods for the Examination of Water and Wastewater, as published by the American Public Health Association, American Water Works Association, and the Water Environment Federation.

1.04 SUBMITTALS

- A. A Disinfection Plan, to include procedures and plans for the disinfection and testing of all segments of the pipeline, inclusive of drains, lateral piping, connections, and related appurtenances. Sample site locations shall be identified. Plan shall be signed by the person responsible for performing and coordinating the work, and shall be submitted to SAWS for approval.
- B. Type of pipeline disinfecting solution and method of preparation.
- C. Method of disposal for highly chlorinated disinfecting water.
- D. A water supply plan for disinfection. Confirm understanding of where and how water will be obtained, how much will be needed, how it will be accounted for and how connections will be made to fill and disinfect all pipeline segments.
- E. Submit proposed arrangement of temporary piping and appurtenances including pressure sustaining valves (if any), backflow prevention, and fittings.
- F. Certification that employees working with concentrated chlorine solutions or gas have received appropriate safety training.

PART 2 PRODUCTS

2.01 WATER FOR DISINFECTION

- A. Clean, uncontaminated and potable.
- B. To facilitate a Program Disinfection Plan, it is SAWS intent to make water available to the CONTRACTOR. CONTRACTOR shall coordinate with SAWS for the source. The CONTRACTOR shall account for all water obtained from SAWS as described in SAWS Standard Specification Item No. 906 Water Use Accountability (www.saws.org). The CONTRACTOR is required to provide SAWS with a written 30-day notice prior to obtaining water for disinfection. The CONTRACTOR is advised that water availability may have limitations subject to SAWS operational needs. Testing requirements shall conform to Section 15085.

2.02 MATERIALS

PROGRAM DISINFECTION CONTRACTOR.

- A. Liquid Chlorine: Meeting the requirements of AWWA B301.
- B. Delivery Storage and Handling.
 - 1. Chlorination and dechlorination shall be performed by competent individuals knowledgeable and experienced in the operation of the necessary application and safety equipment in accordance with applicable Federal, State and Local laws and regulations. The transport, storage and handling of these materials shall be performed in accordance with Code of Federal Regulations (CFR) 1910.120 Hazardous Waste Operations and Emergency Response, CFR 49.172 Hazardous Materials Regulations. Storage location of chemicals on site shall be approved by SAWS.

2.03 CONTRACTOR'S EQUIPMENT

PROGRAM DISINFECTION CONTRACTOR shall:

- A. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection. CONTRACTOR shall provide all necessary valves, piping, backflow prevention devices, pressure sustaining valves, fittings, and any other appurtenances to convey disinfection water to the pipeline at NSPI including any equipment, piping and appurtenances to facilitate disposal of any water from the pipeline to facilitate disinfection.
- B. Provide protection as required by AWWA C651 05, Disinfecting Water Mains, Section 4.3.9 against cross-connections.

PART 3 EXECUTION

- A. CONTRACTORS shall perform preparation, disinfection, and associated work in accordance with their identified roles and as indicated below.

3.01 GENERAL

In accordance with contractor roles and responsibilities described herein, the following items further describe required work:

- A. Cleaning and disinfection procedures shall conform to AWWA C651 05, Disinfecting Water Mains and this Specification.
- B. Clean and disinfect the following items installed or modified under this project, intended to hold, transport, or otherwise contact potable water:
 - 1. Pipeline, beginning of project to end of project, inclusive of all appurtenances and connecting outlets.
 - 2. During construction keep basins, pipe, fittings, equipment, and appurtenances free from dirt and debris.

3. Seal the open ends of pipe with water-tight plugs when pipe is not being laid.
 4. Pump water from trenches before removing the plug when water accumulates in the trench.
- C. Wash the surfaces to be disinfected, including unclean pipe walls, valve components, and other surfaces that will be in contact with potable water.
- D. Pipelines: clean and disinfect new pipelines that connect to existing pipelines up to point of connection.
- E. Disinfect surfaces of materials that will contact finished water, both during and following construction. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.
- F. Prior to application of disinfectants, clean pipelines of loose and suspended material. Use water suitable for flushing and disinfecting.
- G. Conform to AWWA C651 for pipes and pipelines, except as modified in these Specifications.
- H. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so that chlorine-water solution is at specified strength. Do not place concentrated commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

3.02 SEQUENCING AND SCHEDULING

- A. Commence disinfection after completion of following:
1. Completion and acceptance of pipeline installation and thorough cleaning.
 2. Pneumatic testing, hydrostatic testing, pressure testing, and acceptance of pipelines.

3.03 PIPELINES

- A. Flushing (for pipelines smaller than 24-inch diameter, prior to disinfection):
1. Before disinfecting, flush all foreign matter from pipe in accordance with AWWA C651. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties.
 2. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections.
 3. Operate valves during flushing process at least twice during each flush.
 4. The minimum quantity of water used for flushing must exceed the capacity of the line to insure that clean water has traversed the entire length of the pipe.

5. Disinfection can then be performed in accordance with AWWA C651, unless herein modified.
 6. Restore and repair areas damaged by any flushing operations
- B. Cleaning (for pipelines larger than 24-inch diameter):
1. For pipelines larger than 24-inch diameter, CONTRACTORS shall clean all pipe in by broom sweeping and then removing all debris from sweeping.
 2. Cleaning and Disinfection shall be performed in accordance with AWWA C651-99 Paragraph 4.4.3.2.

3.04 DISPOSAL OF WATER AND HEAVILY CHLORINATED WATER

- A. The CONTRACTOR shall dispose of water and heavily contaminated chlorinated water by providing temporary piping and connections and discharging “de-chlorinated” water per the approved Disinfection Plan.
- B. If necessary, the CONTRACTOR shall notify federal, state, and local regulatory agencies to determine if any special procedures or permits are required for disposal of water used for pipeline testing and cleaning and to identify acceptable locations for disposal of the water. Such effort shall be documented and provided to the OWNER for the file in advance of any discharge. All requirements and costs associated with notifications and obtaining any discharge permit or approvals shall be responsibility of the CONTRACTOR. In addition to complying with any federal, state, or local requirements regarding water disposal, following completion of testing, the CONTRACTOR shall dispose of water in a manner acceptable to the OWNER.
- C. Prior to disposal, chlorinated water must be “de-chlorinated” to eliminate adverse impacts to the surrounding environment. Water released to the environment shall meet all AWWA, EPA, and TCEQ regulatory requirements.
- D. CONTRACTOR shall take care when disposing of water to assure the disposal location can handle the flow without damage, and that there will be no adverse impacts downstream. Damage caused downstream due to disposed water will be the responsibility of the CONTRACTOR to remedy at no expense to OWNER.
- E. The use of the sanitary sewer system for disposal will not be allowed. This section shall conform to Section 15085 – Water Pipeline Testing.
- F. Valves shall be manipulated by the CONTRACTOR so that the strong chlorine solution in the main being treated will be flushed out of the main and will not flow back into the main supplying the water.
- G. See the appendix of AWWA C651 for acceptable neutralization methods.
- H. CONTRACTOR shall monitor, track, and estimate all flows being disposed, and provide a report to the OWNER.

3.05 TESTING

- A. OWNER shall collect all samples and perform chlorine and bacteriological testing.
- B. After the completion of all hydrostatic testing and completed the tie-ins, the CONTRACTOR will disinfect the pipeline, take water samples and have them analyzed for conformance to bacterial limitations for public drinking water supplies and other requirements of the regulatory agency of jurisdiction for potable water. The CONTRACTOR will monitor the system for two (2) days. CONTRACTOR shall witness testing to assure compliance with these specifications and regulatory requirements.
- C. If any samples required above are bacterially positive, disinfecting procedures and bacteriological testing shall be repeated until bacterial limits are met, at no additional cost to the OWNER.

END OF SECTION

SECTION 15082**PROCESS PIPING INSULATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 15 - Mechanical
- C. Division 16 – Electrical for Heat Trace requirements.

1.02 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for work performed under this Section. Include the cost for this work in the lump sum Base Bid.

1.03 DESCRIPTION OF WORK

- A. Extent of thermal and mechanical insulation required by this section is indicated on Drawings and/or schedules, and by requirements of this Section.
- B. Types of mechanical insulation specified in this section include the following.
 - 1. Piping Systems Insulation
 - 2. Fiberglass.
 - 3. Cellular Glass.
 - 4. FOAMGLAS
- C. Refer to Sections 09900 – Paintings and Coatings
- D. Refer to Division 15 - Mechanical

1.04 QUALITY ASSURANCE

- A. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulation similar to that required for this project.
- B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame spread index of 25 or less, and smoke developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
 - 1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation in accordance with Section 01300 – Submittals. Submit schedule showing manufacturer's product number, k value, thickness, and furnished accessories for each mechanical system requiring insulation.
- B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation per Section 01730 – Operations and Maintenance Data. Include this data and product data in maintenance manual.
- C. Provide a schedule of all systems that are to be insulated and or heat traced, indicating all pertinent details for each system, each pipe size, etc.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site. Do not install insulation.

PART 2 PRODUCTS**2.01 ACCEPTABLE MANUFACTURERS**

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following.
 - 1. Armstrong World Industries, Inc.
 - 2. Certainteed Corp.
 - 3. Knauf Fiber Glass GmbH.
 - 4. Owens Corning Fiberglas Corp.
 - 5. Pittsburgh Corning Corp.
 - 6. FGH Fabricators, Inc. KoolPhen K Phenolic Foam Insulation.
- B. Adhesives shall be as manufactured by Minnesota Mining, Arabol, Benjamin-Foster, Armstrong, or Insulmastic, Inc., and shall have the same adhesive properties, fire rating, vapor seal, etc., as the types specified herein, subject to review by the Engineer.

2.02 PIPING INSULATION MATERIALS

- A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated. (Indoor locations)
- B. Cellular Glass Piping Insulation: ASTM C 552, Type II, Class 2.
 - 1. Pipe and Round Duct Insulation: (Outdoor locations) FOAMGLAS® insulation as manufactured by Pittsburgh Corning Corporation (7.5 lbs per cf density and thermal conductivity of 0.29 BTU in./hr. ft²•°F @ 75°F) 2-inch minimum thickness or Belform Koolphen K phenolic foam (2.2 lbs per cf density and thermal conductivity of 0.13 BTU in./hr. ft²•°F @ 75°F) 1-inch minimum thickness.
- C. Flexible Unicellular Piping Insulation: ASTM C 534, Type I.
- D. Jackets for Process Piping Insulation: ASTM C1767 - 13a Type II shall be used for all piping temperatures above and below ambient.
- E. Encase pipe fittings insulation with one piece pre-molded 16 MIL Type 316 stainless steel fitting covers, fastened as per manufacturer's recommendations.
- F. Encase exterior piping insulation with 16 MIL Type 316 stainless steel jacket with "Z" closures for weather proof construction.
- G. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.
- H. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated. White all service jacket "ASJ" vapor barrier with dual self-seal strips for all insulation except flexible unicellular.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer. As a minimum the surface to be installed shall be clean, dry and above the ambient air dew point before and during insulation application.

3.02 PROCESS PIPING SYSTEM INSULATION

- A. Insulation Omitted: Omit insulation on chrome plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.
- B. Process piping – Insulate all process piping, exposed to outdoor temperatures, 6-inches and smaller. Provide heat trace where shown on mechanical and/or electrical Drawings. Provide insulation for interior locations where indicated on the Drawings.

1. Insulate each piping system specified above with one of the following types and thicknesses of insulation for indoor applications.
 - a. Fiberglass: 1" thickness.
 - b. Cellular Glass: 2" thickness.
- C. Provide jacketing per Part 2.02 E.

3.03 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- H. Piping insulation on the fire protection riser pipe and valves shall be covered with 0.02" thick smooth aluminum jacket utilizing longitudinal "zee" closures. Jacket shall be secured at both joints with 2" wide aluminum straps containing permanently plastic sealant. Straps shall be centered over butt joints of jackets. Provide 1/2" wide aluminum bands applied on 12" centers.

END OF SECTION

SECTION 15085**WATER PIPELINE TESTING****PART 1 GENERAL****1.01 SCOPE OF WORK**

- A. This Section covers field pipeline cleaning and hydrostatic pressure and leakage testing of all water piping and valves installed under this Contract. The term "piping" shall be used in this Section to refer to piping systems, pipelines, or sections thereof.

1.02 GENERAL REQUIREMENTS

- A. The CONTRACTOR shall furnish all labor, materials, equipment, and incidentals to perform flushing, cleaning, pressure, and/or leakage testing of all pipeline segments and appurtenant piping in accordance with the Contract Documents.
- B. The CONTRACTOR shall be responsible for coordinating testing and providing adequate and safe access to all pipeline segments.
- C. The Owner shall be present during testing and shall be notified of the time and place of testing at least three (3) days prior to commencement of testing. All testing shall be performed to the satisfaction of Owner and in accordance with all governing standards and regulations.
- D. The CONTRACTOR shall be responsible for furnishing the water for filling, depressurizing and testing the piping, including makeup water. Potential sources of water are identified in this Section.
- E. Unless otherwise permitted, during testing, the water shall be kept out of the remainder of the piping not being tested.
- F. As a conservation measure, the water shall be collected for reuse in subsequent testing.
- G. CONTRACTOR shall notify federal, state, and local regulatory agencies to determine if any special procedures or permits are required for disposal of water used for pipeline testing and cleaning and to identify acceptable locations for disposal of the water. All requirements and costs associated with notifications and obtaining any discharge permit or approvals shall be responsibility of CONTRACTOR. In addition to complying with any federal, state, or local requirements regarding water disposal, following completion of testing, CONTRACTOR shall dispose of water in a manner acceptable to Owner.
- H. For air and other testing of gasketed and other joints as applicable, refer to the associated pipe specification.

1.03 RELATED WORK

- A. Section 01300 – Submittals
- B. Division 15 – Mechanical
- C. OWNER Standard Specifications for Construction, Item No. 841.

1.04 SUBMITTALS

- A. A testing schedule, including proposed plans for water source and conveyance, control, and disposal shall be submitted in accordance with Section 01300 - Submittals in writing for acceptance a minimum of 10 work days before each test is to start. The schedule shall indicate the proposed time and sequence of testing of the piping.
- B. Written pressure, and leakage test procedures, required pipeline appurtenances, and testing personnel qualifications. The test procedures shall establish the limits of the piping to be tested, the positions of all valves during testing, the locations of temporary bulkheads, and all procedures to be followed in performing the testing.
- C. Certified test reports documenting the results of the hydrostatic pressure and leakage tests.
- D. Testing Records: Provide a record of each piping installation during the testing. These records shall include: Date of test; Identification of pipeline tested or retested; Identification of pipeline material; Identification of pipe specification; test fluid; test pressure and Signature of Owner's representative witnessing pipe test.
- E. Gauges and water meter calibration reports.
- F. Provision for disposal of flushing and test water.

PART 2 PRODUCTS**2.01 GENERAL**

- A. Testing fluid shall be clean water for all piping except air service and shall be of such quality to prevent corrosion of materials in piping system for all hydrostatic tests.
- B. Makeup water is defined as the quantity of water required to be pumped into the newly laid pipe, or any valved section of it, necessary to maintain the specified test pressure after the pipe has been filled with water and the air expelled.

2.02 TEST EQUIPMENT

- A. All necessary connections between the piping to be tested and the water source, together with pumping equipment, water meter, pressure gauges, backflow prevention and all other equipment, materials, and facilities required to perform the specified tests, shall be furnished by the CONTRACTOR. All required blind flanges, valves, bulkheads, bracing, and other sectionalizing devices shall also be provided. The CONTRACTOR shall use temporary bulkheads, which shall be removed upon completion of testing. The removal

of the temporary bulkheads shall be performed in a manner to minimize damage to the cement mortar lining and tape coating systems. The CONTRACTOR may use an air gauger and a skip method of cutting to remove the temporary bulkheads or any other bulkhead removal method as recommended by the pipe manufacturer. Vents shall be provided in test bulkheads where necessary to expel air from the piping to be tested. No materials shall be used which would be injurious to the construction or its future function.

- B. Test pressures shall be applied by means of a force pump sized to produce and maintain the required pressure without interruption during the test.
- C. The water necessary to maintain the test pressure shall be measured through a water meter satisfactory to the Owner.
- D. Water meters and pressure gauges shall be accurately calibrated and shall be subject to review and acceptance by the Owner.
- E. Pressure gauges shall be ANSI/ASME B40.1, Grade 1A and shall meet or exceed the test pressures specified in this Section. Pressure gauges shall be calibrated to an accuracy of plus or minus 1 percent minimum over the entire range of the gauge. The gauges shall be laboratory bench tested for accuracy just prior to field testing.
- F. Permanent gauge connections shall be installed at each location where test gauges are connected to the piping during the required tests. Field drilling and tapping of pipe walls will not be permitted. Upon completion of testing, each gauge connection shall be fitted with a removable plug or cap acceptable to the Owner.
- G. Permanent or temporary fill and vent connections shall be installed as needed for the required test. Drilling and tapping of pipe walls will not be permitted. Upon successful completion of testing, each permanent fill and vent connection shall be fitted with the permanent fill or vent piping, and each temporary fill and vent connection, if used, shall be fitted with a permanent sealed plug or cap acceptable to the Owner.

2.03 WATER FOR TESTING

- A. Water for CONTRACTOR's use for pipeline filling, testing, and cleaning shall be provided by Owner. Contractor shall be responsible for coordinating with SAWS Inspector for use of Owner provided water.

PART 3 EXECUTION

3.01 GENERAL

- A. The CONTRACTOR may test the pipeline in sections when all the pipe in a particular section has been completely backfilled and in place for at least 14 days. Associated restrained joint piping shall also be complete prior to testing.
- B. Unless otherwise acceptable or indicated in the Contract Documents, during testing of the pipeline, all valves shall be in the open position and temporary bulkheads shall be provided so that the test pressures are not applied to existing or new closed valves and hydrants, or to existing water lines, or to any portion of water lines installed under this Contract that have already been put into service.

- C. Prior to testing, place temporary bulkheads in the pipe and fill the line slowly with water. Care shall be taken to ensure that all air release valves and vents are properly installed and in the open position during the filling. Hand operated vent valves shall not be closed until an uninterrupted stream of water is flowing from each valve. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the air valves. Filling shall be at a reasonable velocity and all the air within the pipeline shall be properly purged. In no case shall the filling rate result in a flow velocity of more than 0.5 foot per second as measured using the full cross-sectional area of the pipe.
- D. After the line or section thereof had been completely filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the lining to absorb what water it will and to allow the escape of air from any air pockets. During this period, the bulkheads, valves, manholes, and connections shall be examined for leaks. If any are found, these shall be repaired.
- E. Piping shall be adequately anchored and supported before the test pressure is applied.
- F. During filling and testing, the CONTRACTOR shall monitor the pipeline alignment for signs of leaks. If leaks are found, the testing shall be halted until the leaks are repaired. Water damage due to testing operations shall be corrected at the CONTRACTOR's expense including leakage, runoff and erosion to areas outside of the pipeline easement or leakage that may cause damage to installed facilities. The CONTRACTOR shall maintain equipment on site, including earthmoving equipment, to mitigate and repair any damage from leaks.
- G. CONTRACTOR shall furnish all necessary equipment and make tests at no additional cost to the Owner.
- H. Test Pressure:
 - 1. All pipe shall be tested at the pressures shown in Table 15085-A and on the contract drawing D-002. If not listed in the Table, the minimum test pressure shall be 1.5 times the normal working pressure of the pipe. The normal working pressure shall be as shown on the contract drawings D-002.

3.02 PIPELINE CLEANING

- A. The CONTRACTOR is required to keep the pipe interior free of all debris. The CONTRACTOR shall completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying, grouting of joints and any necessary interior repairs prior to testing the completed pipeline. The CONTRACTOR shall clean by broom sweeping or other means that will not destroy or damage the inside lining and joint protection system as recommended by the pipe manufacturer and accepted by the Owner. See Owner's Standard Specifications for Construction Item No. 841 for pipe flushing requirements and procedures.

3.03 HYDROSTATIC PRESSURE AND LEAKAGE TESTS

- A. See SAWS's Standard Specifications for Construction Item No. 841 for Hydrostatic Pressure Test requirements and procedures.

- B. Water Reuse. Upon successful completion of tests for the first section(s) of the pipe, the CONTRACTOR shall reuse the remaining available water in addition to the required amount of makeup water to test subsequent sections along the pipeline. This procedure shall be repeated until each section within the pipeline has successfully passed both (hydrostatic and leakage) tests.
- C. Valve Pressure Test. Pressure test valves, as installed in the field, and adjust valves as necessary for drip-tight performance. Valves shall be tested with pressure equal to the pressure class of the valve or pipeline hydrostatic test pressure, whichever is less. Test pressure shall be applied to each side independently, and the valve tested for drip-tight performance with zero pressure on the other side of the valve. Provisions satisfactory to the Owner shall be made for verifying "0" leakage within the duration of the test. Test duration shall be two (2) hours plus any additional time required by the Owner for examination. If pressure class of valve is less than the pipeline hydrostatic test pressure at the valve location, the valve shall then be opened for the pipeline hydrostatic test.
- D. Leakage Test Procedure. Following completion of hydrostatic pressure testing and acceptance by Owner, the piping shall be subjected to a leakage test.
1. The duration of the leakage test shall be two (2) hours plus the additional time required for the Owner to make an accurate determination of leakage.
 2. The hydrostatic pressure maintained during the leakage test shall be at least 75 percent, but not more than 100 percent, of the pressure specified for pressure testing of the piping and shall be maintained within plus or minus 5 psi during the entire time that leakage measurements are being performed.
 3. Measurement of leakage shall not be attempted until all trapped air has been vented and a constant test pressure has been established. After the pressure has stabilized, piping leakage shall be measured with a suitable water meter installed in the pressure piping on the discharge side of the force pump.
 4. The term "leakage", as used herein, refers to the total amount of makeup water which must be added into the piping during the leakage test to maintain the test pressure.

3.04 ALLOWABLE LEAKAGE

- A. During hydrostatic and leakage tests, no leakage will be allowed for sections of piping or water mains consisting of welded joints.
- B. No piping will be accepted if and while it exhibits a leakage rate in excess of that determined by the indicated formula:

$$Q = [0.00135]DLN \text{ (using inch-pound units)}$$

Where

Q = allowable leakage in gallons per hour

D = nominal diameter of pipe in inches

L = length of section tested in thousand feet

N = square root of weighted average test pressure in pounds per square inch

The weighted average test pressure shall be equivalent to the arithmetic difference between the specified test pressure plane elevation in feet and the average elevation of the pipeline in feet, multiplied by 0.433 to obtain psi. The weighted average elevation of the pipeline shall be calculated by (1) breaking the pipeline into sections at each significant change in slope and multiplying the average elevation of each section by the length of each section, (2) then summing the products, and (3) dividing the sum by the total length of the pipeline.

Example: What is the maximum allowable leakage for the 1 mile (5,280 LF) of 54" diameter pipe with gasketed joints tested 2 hours at a weighted average test pressure of 270 psi:

Answer: $Q = 0.00676 \text{ DLN}$
 $Q = 0.00676 (54 \text{ in}) (5.28 \text{ thousand LF}) (270 \text{ psi})^{0.5}$
 $Q = 31.67 \text{ gallons per hour,}$

For 2 hours the total maximum allowable leakage is then 2 hrs x 31.67 gal/hr = 63.34 gallons.

- C. The allowable leakage shall be calculated based on the actual length of pipeline being tested. Whenever the piping to be tested contains pipe of different diameters, the allowable leakage shall be calculated separately for each diameter and the corresponding length of piping. The resulting allowable leakage rates shall be added to obtain the total allowable leakage for the pipeline section being tested
- D. All pipelines and directly connected appurtenant piping shall have no visually detectable leakage and shall not exceed the maximum allowable leakage during the test period. If leakage is detected by testing or by visual inspection, determine the cause of the leakage, take corrective measures necessary to repair the leaks, and again test the pipelines until satisfactory results are obtained at no additional cost to the Owner. A successful "passed" test shall be defined as a test where the amount of water required to be pumped into the piping to maintain the leakage test pressure for the specified duration is less than or equal to the specified allowable leakage.
- E. All joints in piping shall be free from visible leaks during the leakage test. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of CONTRACTOR regardless of the amount that the total leakage may have been below the specified allowable leakage rate during the leakage test.
- G. Pipelines that fail to pass the specified leakage test will be considered defective Work, and the CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall retest the pipeline.

3.05 DISPOSAL OF WATER

- A. After the final section in each pipeline segment has been successfully tested, the CONTRACTOR shall reuse the test water in the next pipeline segment or shall discharge the test water in a manner that will not cause erosion to areas outside of the pipeline easement or damage to installed facilities. The velocity of pipeline drainage for the carrier pipe shall not exceed 0.5 ft/s. Draining shall be controlled by locating an orifice plate to be designed by the CONTRACTOR in the 12-inch section of the drain pipe prior to discharge.
- B. At the CONTRACTOR’s option, the hydrostatic test water may be disposed of by the following methods:
 - 1. Discharging to local drainage ditch, creek, stream, river, or other surface water body.
- C. If CONTRACTOR selects the first option, he/she must comply with general permit number TXG670000 from the Texas Commission on Environmental Quality (TCEQ) for discharges of hydrostatic test water into or adjacent to waters of the state. CONTRACTOR shall submit a notice of intent to the TCEQ unless the following exemptions to the permit for new facilities (TAC 30 Part 1 Chapter 321 Subchapter G Rule 321.103) are met:

- 1. The discharge meets the following effluent criteria:

Maximum Discharge Effluent Concentrations	
<u>Constituent</u>	<u>Daily Maximum Limit (mg/l)</u>
Chemical Oxygen Demand	250.00
Total Organic Carbon	85.00
Oil & Grease	15.00
Chlorine	0.10

- 2. Water used for the hydrostatic test does not contain corrosion inhibitors, anti-freeze compounds, or other chemical additives.
- 3. The discharge is controlled at a rate to prevent flooding and/or erosion of the discharge area.
- 4. The discharge does not cause any nuisance conditions to adjacent land owners along the discharge route.
- D. The TCEQ requires that one grab sample be taken during the first hour and last hour of discharge to analyze water quality. Owner will be responsible for collecting and testing the grab samples in accordance with Standards Methods for the Examination of Water and Wastewater. CONTRACTOR shall notify Owner at least three (3) days prior to the start of discharge of water.
- E. CONTRACTOR shall be responsible for complying with any other Federal, State, or local requirements regarding water disposal, including notifications and any discharge permit or approvals that may be required.

TABLE 15085-A
PIPING PRESSURE TEST SCHEDULE

Service	Label	Test Pressure (psig)
LA ROSA PUMP STATION		
Potable Water	PW	225
Pump Discharge Piping (VTP discharge flange to motorized ball valve	PW	275

END OF SECTION

SECTION 15090**COMMON REQUIREMENTS FOR PROCESS VALVES****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Valves.
 - 2. Valve actuators.
 - 3. Operators.
 - 4. Valve boxes

- B. Related Requirements:
 - 1. Division 3 – Concrete
 - 2. Division 5 – Metals
 - 3. Division 9 - Finishes
 - 4. Division 15 – Mechanical
 - 5. Division 16 - Electrical

1.2 REFERENCE STANDARDS

- A. American Water Works Association:
 - 1. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
 - 2. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.
 - 3. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

- B. ASTM International:
 - 1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
 - 2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

- C. Manufacturers Standardization Society:
 - 1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges, and Unions.

- D. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

- E. NFPA:
 - 1. NFPA 70 - National Electrical Code (NEC).

- F. NSF International:
 - 1. NSF 61 - Drinking Water System Components - Health Effects.
 - 2. NSF 372 - Drinking Water System Components - Lead Content.
- G. UL:
 - 1. Equipment Directory.

1.3 COORDINATION

- A. Section 01300 - Submittals: Requirements for coordination.
- B. Coordinate Work of this Section with piping, equipment, and appurtenances.

1.4 PREINSTALLATION MEETINGS

- A. Section 01200 – Project Meetings: Requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

- A. Section 01300 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
 - 1. Submit manufacturer information for actuator with model number and size indicated.
 - 2. Submit valve cavitation limits.
- C. Shop Drawings: Indicate parts list, materials, sizes, position indicators, limit switches, control system, bill-of-materials showing kind and class of materials, actuator mounting, wiring diagrams, control system schematics, and miscellaneous components.
- D. Certified shop drawings shall include the principal dimensions, general construction and material specification of the valve proposed. The number of turns to open (close) shall be clearly noted in the valve information submitted with the proposal documents. The number of turns to open or close the valve shall be consistent for each valve size for each approved manufacturer.
- E. For each type and model of valve and actuators provide the following:
 - 1. Assembly instructions and spare parts list.
 - 2. Preventative/corrective maintenance instructions.
 - 3. Certificate of seat exposure with entailed fluid exposure.
- F. Erection Drawings: Erection drawings shall include the procedures to be used in setting, supporting, and anchoring the valves, the fitting of the line pipe to the valves for proper coupling, and for adjusting and testing all valve assemblies.

- G. Valve-Labeling Schedule: Indicate valve locations and nametag text.
- H. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- I. Certification of Valves Larger than 12 Inches (305 mm): Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.
- J. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for sizing of control valves.
- K. Manufacturer Instructions: Submit installation instructions and special requirements.
- L. Source Quality-Control Submittals: Indicate results of shop tests and inspections.
- M. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.
- N. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.
- O. Design calculations shall be signed and sealed by a registered professional engineering in the State of Texas.
- P. Qualifications Statement:
 - 1. Submit qualifications for manufacturer and licensed professional.

1.6 CLOSEOUT SUBMITTALS

- A. Section 01700 – Contract Closeout
- B. Project Record Documents: Record actual locations of valves and actuators.

1.7 QUALITY ASSURANCE

- A. Maintain clearances as indicated on Drawings.
- B. Ensure that materials of construction of wetted parts are compatible with process liquid.
- C. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.
- D. All valves, actuators and miscellaneous components shall be new, free from defects or contamination, and wherever possible shall be the standard product of the manufacturer.

1.8 SOURCE QUALITY CONTROL

- A. Section 01400 - Quality Control: Requirements for testing, inspection, and analysis.

- B. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.
- C. Certificate of Compliance:
 - 1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
 - 2. Specified shop tests are not required for Work performed by approved manufacturer.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.
- B. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Texas.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 - Material and Equipment.: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.
 - 3. Provide additional protection according to manufacturer instructions.

1.11 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.12 WARRANTY

- A. Section 01700 – Contract Closeout: Requirements for warranties.
- B. Furnish two (2) year manufacturer's warranty for valves and actuators, unless otherwise noted.

PART 2 - PRODUCTS**2.1 VALVES**

- A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required.
- B. All valves shall be provided as shown in the plans, schedules, and as specified herein. Unless otherwise shown or specified, all aboveground valves shall be flanged, screwed, or welded, non-rising stem, and hand wheel operated. Buried valves shall be mechanical joint, non-rising stem, and wrench operated. The valve assemblies shall be furnished complete and adequate for the specified or shown purpose, and shall include all essential components of equipment, together with all mountings and other appurtenances normal and necessary for proper installation, whether shown or not.
- C. Valve Ends: Compatible with adjacent piping system.
- D. All valves shall be installed with joint restraint including reaction blocks and thrust blocking as detailed in SAWS standard drawings for butterfly and gate valve installations. Where applicable a restrained joint pipe may be used, subject to Engineer's approval.
- E. Operation:
 - 1. All valves inside the fence will open left.
 - 2. All valves outside the fence will open right.
 - 3. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.
- F. Valve Marking and Labeling:
 - 1. Marking: Comply with MSS SP-25.
 - 2. Labeling: As specified in valve schedule.

2.2 OPERATORS

- A. General: The operators shall be sized based on the maximum expected torque as per valve manufacturer's recommendations. The responsibility for proper operation shall reside with the valve supplier.
- B. Manual Operators
 - 1. Manual operators for AWWA butterfly valves shall be in compliance with AWWA C504 and shall be quarter-turn traveling nut type actuators. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.
 - 2. Actuators with output torque ratings less than 18,600 ft-lbs shall be of the slotted lever design using centralizing ACME threads. Actuators with output torque ratings greater than 18,600 ft-lbs shall be of the link and lever design.
 - 3. Actuator shall be equipped with a 2 inch cast iron nut requiring a maximum torque of 150 ft-lbs, or a handwheel requiring a maximum of 80 lbs rim pull.
 - 4. Actuator shall be equipped with a bevel gear unit. A three to one (3:1) mechanical ratio to reduce input torque is required for the link and lever design.

5. The actuator housing shall be fully sealed and constructed of ASTM A48 Class 40 gray iron or ASTM A536 Grade 65-45-12 ductile iron. Mounting shall use blind tapped holes to prevent leakage of grease. All fasteners shall be type 316 stainless steel.
6. Actuators shall be equipped with position stops capable of withstanding 450 ft-lbs of input torque. External stop covers shall be sealed with o-rings.
7. Actuators of the link and lever design shall be equipped with adjustable threaded stops secured to the stem with spring pins. Closed stops shall be externally adjustable.
8. Actuators of the link and lever design shall have provisions for installing a lifting eye bolt.
9. Materials:
 - a. Lever shall be ductile iron to prevent fracture from valve vibration.
 - b. Crosshead shall be bronze or aluminum bronze and the stem shall be alloy steel to prevent galling.
 - c. Moving parts shall be lubricated with water resistant, extreme pressure grease.
 - d. Actuator shall be equipped with Teflon-lined, fiberglass-backed sleeve bearings to reduce friction. Link and lever design shall be equipped with thrust ball bearings to absorb the crosshead thrust.
10. For above ground indication, an indicator arrow shall rotate over "OPEN" and "CLOSE" markings on the actuator cover. For buried service, the input shaft shall be stainless steel and the housing shall be 90-percent grease packed.

C. Electric Motor Actuators

1. Manufacturers: Beck or Rotork.
2. Each motor operator includes an electric motor, reduction gearing, and limit controls. Gears totally enclosed in a waterproof and dustproof housing with an integrally cast mounting for the motor, and a separate compartment with removable cover for the limit controls.
3. Provide a strip heater in the compartment.
4. Motor operator designed for use with type of valve called for in the plans.
5. Size motor operator to fully open or fully close the valve in a period of time as indicated in the valve specification.
6. Each unit shall be capable of being operated manually.
7. Provide local control of actuator by a push button station with buttons for OPEN, STOP and CLOSE. Provide red and green indicating lights on the operator, the green light to be lighted with the valve becomes completely opened, the red light when the valve becomes completely closed. Both red and green lights are to be lighted during operation at intermediate positions or when the actuator is stopped in any intermediate position. Control circuits operate on 120 volt, single phase, 60 Hz current, supplied by a suitable control transformer.
8. Provide push button station as a separate enclosure attached to an adjacent structure. Each unit includes a fuse enclosed with the station to protect the actuator. Enclose pushbuttons in a watertight case with a suitable door and latch and without a lock.
9. All contacts and operating parts made of non-corrodible metal.
10. Limit controls for actuators, positive in action and ensuring a tight seating and full openings. Design mechanism to minimize drift or over travel and to open or close valve to a fixed, predetermined point at every operation. Controls disconnect driving mechanism from stem. Controls of either the geared-limit or torque-limit type, but capable of ready adjustment for predetermined limits of opening and closing travel.
11. Operating units fully wired at the factory and furnished complete with terminal strips for external power and control connections which are specified under the appropriate electrical sections.

12. Provide high torque, total enclosed reversing motors of standard make and with grease packed bearings. Motor starting torques equal to 2 1/2 times the running torque. Motor speed not to exceed 1800 rpm.
 13. Motor operates on a 208 volt, three phase, 60 Hz electrical power.
- D. Chain Actuator:
1. Description: Chain guides and hot-dip galvanized operating chain extending to 5-1/2 feet above operating floor level.
 2. Chain Wheels: Sprocket-rim type.
 3. Furnish chain storage if chains may interfere with pedestrian traffic.
- E. Valve Actuators in NEC Class I, Group D, Division 1 or 2 Hazardous Locations: UL approved.

2.3 VALVE BOXES

- A. The CONTRACTOR shall provide cast-iron valve boxes for each buried valve. Each valve box shall be adjustable to fit the depth of cover over the valve and shall be designed to prevent the transmission of surface loads directly to the valve. Valve boxes shall have an interior diameter of not less than 6 inches and shall be coated with a bituminous coating two (2) mils thick. Valve boxes shall be installed to reserve a minimum of fifty (50) percent of the adjustment for future extension. Extension sections shall be cast-iron only. All valve boxes shall be constructed to prevent tipping and rattling.
- B. Boxes shall be a minimum of 3/16 inch thick as manufactured by Western Iron Works, Alamo Iron Works, US Foundry, or approved equal.
- C. All valve boxes installed in paved areas shall be provided with a protective concrete collar as shown in the Contract Drawings.
- D. Cast iron valve box covers shall read "Water - Open Left" for all valves located inside the fenced production area.
- E. Square covers shall be provided for all recycled water main valve boxes.

2.4 INSULATION

- A. As specified in Section 15082 - Process Piping Insulation and as indicated on the drawings.

2.5 PROTECTIVE COATINGS

- A. All interior non-working ferrous surfaces other than stainless steel shall receive an epoxy coating in accordance with this specification. The interior waterway passages of all valves shall be given a shop applied coating system unless provided with a shop applied epoxy coating. The exterior surfaces shall have a coating system equal to the steel pipe exterior coating system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install valves, actuators, extensions, valve boxes, and accessories according to manufacturer instructions.
- B. Valves and valve boxes shall be in true alignment and grade in accordance with the procedures submitted with the shop and erection drawings. All adjustments and operating settings of the valves shall be made in accordance with the procedures and details presented in the erection drawings. All valve boxes and extended bonnets installed in paved areas shall have a concrete collar cast around the box or bonnet once it has been set at proper grade.
- C. Buried valves shall be firmly supported in place by foundations to preclude strain on the pipe connections. The valve boxes shall be checked for centering plumb over the wrench nut to ensure that the box cover is flush with the finished grade. Earth backfill shall be carefully tamped around each valve box on all sides to the undisturbed face of the trench wall. Valves shall have their interiors cleaned of all foreign matter before installation. The valves shall be inspected in opened and closed positions to ensure that all parts are in working condition.
- D. Above ground valves shall be rigidly held in place using supports and hangars as shown in the plans. The stem orientation of valves in elevated piping shall be approved by the Owner for accessibility, but no valve shall have the stem in the downward direction. Saddle type supports shall be provided for all valves located in vaults. Supports shall be of rugged construction providing at least 120 degrees under support for the valve body. All supports shall be anchored to concrete foundations using type 316 stainless steel anchor bolts.

3.2 TESTING

- A. Test for proper alignment.
- B. If specified by valve Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.
- C. Architect/Engineer will witness field testing.
- D. Shop and Laboratory Tests: Perform shop and laboratory tests on valves and appurtenances as follows:
 - 1. Gate Valves: Perform shop tests in accordance with AWWA C500, except no leakage shall occur with design pressure held for one minute.
 - 2. Butterfly Valves: The following applies to all sizes up to 48 inches in diameter:
 - a. Material Tests: Physical and chemical properties tests shall be performed on all material components to be used in the manufacture of butterfly valves in accordance with AWWA C504, including valve seat bearing materials.
 - b. Gear Operator Tests: Manufacturer shall test each model of gear operator and establish torque rating curves in accordance with AWWA C504.
 - c. Performance Tests: Manufacturer shall shop test each butterfly valve for performance, leakage, and hydrostatic pressure in accordance with AWWA C504.

Results of these tests shall be submitted in accordance with Section 01300 – Submittals.

- E. Field Tests: Test all valves and appurtenances for proper operating adjustments and settings and for freedom from vibration, binding, scraping, and other defects. The adequacy of all pipe hangers, pipe supports, and valve supports to meet specified requirements shall be verified. Upon installation all valves shall be field tested hydrostatically for 2 hours in the presence of the Owner.

3.3 COORDINATION WITH INSTRUMENTATION

- A. The CONTRACTOR is responsible to coordinate with Division 17 – Instrumentation regarding the requirements of electric actuated valves, control valves and flow monitoring.

END OF SECTION

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SECTION 15093
CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Check valves of the water tight, wafer style body, 2 through 48 inches.
 2. Small diameter swing check valves are covered in the Small Diameter Valves and Appurtenance section.
- B. Related Requirements:
1. Section 15090 - Common Requirements for Process Valves: Basic materials and methods related to valves commonly used for process systems.

1.2 REFERENCE STANDARDS

- A. American Water Works Association:
1. AWWA C518 – Dual-Disc Swing-Check Valves for Waterworks Service.
- B. ASME International:
1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
 3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
- C. ASTM International:
1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
 3. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
- D. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends.
 2. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

1.3 SUBMITTALS

- A. As specified in Section 15090 - Common Requirements for Process Valves: Submittal requirements for compliance with this Section.

- B. Closure Time Data

1.4 WARRANTY

- A. Furnish five-year manufacturer's warranty for check valves.

PART 2 - PRODUCTS

2.1 DOUBLE-DISK CHECK VALVES

- A. Approved manufacturers
 1. Crane Duo Check II Style G.
 2. Gulf Wafer Check.
 3. APCO Style 9000.
- B. Description:
 1. Suitable for service working pressures as identified in Section 15055 – Steel Pipe. The valve furnished shall have a cast iron ASTM A126 GR.B or Ductile Iron ASTM A536 body. The check valve doors will be aluminum bronze ASTM B148 C95800 or 316 SST with Buna-N seals and standard trim materials for IBBM construction. The valve body shall be wafer style.
 2. Seating shall be resilient and water tight; the seating element shall be Buna-N molded to the body casting.
 3. The valve body will be short face-to-face, dimension to ANSI standards, flangeless.
 4. The check valve doors shall be spring loaded, NORMALLY closed, by means of one or more heavy duty stainless steel torsion springs, flow from the tank shall cause the doors to open, the torsion spring will shut the doors before reverse flow starts and at a point of zero velocity for non-slam closure. The valve spring shall be a torque spring specifically designed for this style valve.
 5. Torsion springs shall be T316 SST. The hinge and stop shaft shall be T316 SST.
 6. Valves shall have a pressure rating adequate to meet the working and transient / test pressures of pipeline where the valve is being installed. The valve is to be clamped between two mating flanges, ANSI B16.5 class 150 unless otherwise noted, which are connected by studs and nuts.
 7. Studs and nuts shall be included and shall be ASTM A193 grade B7 with quantity two (2) 2H nuts.
 8. The valve spring shall be a standard torque spring specifically designed for this style valve.
 9. The valve body shall be equipped with a lift hole and eye bolt for lifting and moving the valve.

10. The approved products must be certified by a manufacturer's registered engineer that they meet this specification and the referenced ASTM Standards.

PART 3 - EXECUTION

- A. As specified in Section 15090 - Common Requirements for Process Valves: Submittal requirements for compliance with this Section.

3.2 INSTALLATION

- A. According to AWWA C518, manufacturer's instructions and as specified in Section 15090 - Common Requirements for Process Valves.

3.3 FIELD QUALITY CONTROL

- A. Inspection:
 1. Inspect for damage to valve lining or coating and for other defects that may be detrimental as determined by Architect/Engineer.
 2. Repair damaged valve or provide new, undamaged valve.
 3. After installation, inspect for proper supports and interferences.
- B. Pressure Testing: As indicated in Section 15055 – Steel Pipe.

END OF SECTION

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SECTION 15101**AWWA BUTTERFLY VALVES****PART 1 GENERAL****1.01 WORK INCLUDED**

- A. Class 150/250 rubber seated butterfly valves, 4-inches through 54-inches. Furnish labor, materials, equipment and incidentals necessary to install butterfly valves. All products furnished shall be in conformance with ANSI/AWWA C504-10 (latest version thereof). All valves and coatings in contact with potable water shall be certified to N.S.F. 61. A proof of design certification shall be provided upon request.

1.02 DEFINITIONS

All definitions are defined according to ANSI/AWWA C504-10.

- A. Actuator: A device attached to the valve for the purpose of rotating the valve disc to an open, closed, or intermediate position; preventing discover travel; and maintaining the disc in any position.
- B. Butterfly Valve: A valve that uses a disc rotatable through an angle of approximately 90 degrees as a closure member. The valve is closed when the disc is perpendicular to the flow way, open when parallel to the flow way, or used for throttling when positioned between open and closed.
- C. Disc: The closure member that is positioned in the flow stream to permit flow or to obstruct flow (depending on closure position) and that rotates through an angle of 90 degrees from full open to full shutoff.
- D. Rubber Seat: A resilient rubber ring that is securely attached to the valve disc or body.
1. Rubber seats attached to the valve body shall consist of a rubber ring around the inside of the valve body that is securely attached to the valve body to affect a seal against the metal seating surface when the disc is closed.
 2. Resilient seats attached to the valve disk shall provide a 360 degrees continuous, uninterrupted seating surface. Seats shall be mechanically retained with a stainless steel retaining ring and stainless steel Nylok cap screws, which shall pass through both the resilient seat and the retaining ring.
 3. The resilient seat's mating surface shall be to a 360 degrees continuous, uninterrupted stainless steel body seat ring. The retaining ring shall be continuous or investment cast with overlapping sections serrated grooves, and shoulders.
 4. Resilient seats shall be field adjustable and replaceable.

1.03 QUALITY ASSURANCE

- A. Manufacturers shall have an ASME or I.S.O. 9001 registered commercial quality system. If on receipt of butterfly valves they are found to be noncompliant, the manufacturer shall replace the defective butterfly valves according to butterfly valve size with a butterfly valve that meets the San Antonio Water System's specifications. The defective butterfly valves will be returned to the manufacturer, freight collect, and the manufacturer shall replace the butterfly valve, freight prepaid. If San Antonio Water System audits, product inspection and performance data review in accordance with these specifications determine excessive butterfly valve non-compliance, the manufacturer will be subject to removal by the Products Standards Committee. If the butterfly valve becomes defective during the manufacturer's specified warranty period a San Antonio Water System quality assurance and manufacturer review will ensue. If the review determines manufacturing non-conformance the manufacturer shall replace the butterfly valve according to size with a butterfly valve that meets the San Antonio Water System's specifications. The defective butterfly valve removed from the field will be returned to the manufacturer, freight collect, and the manufacturer shall replace the butterfly valve, freight prepaid. If the nonconformance product amounts are excessive and result in increased product replacement by San Antonio Water System field staff the manufacturer may be subject to time and material charges.
- B. Acceptable Manufacturers:
1. Mueller Company – Linseal XP
 2. Henry Pratt Company –HP-250II
 3. Henry Pratt (above ground) – 2FII (3” through 20”) and XR-70 (24” through 72”).
 4. Henry Pratt (below ground) – Ground hog (3” through 72”)
 5. DeZurik – BAW
 6. Crispin Multiplex – K-Flo Models 504 and 47
 7. Val-Matic Series 2000
- C. Experience Requirements: The Manufacturer shall have had successful experience in manufacturing tight-closing, rubber-seated butterfly valves for this type service in the sizes indicated. The Manufacturer shall have at least 10 years' experience in the manufacture of valves.
- D. Manufacturer's Representative for Startup and Testing: The Valve Vendor or Manufacturer shall provide the services of a competent manufacturer's representative for an indefinite period of time as required to insure proper adjustment, installation, and operation of the valve.

1.04 SUBMITTALS

Submittals shall be in accordance with Section 01300 – Submittals and Section 15090 – Common Requirements for Process Valves and shall include:

- A. Complete shop drawings in accordance with the requirements of Section 01300 and the General Requirements. In addition, valve manufacturer shall certify in writing that valve design and materials of construction are suitable for the intended service.
- B. Quality Control Submittals:
 - 1. Certificate of Compliance for:
 - a. Electric Operators; full compliance with AWWA C540.
 - b. AWWA service Butterfly Valves; full compliance with AWWA C504.
 - 2. Test and inspection data.
 - 3. Manufacturer's Certificate of Proper Installation.
 - 4. Operation and Maintenance Manual.

1.05 STANDARDS

- A. The applicable provisions of the following standards shall apply as if written here in their entirety:
 - 1. American National Standards Institute (ANSI) Standards:

ANSI B16.1	Cast Iron Pipe Flanges and Fittings
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 - 2. American Society for Testing and Materials (ASTM) Standards:

ASTM A48	Standard Specification for Gray Iron Castings
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276	Standard Specifications for Stainless Steel Bars
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM B148	Standard Specifications for Aluminum Bronze Coatings
 - 3. American Water Works Association (AWWA) Standards:

AWWAC504-10	Standard for Rubber-seated Butterfly Valves
AWWA C550	Standard for Protective Interior Coatings for Valves and Hydrants

PART 2 PRODUCTS

2.01 VALVE CONSTRUCTION

- A. Except as otherwise modified or supplemented herein, AWWA Standard C504-10 or the latest revision thereof, shall govern the design, component material construction, manufacture and testing of all butterfly valves.

- B. The OWNER reserves the right to limit the purchase of Butterfly valves from manufacturers and to the models specified, provided such butterfly valves conform to the provisions contained herein.
- C. The valve shall be rated for the maximum working pressure identified in Table 1 of Section 15055 – Steel Pipe. Tight shutoff pressure rating of the valve with pressure applied in either direction. All valves shall have a maximum upstream line velocity rating according to the table listed below unless specified otherwise.

Diameter	Velocity
4 inch through 20 inch	16 feet per second
24 inch through 72 inch	8 feet per second

- D. Valve shall be in the same alignment as a horizontal pipe and shall be for buried service, unless otherwise specified. Valve shall be configured with a horizontal valve shaft and a vertical actuator shaft with standard 2-inch AWWA operating nut. The actuator shall be side mounted.
- E. Valve body shall be constructed of Cast Iron conforming to ASTM Specification A-126, Class B, or Ductile Iron ASTM A536, Grade 65-45-12.
- F. All valves shall conform to AWWA C504-10, Table 2 of Section 4.2.1 Valve Bodies. Valve body ends shall be flat-faced flanged in accordance with ANSI B16.1, Class 250 for Class 250 Valves and Class 150 for Class 150 Valves. Valve shall be of such design that the disc will seat at 90 degrees with the pipe axis.
- G. Valve shall be of such design that the disc will not flutter or vibrate when operated in a throttled position.
- H. Valves disc shall be of Cast Iron A-48, Class 40 Cast Iron A-126, Class B or Ductile Iron ASTM A-536, grade 65-45-12 and shall be of disc design to provide 360 degree uninterrupted seating.
- I. The valve seat shall be natural or synthetic rubber resilient seat applied integrally to the disc or body to provide tight shut off at the pressure specified. Valve seats shall be epoxy bonded or retained. For valves 24 inches or larger, the rubber seat shall be capable of mechanical adjustment in the field and shall be field replaceable. Special tools required for seat adjustment shall be provided with the valve. Special tools required for seat replacement shall be furnished with the replacement seat. Mechanical adjustment or attachment of the seat and seat ring does not include welding. The mating seat surface shall be type 304 or type 316 stainless steel, ni-chrome or monel. Sprayed or plate mating seat surfaces are not acceptable.
- J. Valve shafts shall be type 304 stainless steel conforming to ASTM A-276 and shall have a diameter equal to or greater than that shown for Class 250B in Table 3 of AWWA C504-10, Section 4.2.3 Valve Shafts. Shafts shall conform to the requirements of Section 4.2.3, Valves Shaft of AWWA C504-10 for one-piece or stub shaft types. Connection between the shaft and disc shall be dowel or taper pins, which are mechanically secured.

- K. The valve assembly shall be furnished with a factory-set, non-adjustable disc shaft thrust bearing that insures the valve disc is centered within the valve body seat at all times.
- L. Valve shaft bearings shall be permanent, self-lubricated, bearings, which provides continuous, low-friction maintenance-free operation. Shaft bearing shall be contained in integral hubs of the valve body.
- M. Valve shaft seal shall consist of O-ring, V-type, or U-cup type packing where the shaft projects through the valve body for the actuator connection.
- N. The valve shall be provided with a fully enclosed, permanently lubricated actuator of the traveling nut or worm gear design. The operator shall be designed such that constant input speed results in variable output speed with slowing down valve closure at the ends of travel. The effect is to maintain the rated output torque throughout the entire travel. The actuator shall be connected to the valve shaft by means of a key and keyway connection.
- O. All valves shall be configured to “open left” located inside the fence.
- P. All actuators shall have adjustable, mechanical stop limits in accordance with AWWA C504-10 Section 4.2.8. All valve actuators shall be capable of withstanding 450 ft.-lbs. of input torque against the open or closed stops without damage. External stop covers shall be sealed with o-rings.
- Q. Valves for below ground applications shall be provided with an AWWA wrench nut. The wrench nut shall have an arrow cast thereon, indicating the direction on of opening. The wrench nut shall be suitably fastened to the actuator input shaft. If the shaft is smooth, the wrench nut shall be fastened to the input shaft by means of a minimum 5/16-inch diameter steel pin passing entirely through the shaft and the wrench nut. Key with keyway will be acceptable. If the shaft is splined, the wrench nut shall be formed to fit the splined shaft. The actuator shall be designed to produce the specified torque with a maximum input of 150 ft.-lbs. applied to the wrench nut.
- R. Valves for aboveground or vault applications shall be provided with a handwheel. The handwheel shall have an arrow thereon, indicating the direction of the opening. The handwheel shall be suitably fastened to the actuator input shaft. Actuators equipped with handwheels shall be designed to produce the specified torque with a maximum pull of 80 pounds of the handwheel rim.
- S. The requirement for either wrench nut or handwheel and the direction of opening will be specified on each purchase order.
- T. The number of turns to open (close) the valve shall be consistent with each valve size for the manufacturer and shall be approved by the Owner.
- U. The bidder shall submit with his proposal three sets of certified drawings showing the principal dimensions, general construction and material specification of the valve proposed. The number of turns to open (close) shall be clearly noted in the valve information submitted with the proposal documents.

- V. The supplier/manufacturer shall provide Affidavit of Compliance with applicable sections of AWWA C504 to include the following: Results of ASTM testing procedures and requirements for materials, Manufacturer's Quality Assurance Program, leak-tightness testing and proof of design testing of representative actuators in accordance with AWWA C504 Section 3.8.5.2 as modified herein (450 ft-lbs). Compliance assurance will be required in accordance with AWWA C504 Section 5.1.2 Affidavits. Results of performance tests, proof of design test, AWWA C504 Section 5.1.4, hydrostatic test, leakage test, and Affidavit of Compliance shall be provided with the bid or with the shipping documents and shall be approved by the San Antonio Water System.

PART 3 EXECUTION

3.01 WORKMANSHIP

- A. All parts of the butterfly valve shall be designed and manufactured to the tolerances specified in ANSI/AWWA C504-10 or latest version thereof and this specification.
- B. All parts of the butterfly valve manufactured by a given manufacturer shall be interchangeable with like parts from another butterfly valve of the same model and size and by the same manufacturer.

3.02 PAINTING

- A. Shop Coating:
1. All interior and exterior ferrous surfaces of the valve, including the disc, shall be coated with fusion bonded epoxy, N.S.F. 61 certified. The fusion bonded epoxy shall have a nominal thickness of 8 mils, and shall be in accordance with AWWA C550, latest revision.
 2. Coating shall be holiday tested and holiday free in accordance with AWWA C550.
- B. Field Coating: Valves installed above grade, exposed valves, and valves in vaults shall be shop coated, and shall receive additional field coating protection in accordance with Section 09900 – Painting and Coating.

3.03 INSTALLATION

- A. Installation shall be in accordance with the Manufacturer's instructions and shall follow instructions given in AWWA C504. Valve shaft shall be truly vertical or horizontal as indicated.

3.04 FIELD QUALITY CONTROL

- A. Upon completion of installation of the butterfly valves an acceptance test shall be conducted to verify the satisfactory operation of the valves. The valves must perform in a manner acceptable to the Engineer before final acceptance will be made by the OWNER.

3.05 TESTING

- A. Testing of installed butterfly valves shall be conducted in coordination with Section 15085 – Water Pipeline Testing.
- B. Performance Tests: Performance tests shall be performed on each valve in accordance with Section 5.1.1 Testing of ANSI/AWWA C504-10 or latest revision thereof.
- C. Leakage Tests: Leakage tests shall be performed on each valve in accordance with Section 5.1.2 Testing of ANSI/AWWA C504-10 or latest revision thereof.
- D. Hydrostatic Tests: Hydrostatic tests shall be performed on each valve in accordance with Section 5.1.3 Testing of ANSI/AWWA C504-10 or latest revision thereof.
- E. Proof-of-Design Tests: Proof-of-Design tests shall be performed on each valve in accordance with Section 5.1.4 Testing of ANSI/AWWA C504-10 or latest revision thereof.
- F. An Affidavit of Compliance certifying that all required tests have been performed shall be provided.
- G. The Affidavit of Compliance and the records of all tests performed on the valves shall be kept and provided in a single hard cover bound notebook.

END OF SECTION

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SECTION 15102**SMALL DIAMETER VALVES AND APPURTENANCES****PART 1 - GENERAL****1.01 SCOPE OF WORK:**

- A. This section covers the following small diameter valves and appurtenances.
 - 1. Four inch and smaller ball valves and non AWWA ball valves

1.02 RELATED WORK:

- A. San Antonio Water System (SAWS) latest specifications.
- B. Division 1: General Requirements
- C. Section 09900: Painting and Coating
- D. Division 15: Mechanical

1.03 REFERENCES:

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM A48: Specification for Gray Iron Castings.
 - 2. ASTM A126: Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - 3. ASTM A536: Specification for Ductile-Iron Castings.
 - 4. ASTM B98: Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
 - 5. ASTM D1785: Standard Specification for Polyvinylchloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- B. American National Standards Institute (ANSI):
 - 1. ANSI B2.4: Hose Coupling Screw Threads.
 - 2. ANSI B16.1: Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
 - 3. ANSI B16.4: Cast-Iron Threaded Fittings, Class 125 and 250.

4. ANSI B16.10: Face-to-Face and End-to-End Dimensions of Ferrous Valves.

C. American Water Works Association (AWWA):

1. AWWA C515: Standard Specification for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.

1.04 SUBMITTALS:

A. Shop Drawings: Submit the following in accordance with Section 01300, and as specified herein.

1. Submit manufacturer's certified shop and erection drawings, specifications, catalog data, illustrations, and descriptive material, etc.
2. Data, regarding valve characteristics and performance:
3. Shop drawing data for accessory items.
4. Manufacturer's literature as needed to supplement certified data.
5. Operating and maintenance instructions and parts lists.
6. List of recommended spare parts other than those specified.
7. Recommendations for short and long term storage.
8. Special tools.

1.05 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01400 and as specified herein.
- B. Provide enclosures for atmospheres as specified and indicated.
- C. Contractor responsible for verifying outside diameter of pipe to be tapped.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Shipping:

1. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.
2. Pack spare parts in containers bearing labels clearly designating contents and pieces of

equipment for which intended.

3. Deliver spare parts to the Owner after completion of work.

B. Receiving:

1. Inspect and inventory items upon delivery to site.
2. Store and safeguard equipment, material and spare parts in accordance with manufacturers written instructions.

PART 2 - PRODUCTS

2.01 BALL VALVES - 4-INCH AND SMALLER:

A. Manufacturers:

1. Kitz.
2. Worcester Controls
3. Flowserve
4. Or acceptable equivalent product.

B. Materials:

1. Body: Type 316 stainless steel.
2. Seat: TFE.
3. Ball: Type 316 stainless steel.
4. Stem: Type 316 stainless steel.

C. Ends:

1. 2-in. and Smaller: Screwed or flanged.

D. Actuators:

1. Valves 3-in. and smaller: Lever
2. Valves 4-in: Geared handwheel

2.02 TAPPING SLEEVES AND VALVES:

- A. Provide tapping sleeves and valves consisting of epoxy coated fabricated steel split type sleeve with flanged outlet, and tapping type gate valve with one flange end and one mechanical joint end. Provide valve conforming to requirements for gate valves specified in this Section and furnished with 2-in. square operating nut.

2.03 CUTTING-IN VALVES:

- A. Provide double-disk, parallel-seat gate valves conforming to requirements specified under this section.
- B. Provide mechanical joint ends on valve and cutting-in sleeve.

2.04 CORPORATION STOPS:

- A. Manufacturers: Clow Corporation, Mueller Co., or acceptable equivalent product.
- B. Materials: Bronze with a lapped, ground key. Inlet thread of steep taper type. Outlet connections to suit type of pipe or tubing connected.

2.05 T-HANDLE OPERATING WRENCHES:

- A. Furnished by valve manufacturer.
- B. Provide T-handle operating wrenches in lengths as required to permit operation as specified and indicated.
- C. Provide One wrench for every (3) wrench operated valves.

2.06 PAINTING:

- A. Provide in accordance with Section 09900 and as specified herein.
 - 1. Clear and shop finish interior surfaces of all iron body gate valves, the exterior surfaces of buried or submerged valves and gates, and miscellaneous piping appurtenances with asphalt varnish.
 - 2. Apply coats of paint filler and enamel or other acceptable treatment customary with manufacturer, to floorstands and similar parts customarily shop finished.

PART 3 - EXECUTION**3.01 GENERAL:**

- A. Prior to installation, protect stored valves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, freezing and thawing, vandalism, etc.
- B. Clean all debris, dirt, gravel, etc, from inside of piping before placing valves in place.
- C. Erect and support valves in respective positions free from distortion and strain on appurtenances during handling and installation. Inspect material for defects in workmanship and material. Clean out debris and foreign material from valve openings and seats, test operating mechanisms to check functioning, and check nuts and bolts for tightness. Repair, valves and other equipment which do not operate easily or are otherwise defective at no additional cost to the Owner.
- D. Set plumb and support valves in conformance with instructions of manufacturer. Shim valves mounted on face of concrete vertically and grout in place. Install valves in control piping for access.
- E. Provide sleeve type coupling or flexible type grooved coupling on downstream side of buried valves to assist in valve removal.
- F. Provide valves with extension stems where required for operation. Provide extension stems for valves installed underground and elsewhere so that operating wrench does not exceed 6 ft. in length.

3.02 CHECK VALVES:

- A. Install swing check valves horizontally in pipelines.

3.03 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01770.

END OF SECTION

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SECTION 15103**AWWA BALL VALVES****PART 1 GENERAL****1.01 SCOPE OF WORK**

- A. This section covers furnishing 6 inch and larger AWWA ball valves as required by the Work. AWWA ball valves shall be furnished complete with actuators and accessories as specified herein.
- B. The Contractor shall furnish all labor, materials, equipment and incidentals required to completely install and put into operation, ball valves and electric actuators as specified herein and shown on the plans. All products furnished shall be in conformance with ANSI/AWWA C507 (latest version thereof). All coatings in contact with potable water shall be certified to N.S.F. 61. A proof of design certification shall be provided upon request.
- C. The Contractor shall coordinate the ball valve installation with the electric actuators to insure a complete functional operation.
- D. Unit Responsibility and Coordination: The Contractor shall cause all equipment specified under this section to be furnished by the valve and actuator manufacturers who shall be responsible for the adequacy and compatibility of their respective components. Any component of each complete unit not provided by the manufacturers shall be designed, fabricated, testing, and installed by factory-authorized representatives experienced in the design and manufacture of the valve and actuator equipment. This requirement, however, shall not be construed as relieving the Contractor of the overall responsibility for this portion of the work.

1.02 REFERENCES

- A. San Antonio Water System (SAWS) latest specifications.
- B. American Water Works Association (AWWA)
 - 1. AWWA C507 – Ball Valves, 6 in. Through 48 in.
 - 2. AWWA C542 – Electric Motor Actuators for Valves and Slide Gates
- C. American Society for Testing and Materials (ASTM)
 - 1. ASTM A126 – Gray Iron Castings for Valves, Flanges, and Pipe Fittings
 - 2. ASTM A536 – Ductile Iron Castings.
- D. American National Standards Institute (ANSI) ANSI C50.41 – Polyphase Induction Motors for Power Generating Stations

- E. National Electrical Manufacturer's Association (NEMA) NEMA MG1 – Motors and Generators.

1.03 SUBMITTALS

A. Required Submittals

Drawings & Data	Complete Assembly
	Materials List
	Foundation
	Installation
	Equipment
	Drawings

Valve	Name of the Manufacturer
	Type, Model, and Serial Number
	Design Pressure
	Shutoff pressure
	Weight
	Complete Performance Curves
	Shop Coatings

Motor	Name of Manufacturer
	Type and Model No.
	Rated Size of Motor in Hp
	Temperature Rating
	Run Amps (15 mins)
	Stall Amps
	Weight
	Power Requirements
	Operation and Maintenance Manuals with Connection Diagrams
	Motor Capabilities Curve
	Starting Current Curve

Product Data Section	Manufacturer's Technical Data
	Performance Charts and Curves
	Catalog Cuts
	Installation Instructions

	List of Parts with Price and Source
	List of Supplies with Price and Source

Drawings Section	Complete List of Equipment and Materials
	Wiring and Schematic Diagrams
	System Layout
	Anchorage of Equipment and Appurtenances
	Curve plotting: “Area of Opening in Percent of Full Opening” vs “Plus Rotation in Degrees” and “Area of Opening in Percent of Full Opening” vs “Percent of Total Crosshead Travel”.

Instruction Section	Operating Instructions
	Maintenance Procedures
	System Checking Methods
	Staff Training

Certification	Specify and Describe the Names and Qualifications of the Factory Trained Personnel
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Operation and Maintenance Manuals	Specify and Describe the Six Complete Sets of the Manufacturer's Instructions.
	System Layout Showing Piping, Valves, and Control, Approved Wiring and Control Diagrams,
	Control Sequence Describing Startup, Operation, and Shutdown
	Operating and Maintenance Instructions for Each Piece of Equipment, Including Lubrication Instructions, and Troubleshooting Guide.

B. Shop Drawings:

1. Product data sheets for make and model.

2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 3. Separate detailed point-to-point internal wiring diagram for each pump control valve.
 4. Power and control wiring diagrams, including terminals and numbers.
 5. Complete motor nameplate data.
 6. Electric operator sizing calculations.
- C. Quality Control Submittals:
1. The manufacturer shall submit product data and manufacturer's installation instruction under provisions of Section 01300 - Submittals.
 2. Three complete sets of certified assembly drawings showing the principal dimensions, construction details, and material used for all parts of the valve.
 3. The Drawings shall include a specific comprehensive elementary control schematic.
 4. The Drawings shall include a separate detailed point-to-point internal wiring diagram for each electrically operated or controlled valve and the associated electrical control equipment to include all external device connections.
 5. Five certified copies of the test record report including the Affidavit of Compliance.
 6. Manufacturer's Certificate of Proper Installation.
 7. Six copies of the Operation and Maintenance Manual.

1.04 QUALITY ASSURANCE

- A. Acceptable ball valve manufacturers (no approved equals):
1. Henry Pratt Company
 2. Val-Matic Valve & Manufacturing Corporation
 3. DeZurik, Inc.
 4. GA Industries, LLC
 5. No approved equals
- B. Acceptable actuator manufacturers (no approved equals): As specified in Section 15090 – Common Requirements for Process Valves.

- C. Ball Valves shall be built and tested in accordance with the latest version of AWWA C507 and Institute of Electrical and Electronics Engineers, Inc. Standard Test Procedures for Polyphase Induction Motors and Generators (IEEE 112) or latest standard. The following tests are required:
1. Hydrostatic Test
 2. Shop seat-leakage Test
 3. Performance Test
 4. Proof-of-Design Test
 5. Motor test per IEEE 112

1.05 SPARE PARTS AND TOOLS

- A. Furnish one set of special tools required for the proper servicing of all equipment supplied under these Specifications, packed in a suitable steel tool chest with a lock.

1.06 SHIPPING INSTRUCTIONS

- A. Comply with recommendations of AWWA C507.
- B. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.
- C. All equipment and parts must be properly protected against any damage during a prolonged period at the site.
- D. The finished surfaces of all exposed flanges shall be protected by wooden blank flanges, strongly built and securely bolted thereto.
- E. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- F. Storage and Protection: Take special care to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, preventing any deformation.

1.07 WARRANTY

- A. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no expense to the Owner. Warranty shall be for a period of five (5) years and begin on the Date of Substantial Completion.

PART 2 – PRODUCTS

2.01 BALL VALVES

- A. The main valve shall have a full, circular, unobstructed waterway and be shaft in complete conformance with the latest requirements of AWWA C507.
- B. Ball valves shall be rated for a working pressure as indicated in Table 1 of Section 15055 – Steel Pipe for the applicable area.
- C. Components

Body	Gray Iron - ASTM A126, class B, or ASTM A48, class 35 Ductile Iron - ASTM A395 or ASTM A536, grade 65-45-12 Cast Steel - ASTM A27, grade 65-35, or ASTM A216, grade WCB
Valve Ball	Gray Iron - A126, class B, or ASTM A48, class 35 Ductile Iron - ASTM A536, grade 65-45-12 Cast Steel - ASTM A27, grade 65-35, or ASTM A216, grade WCB
Valve Seats - Metal Body and Ball Seats	<p>Metal Body and Ball Seats: Stainless Steel, Nickel-Chromium Alloy, Monel, or formed, molded, or extruded rubber materials</p> <p>Mating Seat Surfaces:</p> <p>Stainless Steel - 18-8 Stainless Steel (Castings conforming to ASTM A351, grade CF8 or grade CF8M; ASTM A743; or Wrought materials conforming to ASTM A276, type 304 or type 316</p> <p>Nickel-Chromium Alloy - Nickel-chromium alloy; or weld overlay having a minimum total thickness of at least 1/4 in. including 1/8 in. thickness of base weld material of weld rod or wire having greater than 50% nickel overlaid with stainless steel rod or wire conforming to AWS A5.4, E308L, or AWS A5.9, ER308L, for gray-iron or ductile iron valves; or weld overlay with a minimum thickness of 1/8" Monel Rod conforming to AWS A5.11, ENicu-1, ENicu-2, or AWS A5.14, ERNicu-5 for use with gray-iron, ductile iron, or cast-steel valves.</p> <p>Monel - Wrought and cast conforming to ASTM B127 formed, molded, or extruded rubber materials</p>
Bearings	Bearings exposed to potable water shall be bronze, stainless steel, Monel, or nonmetallic materials

Shaft	<p>Austenitic Stainless Steel - ASTM A276</p> <p>Ferritic Stainless Steel - ASTM A276 Type 410 with metal sleeve of bronze, stainless steel, or Monel through support-bearing areas</p> <p>Chrome Molybdenum Steel - ASTM A322 Grade 4140 or ASTM A331 Grade 4140 with metal sleeve of bronze, stainless steel, or Monel through support-bearing areas</p> <p>Monel</p>
Shaft Seals	<p>V-type packing</p> <p>O-ring or nongraphited - lubricated compression packing</p>
Manual Actuators	<p>Gray Iron - ASTM A126, Class B or ASTM A48, Class 35</p> <p>Ductile Iron - ASTM A536, Grade 65-45-12</p> <p>Cast Steel - ASTM A27 or better</p>
Power Actuators	<p>Designed and manufactured in accordance with all applicable requirements of ANSI/AWWA C540</p>

- C. Valve bodies shall be marked with the size, design pressure, and manufacturer's name. Single-seated valves shall also be marked with an arrow showing the direction of flow.
- D. Accessories
1. Equipment Identification Plate: 16 – gauge stainless steel with 1/4-inch die stamped equipment tag securely mounted in a readily visible location with manufacturer name, model number, serial number, size of valve, design pressure, shutoff pressure, operational data, and date of manufacture.
 2. Lifting Lugs: Equipment weighing over 100 pounds.
 3. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter.
- E. Flanges shall conform to ANSI/ASME B16.1, Class 250.
- F. All ball valves shall be coated with a fusion bonded epoxy coating, 25 mils minimum dry film thickness. Epoxy coating shall be N.S.F 61 certified and shall be in accordance with AWWA C550, latest revision.

2.02 VALVE ACTUATOR

- A. Design: Valve actuators shall conform to the latest requirements of AWWA C507 and C542. The valve actuator shall be designed to hold the valve in any intermediate position between full open without creeping or fluttering. Valve actuators shall be of the worm gear design.

- B. Position Indicator: Valve actuators shall be equipped with a travel indicator for valve position between full open and full close. The indicator shall be raised, clearly showing the legends "Open" and "Closed" at the end of a 90 degree arc with a pointer to show the disc position (Closed at 0 degrees and Open at 90 degrees) and the arc graduated in increments of ten degrees.
- C. Direction of Operation: Clockwise direction shall close the valve and counter-clockwise direction shall open the valve. The valve actuator shall be located on the side of the valve, suitable for vault service or above ground service.

2.03 ELECTRIC MOTOR ACTUATOR (AC REVERSING CONTROL TYPE)

- A. General:
 - 1. Comply with AWWA C542.
 - 2. Size to 1-1/2 times required operating torque starting with valve wide open at maximum port velocity and ending with a differential equal to the specified maximum shutoff pressure. Motor stall torque not to exceed torque capacity of valve.
 - 3. Stem protection for rising stem valves.
 - 4. Complete with motor, gearing, handwheel, limit and torque switches, lubricants, space heaters, wiring, and terminals.
 - 5. Self-contained unit with cast iron weatherproof housing.
 - 6. Integrally assembled on valve by valve manufacturer.
- B. Open-Close Service:
 - 1. Size motors for two complete OPEN-CLOSE-OPEN cycles that occur in immediate succession without overheating at full differential pressure.
- C. Actuator Power Supply:
 - 1. 480-volt, three-phase unless otherwise indicated.
 - 2. Control power transformer, 120-volt secondary.
 - 3. Remotely located, externally operable power disconnect switch.
- D. Motors:
 - 1. Totally enclosed, high torque.
 - 2. In accordance with NEMA standards.
 - 3. Operate at any voltage within 10 percent above or below rated voltage.

4. Permanently lubricated motor bearing.
- E. Gearing:
1. Hardened steel spur or helical gears.
 2. Alloy bronze or hardened steel worm gear.
 3. Designed for 100 percent overload.
 4. Hardened steel gears not less than 350 Brinell.
 5. Sealed against entrance of foreign matter.
 6. Self-locking so that actuation of a torque switch by a torque overload condition will not allow the operator to restart until the torque overload is eliminated.
 7. Planetary or cycloidal gearing; aluminum, mild steel, or nonmetallic gearing will not be acceptable.
 8. Contain continually energized space heaters rated for 230 volts and connected to 120 volts.
- F. Handwheel Mechanism:
1. Prevent handwheel rotation during motor operation and prevent effect of motor rotation during handwheel operation.
 2. Geared so that force required to operate does not exceed 80 pounds.
- G. Torque Switches:
1. Provide for torque and thrust loads in both opening and closing directions.
 2. Provide with micrometer adjustment and reference setting indicator.
 3. Adjustment with approximately 40 percent torque setting variation.
 4. Rated for not less than 6 amperes at 120 volts ac.
- H. Limit Switches:
1. The design of each multi-turn electric operator shall be such that it is readily field adaptable for four limit switch assemblies.
 2. Each switch assembly shall consist of two tandem 2-pole switches.
 3. Each switch assembly shall be operated by the driving mechanism and shall be independently adjustable to trip at any point between the fully open and fully closed valve position.

4. All switches shall have silver contacts with an inductive contact rating of not less than 6 amperes at 120 volts ac, and 3 amperes at 240 volts ac.
 5. Limit switches shall be furnished as indicated in valve and pump control schematics in the Plans.
 6. Housed in actuator control enclosure.
- I. Control Features: As specified in Section 17400 – Control Loop Descriptions.
- J. Valve Control Cabinet:
1. Remote to valve actuator.
 2. Provide complete with open and close three-phase reversing motor starter contactors, open and closed indicating lights, open and close pushbutton switches, “HAND-OFF-AUTO” selector switch, three-phase circuit breaker, motor overload protector, control power transformer, wiring and terminals, as indicated on the Contract Drawings.
 3. Enclosure:
 - a. As defined in NEMA 250, Type 4.
 - b. Contain continually energized space heaters rated for 230-volts and connected to 120 volts.
 - c. Oversized to permit adequate and convenient clearance to all internally mounted devices.
 4. Selector Switch, Pushbuttons, and Indicator Lights:
 - a. Heavy duty, oiltight/watertight construction for outdoor use with NEMA A600 modular contact blocks.
 - b. Four-stage, three-position maintenance contact selector switch.
 - c. Momentary spring return, nonilluminated, recessed type, pushbuttons.
 - d. Push-to-test indicating lights, both lamps shall illuminate in intermediate valve position.
 - e. Mount devices on interior swing panel.
 5. Terminals:
 - a. Provided in motor starter enclosure for all external control connections.
 - b. Provide sufficient terminals so that no more than two conductors are connected to a single terminal.
 - c. Provide permanent designations which agree with wiring diagrams.
 - d. Heavy duty, phenolic strap-screw type, 300-volt, 30-amp rating.
 6. Wiring:
 - a. Flame retardant switchboard type.
 - b. Minimum No. 14 AWG.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Valves and actuators shall be installed in accordance with instructions of the manufacturer and as shown on the plans.
- B. Installation and adjustment shall be checked and approved by a manufacturer's direct factory representative. After acceptance, the representative shall address a letter to the Consultant outlining all installation and start up procedures. The letter shall include a statement that the valves are installed per the manufacturer's recommendations. The manufacturer or his qualified representative shall conduct training session for the Owner's personnel in the operation and maintenance of the valves.
- C. Ball valves and actuators shall be field tested and all deficiencies shall be corrected.

END OF SECTION

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SECTION 15104**GATE VALVES****PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Resilient-seated gate valves.

B. Related Requirements:

1. Section 15090 - Common Requirements for Process Valves: Basic materials and methods related to valves commonly used for process systems.

1.2 REFERENCE STANDARDS**A. American Water Works Association:**

1. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

C. ASTM International:

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
3. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

D. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends.
2. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

1.3 SUBMITTALS

- A. As specified in Section 15090 - Common Requirements for Process Valves: Submittal requirements for compliance with this Section.

PART 2 - PRODUCTS**2.1 RESILIENT-SEATED GATE VALVES**

- A. Approved manufacturers of gate valves:
1. Sizes three inch through twelve inch, include:
 - a. American Flow Control – Series 2500
 - b. Clow Valve Company – 2640
 - c. Kennedy Valve – Ken-Seal II
 - d. M&H Valve Company – 4067
 - e. Mueller Company – 2360 Series Gate Valve
 - f. United States Pipe and Foundry – A-USPO
 2. Sizes sixteen through twenty-four inch, include:
 - a. United States Pipe and Foundry – A-USPO
 3. Two inch and smaller gate valves are covered in the Small Diameter Valves and Appurtenance section.
- B. In accordance with SAWS Standard Construction Specification Item No. 828, “Gate Valves” and SAWS Material Specification, “Resilient Seated Gate Valves” Item No. 21 except as otherwise noted or specified herein.
- C. Description:
1. As specified in Section 15090 - Common Requirements for Process Valves.
 2. Except as otherwise noted or specified herein, AWWA Standard C509 shall govern the design, physical and chemical properties of component materials, construction, manufacture and testing of all resilient seated gate valves furnished for this specification. Valves shall be suitable for frequent operation as well as service involving long periods of inactivity. Valves shall be NSF-61 certified.
 3. The minimum design working pressure for gate valves that have a nominal diameter of 3-inches through 12-inches shall be 200 psig unless otherwise specified. The minimum design working pressure for gate valves that have a nominal diameter of 16 inches or larger shall be 150 psig unless otherwise specified.
 4. End Connections: As indicated on the drawings.
 5. Gear Actuators for Manual Valves: Comply with AWWA C509.
 6. Valves within the fenced production facilities shall open left (counterclockwise), unless otherwise specified. Valves outside the fenced areas shall open right (clockwise).
 7. Gate valves shall be designed for installation in either a horizontal or vertical position. Valves shall be designed for buried installation with stem in the vertical position and shall be furnished for mounting in a horizontal pipeline, unless otherwise specified.

8. Enclosed and buried valves shall be coated inside and outside with a fusion bonded epoxy having a nominal 8 mils dry film thickness, which meets or exceeds AWWA C550 and to the maximum extent possible shall be free of holidays. All coatings in contact with potable water shall be ANSI/NSF Standard 61 approved.
9. Tapping Valves: The tapping valves shall be configured with a mechanical joint on one end and a tapping flange on the other end. The tapping valves shall be furnished complete with glands, bolts, and gaskets. The tapping valve shall have a clear unobstructed waterway. The seat rings shall be of a large diameter to permit the entry of the full diameter tapping machine cutters. The valve end which mates with the tapping sleeve shall have an alignment lip to fit the recess in the tapping sleeve flange for proper alignment. The lip will be dimensioned in accordance with MSS SP-60 for valves 20-inch nominal pipe size and smaller.

D. Operation:

1. As specified in Section 15090 - Common Requirements for Process Valves.
2. Stem: Nonrising.
3. Handwheel: Handwheel diameters shall be at least 8 inches but not more than 24 inches for 30 inch and smaller valves and not more than 30 inch and smaller valves and not more than 30 inches for 36 inch and larger valves.
4. Valves 20 inch nominal pipe size and larger shall be geared. Gears shall be cut tooth steel and gear cases shall be the totally enclosed, weather tight type to enclose the gears, stuffing box, and the valve stem, attached to the bonnet.
5. Valves 20 inch nominal pipe size and larger shall be provided with a bypass and bypass valve.

E. Materials:

1. Gate valves shall be resilient-seated types, bronze mounted with non-rising stems. The closure member shall be fully encapsulated by an elastomer without thin spots or voids. When open the valve shall have a clear, full-port, unobstructed waterway.
2. Valve components of brass or bronze shall be manufactured to ASTM recognized alloy specifications of low zinc content bronze, as shown in Table 1 of Section 2.2.4 of ANSI/AWWA Standard C509 or the latest revision thereof. Materials for the stem have minimum yield strength of 40,000 psi. A minimum elongation in 2 inches of 12% and shall be made of bronze per ASTM B763, alloy number UNS C99500. A maximum zinc content of 2% as shown in Table 2 Chemical Requirements of ASTM B763-96 or the latest revision thereof. Stem nut material shall be ASTM B62 UNS C83600 or ASTM B584 UNS C84400. The stem shall have a visible external marking at the top to indicate low-zinc, high strength material. The marking shall include a red plastic or neoprene washer placed around the top of the stem under the operating nut.
3. Valve ends shall be either flanged, tapping valve, mechanical joint, push-on joint or any combination thereof, as specified. All mechanical joint valves shall be supplied with

glands, bolts, and gaskets. Valve body bolts and nuts shall meet the strength requirements of ASTM A307 with dimensions conforming to ANSI B18.2.1. The size of the bolt head shall be equal to the size of the nut and shall be stainless steel in accordance with ASTM 276.

4. The following parts of the valve shall be made of either gray or ductile iron: bonnet, body, yoke, wrench nut, O-ring packing plate or seal plate, and gland follower. The gate may be made of gray or ductile iron.
5. If glands and bushings are used for NRS valves they shall be made of ASTM B763 bronze UNS C99500. The stem shall be made of cast, forged, or rolled ASTM B763 bronze UNS C99500. The stem nut material shall be ASTM B62 bronze UNS C83600 or ASTM B584 bronze UNS C84400. The gate may be made of bronze ASTM B763 bronze UNS C99500. Stem seals shall be "O" ring type. The seals shall be designed for dynamic applications. The design shall be such that the seal above the stem collar can be replaced with the valve under full pressure in the fully open position. Materials for the "O" ring packing plate shall be in accordance with Section 4.8.3 of the ANSI/AWWA C509 Standard or the latest revision thereof.

2.2 SOURCE QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Requirements for testing, inspection, and analysis.
- B. As specified in Section 15090 - Common Requirements for Process Valves.
- C. Testing: Test gate valves according to AWWA C509.

PART 3 - EXECUTION

- A. As specified in Section 15090 - Common Requirements for Process Valves: Submittal requirements for compliance with this Section.

3.2 INSTALLATION

- A. According to AWWA C509 and as specified in Section 15090 - Common Requirements for Process Valves.

END OF SECTION

SECTION 15108**AIR RELEASE AND AIR VACUUM VALVES****PART 1 – GENERAL****1.01 SCOPE OF WORK**

- A. The CONTRACTOR shall furnish all labor, materials, equipment and incidentals necessary to install air release and air and vacuum valves of the sizes and types indicated on the Drawings. Furnish the isolating valves and piping as shown on the Drawings

1.02 RELATED WORK

- A. Section 09900 – Painting and Coatings
- B. Section 15055 – Steel Pipe

1.03 REFERENCE STANDARDS

- A. American Water Works Association:
 - 1. AWWA C512 - Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
- B. NSF International:
 - 1. NSF 61 - Drinking Water System Components - Health Effects.
 - 2. NSF 372 - Drinking Water System Components - Lead Content.

1.04 QUALITY ASSURANCE

- A. The manufacturers shall provide certification that products furnished under this specification are manufactured in an ISO 9001 certified facility or documentation from an accredited facility that ISO 9001 certification is in process.

1.05 SUBMITTALS

- A. Section 01300 – Submittals : Requirements for submittals.
- B. Section 15090 - Common Requirements for Process Valves
- C. Product Data: Submit manufacturer catalog information.
- D. Shop Drawings: Submit assembly drawings indicating materials, dimensions, weights, and end connections.

- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Manufacturer Instructions: Submit special procedures and setting dimensions.
- G. Source Quality-Control Submittals: Indicate results of shop tests and inspections.
- H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- I. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.
- J. Qualifications Statements:
 - 1. Submit qualifications for manufacturer and installer.
 - 2. Submit manufacturer's approval of installer.

1.06 CLOSEOUT SUBMITTALS

- A. Section 01700 – Contract Closeout: Requirements for submittals.
- B. Project Record Documents: Record actual locations of air release valves.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Valves shall be manufactured in accordance with AWWA C512.
- B. All wetted parts of all valves, including interior coatings and seals, shall comply with AWWA/NSF Standard 61 requirements for potable water service.

2.02 AIR RELEASE VALVES

- A. General: The automatic air release valve shall allow trapped air to escape from a pipeline, pump, tank, or water system. After the air escapes out of the air release valve through the orifice, the valve shall close to prevent water from escaping. The air release valve will then stay closed until more air accumulates and then the cycle repeats itself.
- B. The valve body and cover shall be cast iron fabricated in accordance with ASTM A48-35 or ASTM A126 Class B. Inlet sizes through 2 inch shall be screwed (NPT). Pipe sizes 3 inches and above shall have flanged inlets (125# ANSI B.16.1). A protective hood or cowl shall be installed on the outlet of the flange-bodied valves.
- C. Internal seat trim float arm and pivot pin shall be type 303, 304 or 316 stainless steel. Floats shall be stainless steel ASTM A240 or ASTM A276.

- D. Internal seat or orifice button shall be BUNA-N nitrile rubber compounded for water service. Cover gasket shall be composition-type, equal to Armstrong CS- 231, Garlock 3000, or Lexide NK-5 11. Cover bolts shall be alloy steel.
- E. Valve body shall have a working pressure rating as specified in Table 1 in Section 15055 – Steel Pipe for the applicable connecting pipelines and a test pressure rating of 2 times the working pressure.
- F. All air release valves shall be as manufactured by APCO Valve Company, GA Industries, Multiplex Manufacturing Company, Val-Matic Manufacturing Company, Powerseal Corporation, ARI Flow Control or approved equal.

Air Release Valves (Inlet x Orifice)		
Manufacturer	1" NPT x 3/16"	2" NPT x 3/16"
Apco Valve Company	200A	200A
G.A. Industries, Inc. (Empire)	920	920
Multiplex Mfg. Co. (Crispin)	PI-10	PL-10A
Val-Matic Mfg. Co.	38	38
PowerSeal Corporation	5401-D	5401-E
ARI Flow Control	S-050 1T	D-040 2T

2.03 AIR AND VACUUM VALVES

- A. General: The air and vacuum valve shall be designed in accordance with AWWA CS 12-92 to allow large quantities of air to escape out of the orifice during filling and to close tight when the liquid enters the valve. It shall also allow large quantities of air to enter the pipeline through the orifice during draining operations. The discharge orifice area shall be equal to or greater than the inlet area of the valve. It shall consist of a body, cover, baffle, float and seat.
- B. The baffle will be designed to protect the float from direct contact of rushing air and water in order to prevent the float from closing the valve prematurely. The seat shall be fastened into the valve cover, without distortion, and shall be easily removed for maintenance.
- C. The float shall be stainless steel and center guided through the guide bushings for positive shutoff into the seat. Valve sizes shall be as shown on the Drawings. An isolation valve shall be installed upstream from each air and vacuum valve.
- D. The valve body and cover shall be cast iron fabricated in accordance with ASTM A48-35 or ASTM A126 Class B. Inlet sizes through 3 inch shall be screwed (NPT). Pipe sizes above 3 inches shall have flanged inlets (125# ANSI B.16.1). A protective hood or cowl shall be installed on the outlet of the flange-bodied valves.
- E. Internal seat trim float arm and pivot pin shall be type 303, 304 or 316 stainless steel. Floats shall be stainless steel ASTM A240 or ASTM A276.

- F. Internal seat or orifice button shall be BUNA-N nitrile rubber compounded for water service. Cover gasket shall be composition-type, equal to Armstrong CS- 231, Garlock 3000, or Lexide NK-511. Cover bolts shall be alloy steel.
- G. Valve body shall have a working pressure rating as specified in Table 1 in Section 15055 – Steel Pipe for the applicable connecting pipelines and a test pressure rating of 2 times the working pressure.
- H. All air and vacuum valves shall be as manufactured by APCO Valve Company, GA Industries, Multiplex Manufacturing Company, Val-Matic Manufacturing Company, Powerseal Corporation, ARI Flow Control or approved equal.

Air and Vacuum Valves (Inlet x Orifice)		
Manufacturer	2” NPT x 3/16”	4” Flg with Cowl
Apco Valve Company	144	152
G.A. Industries, Inc. (Empire)	930	930-C
Multiplex Mfg. Co. (Crispin)	AL20	AL41
Val-Matic Mfg. Co.	102	104
PowerSeal Corporation	5402-B	5402-D
ARI Flow Control	D-040 2T	K060 C-HF

2.04 COMBINATION AIR VALVES – WITH AND WITHOUT SURGE PROTECTION

- A. General: Combination air valves shall provide for both automatic air release under system pressure and to allow air movement during filling or draining operations.
- B. The housing shall be designed to incorporate conventional or kinetic flow principles to properly vent the air without premature closure.
- C. Flanged size (4 inch and larger) may be furnished in a dual housing. When dual casings are used, a bronze manual isolation valve shall be installed. This will allow the air release valve to be serviced when the system is under pressure. Field service of the valve may also be performed by closing the isolation valve between the air valve and the pipe connection.
- D. The valve body and cover shall be cast iron fabricated in accordance with ASTM A48-35 or ASTM A126 Class B. Inlet sizes through 3 inch shall be screwed (NPT). Pipe sizes above 3 inches shall have flanged inlets (125# ANSI B.16.1). A protective hood or cowl shall be installed on the outlet of the flange-bodied valves.
- E. Internal seat trim float arm and pivot pin shall be type 303, 304 or 316 stainless steel. Floats shall be stainless steel ASTM A240 or ASTM A276.

- F. Internal seat or orifice button shall be BUNA-N nitrile rubber compounded for water service. Cover gasket shall be composition-type, equal to Armstrong CS- 231, Garlock 3000, or Lexide NK-511. Cover bolts shall be alloy steel.
- G. Valve body shall have a working pressure rating as specified in Table 1 in Section 15055 – Steel Pipe for the applicable connecting pipelines and a test pressure rating of 2 times the working pressure.
- H. Combination air valves with surge protection shall have a combination air valve as described above which is mounted on top of a normally opened surge check valve. The surge check shall provide anti-slam slow closing operation of the air and vacuum valve. The disc of the surge check shall have drilled orifices to throttle water flow and shall be spring loaded. Combination air valves with surge check shall have ductile iron flanges with a fusion bonded coating.
- I. All combination air valves up 4-inches in diameter shall be as manufactured by APCO Valve Company, GA Industries, Multiplex Manufacturing Company, Val-Matic Manufacturing Company, Powerseal Corporation, ARI Flow Control or approved equal.

Combination Air Valves (Inlet x Orifice)		
Manufacturer	2” NPT x 3/16”	4” Flg with Cowl
Apco Valve Company	145C	149C
G.A. Industries, Inc. (Empire)	945	960C
Multiplex Mfg. Co. (Crispin)	UL20 (1/4”)	UL41 (1/4”)
Val-Matic Mfg. Co.	202C	204C
PowerSeal Corporation	5403-B	5403-D
ARI Flow Control	D-040 2T	D-060 C-HF

2.05 VALVE COATING

- A. Shop Coating
3. All interior and exterior ferrous surfaces of the valve, including the disc, shall be coated with epoxy, NSF 61 certified. The epoxy shall have a nominal thickness of 8 mils, holiday tested at the manufacturer’s facility with certification and shall be in accordance with AWWA C550, latest revision. Manufacturer shall provide patch kit for use during installation to repair minor dings.
 4. Do not coat machined flange surface, provide with light primer or other means to protect from rusting during delivery/storage.
 5. Coating shall be holiday tested and holiday free in accordance with AWWA C550.

- B. Field Coating: Valves installed above grade, exposed valves, and valves in vaults shall be shop coated, and shall receive additional field coating protection in accordance with Section 09900 – Painting and Coatings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Carefully handle and install valves vertically in such a manner as to prevent damage to any part of the valves. Installation shall be in accordance with the Manufacturer's instructions.

3.02 TESTING

- B. Test valves at the same time that the connecting pipelines are pressure tested. Protect or isolate any parts of valves, operators, or control or instrumentation systems whose pressure rating is less than the test pressure.

END OF SECTION

SECTION 15120
CONTROL VALVES

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This Specification covers automatically acting valves used for the purpose of controlling flows in pipelines.
- B. The CONTRACTOR shall furnish all labor, materials, equipment, and incidentals to perform all necessary installation and testing to complete the work described herein.
- C. Equipment shall be assembled and placed into proper operating condition in conformance with the drawings, engineering data, instructions and recommendations of the equipment manufacturer, unless exceptions are noted by the plans and specifications.
- D. Each item shall be furnished and installed complete with all mechanical and electrical equipment required for proper operation, all components indicated on the drawings or specified, and all additional materials or construction required by the design of the system.

1.2 RELATED SECTIONS

- A. The following is a list of related specification sections. Other sections may also apply.
 - 1. Section 01050 – Field Engineering
 - 2. Section 01025 – Measurement and Payment
 - 3. Section 01300 – Submittals
 - 4. Section 01400 – Quality Control
 - 5. Section 01600 – Materials and Equipment
 - 6. Section 01730 – Operations and Maintenance Data
 - 7. Division 9 – Finishes
 - 8. Division 15 – Mechanical
 - 9. Division 16 – Electrical

1.3 REFERENCES

- A. The following standards are listed for references. Other standards may also apply.

1. ASME/ANSI B16.5: Pipe Flanges and Flanged Fittings
2. ASME/ANSI B16.42: Ductile Iron Pipe Flanges and Flanged Fittings
3. ASTM A536: Ductile Iron Casings
4. ASTM B62: Composition Bronze or Ounce Metal Castings
5. AWWA C110: Ductile Iron and Gray Iron Fittings
6. AWWA C115: Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges
7. AWWA C116: Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray Iron Fittings for Water Supply Service
8. AWWA C153: Ductile Iron Compact Fittings
9. AWWA C530: Pilot Operated Control Valves
10. AWWA C550: Protective Interior Coatings for Valves and Hydrants
11. NSF/ANSI 61: Drinking Water System Components

1.4 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for supply, installation, etc. of equipment under this Section. Include complete cost in total contract cost. Provide a separate line item for each control valve in Section 01370 – Schedule of Values.

1.5 QUALITY ASSURANCE

- A. All work shall comply with Section 01400 – Quality Control.
- B. Equipment supplied shall be of manufacturer's latest and proven design, compatible with functions required. Supplier shall be regularly engaged in the manufacture of pilot operated control valves having similar service and size. The valves covered by this specification are intended to be standard equipment that has proven ability and shall be new and free from defects or contamination.
- C. All equipment from manufacturers not included in this specification will be considered a substitution, and the CONTRACTOR will be required to submit a formal substitution request. The Owner shall be the sole judge of the acceptability of any substitution requested. If the substitution request is found to be unacceptable by the Owner then the CONTRACTOR shall provide the listed equipment at no additional expense to the Owner. The CONTRACTOR shall be responsible for any delays as a result of a substitution request.
- D. Equipment from a manufacturer included in this specification must still conform to all specifications, and must undergo the standard submittal review process.

- E. Components furnished shall be consistent with the manufacturer's standard for the intended service.
- F. All equipment specified under this section shall be furnished by the equipment manufacturer who shall be responsible for the adequacy and compatibility of all components, including but not limited to the valve body, actuator, pilot system, and any electronic components. Any component of each complete unit not provided by the equipment manufacturer shall be designed, fabricated, tested, and installed by the factory authorized representatives experienced in the design and manufacturer of the component. This requirement does not relieve the CONTRACTOR of the overall responsibility for this portion of the work.
- G. The CONTRACTOR shall coordinate the work schedule of the manufacturer's service personnel during construction, testing, start-up, and acceptance.
- H. Provide services of factory-trained representative, specifically trained on type of equipment specified. Submit qualifications of representative for approval prior to start-up and training. If difficulties in operation during start-up, testing, calibration, or instruction, additional time shall be provided at no cost to the owner to complete the necessary work. (Hourly requirements listed below are exclusive of travel time, and do not relieve CONTRACTOR of obligation to provide sufficient service to place equipment in satisfactory operation.)
 - 1. Installation: to assist in location of anchor bolts; setting, leveling, field erection, etc.; coordination of piping, electrical, miscellaneous utility connections.
 - a. 8 hours
 - 2. Start-up, testing, and calibration:
 - a. 8 hours
 - 3. Operation and maintenance instruction, including use and explanation of manual:
 - a. 8 hours
 - 4. Service-inspection during the first year of operation, for use at Owner's request and exclusive of repair, malfunction, or other trouble-shooting service calls:
 - a. 8 hours (not anticipated as consecutive.)
 - 5. Time and materials used to correct defective equipment at no cost to Owner and in addition to time periods specified above.

1.6 SUBMITTALS

- A. Field Measurements:
- B. The CONTRACTOR shall comply with Section 01300 – Submittals.
- C. Submittals required after award of contract and prior to shipping:
 - 1. Technical bulletins and brochures
 - 2. Certification of compliance with specifications
 - 3. Fabrication drawings

4. Manufacturer specifications
 5. Cavitation chart showing flow rate, differential pressure, percentage of valve opening, Cv factor, and system velocity.
 6. Submittals required as soon as practical after generation, and prior to installation and testing
 7. Shop Test Reports
 8. Submittals required prior to final walkthrough
 9. Operation & Maintenance Manual
 10. Complete parts list
- D. Submit certified shop drawings, manufacturer's specifications, catalog data, descriptive literature, illustrations, and other materials as may be deemed necessary for proper appraisal of quality and function. Submission includes factory work sheets which identify each piece of equipment as specified hereinafter.
- E. Material submitted for review contained in one submission. Partial submittals will not be reviewed. Sales bulletins or other general publications not acceptable as submittals for review except where necessary to provide supplemental technical data.
- F. Mark drawings and data to show only items applicable to work herein specified. Show all data including nozzle schedule, bill of materials, rated capacities, materials of construction, layouts, and construction details. Show dimensions, mounting, and external connection details on all drawings.
- G. Number and identify equipment to correspond with terminology on drawings. Use numbers on all submittal sheets and shop drawings.
- H. Submit operating and maintenance instructions and separate parts lists. Operating instructions shall also incorporate a functional description of entire system including system schematics which reflect "as-built" modifications. Clearly define special maintenance requirements particular to system along with special calibration and test procedures, and safety and material handling considerations.
- 1.7 DELIVERY, STORAGE AND HANDLING**
- A. Furnish five -year manufacturer's warranty for solenoid valves.
- B. The CONTRACTOR is expressly directed to make himself, his workers, and his subcontractors familiar with the hazards involved in handling the equipment and all components, and to cause all safety precautions to be taken.
- C. Packing:

1. All parts shall be property protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the equipment is read for operation, including periods of storage on the site.
2. The packing and protection shall be accomplished in such a way as to allow easy identification of the individual components without damaging the protection of those components.
3. Exposed finished surfaces, such as flanges, shall be protected by wooden blank flanges or similar, strongly built and securely bolted thereto.
4. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion
5. Plastic and other materials that are brittle or subject to degradation shall be protected for direct exposure to the sun, extremes in temperature, or any other condition that may cause damage, degradation, or deformation.

D. Shipping:

1. Ship equipment, material, and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.
2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
3. Deliver spare parts at same time as pertaining equipment. Deliver to Owner after completion of work.

E. Receiving:

1. All material shall be checked immediately on receipt to ensure no damage has occurred during shipment. In the event of damage, CONTRACTOR shall obtain replacement components at no additional cost to Owner and in a prompt manner to prevent delays to the schedule
2. Following receipt CONTRACTOR shall store all equipment in a secure manner to prevent loss or damage.

1.8 WARRANTY

- A. The manufacturer shall warrant the equipment and accessories against material and workmanship defects for a period of two (2) years which starts on the date of Substantial Completion of the Project. The CONTRACTOR shall submit the manufacturer's warranty document before final acceptance.

1.9 SPECIAL REQUIREMENTS

- A. Refer to applicable sections in Division 1 – General Requirements with regard to the following:

1. Special Tools: Provide kit containing special size wrenches and other types of tools necessary for assembling, disassembling, aligning, and calibrating equipment.
2. Foundations, installation, and grouting.
3. Services of manufacturer's representative.
4. Spare parts.

PART 2 - MATERIALS

2.1 MANUFACTURERS

- A. Control Valves: The equipment supplied shall be the latest standard product of a manufacturer regularly engaged in the production of pilot operated control valves, and shall be as manufactured by:
 1. Cla-Val
 2. No other manufacturers will be accepted

2.2 GENERAL

- A. CONTRACTOR to provide an integrated system with components supplied by one manufacturer who provides equipment and appurtenances and is responsible to CONTRACTOR for operation.
- B. The CONTRACTOR shall furnish and install control valves, tubing, solenoid valves, controls, wiring, and appurtenances, complete and operable, in accordance with these Contract Documents.
- C. Construction of control valves shall conform to the following requirements:
 1. Valves shall be a hydraulically operated, single diaphragm, control valve with full size internal port. Either globe or Y-pattern configuration is acceptable for installation in horizontal runs of pipe. Angle configuration is acceptable where indicated in the plans.
 2. The valve body shall consist of three major components: the body (with seat installed), the cover, and the diaphragm assembly (including the diaphragm, shaft, and seal). A separate pilot system shall be incorporated to provide necessary control of the valve.
 3. The diaphragm assembly shall form a sealed chamber in the upper portion of the valve, and be guided by means of bushing(s) or guides. Packing glands and/or stuffing boxes are not permitted, and there shall be no pistons operating the main valve.
 4. The diaphragm assembly shall be the only moving part and shall be securely mounted on a stem of sufficient diameter to withstand high dynamic pressures.

5. When closed the valve shall form a drip-tight seal between the stationary seat ring and the resilient disk.
6. Valve shall operate with non-slam closing under all conditions.
7. Valve body and cover shall be manufactured of cast material; no fabrication or welding shall be used in the manufacturing process.
8. Valve assembly and all wetted components shall have NSF 61 certification.
9. Materials of construction must be certified in writing to ASTM Specifications as follows:
 - a. Valve Body & Cover (all accepted and approved):
 - 1) Cast Ductile Iron (ASTM A536)
 - 2) Cast Steel (ASTM A216 WCB)
 - 3) Cast Iron (ASTM A136 GR.B)
 - b. Stem: 316 SS
 - c. Seat Ring: 316 SS
 - d. Trim: 316 SS
 - e. Bolts: 316 SS
 - f. Tubing & Fittings: 316 SS
 - g. Resilient Disk: Buna-N (NBR) or EPDM
 - h. Pressure Rating: adequate to meet the working and transient / test pressures as shown on the drawings
 - i. Ambient Temperature Range: -40 to + 180 °F
 - j. Operating Fluid: Potable Water
 - k. Installation Location: Suitable for outdoors
 - l. End Connections: ASME B16.42 Class 150 flanges
10. Valves shall have a protective fusion bonded epoxy coating internally and externally, 10 mil thick and consistent with Section 09900 – Paintings and Coatings. The epoxy coating shall conform to the AWWA C550 and NSF 61. No machining of any external parts after final coating will be acceptable to ensure a continuous coating surface throughout the entire valve.
11. Diaphragm shall be of flexible, non-wicking, FDA/NSF approved material consisting of synthetic rubber compatible with the operating fluid. The diaphragm shall be fully supported in the valve body and cover by machined surfaces in the fully open and closed positions.
12. The seat ring shall be easily replaceable without special tools.
13. The resilient disk shall have a rectangular cross-section. No O-ring type disks (circular, square, or quad-type) shall be permitted as the seating surface. The disk retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks.
14. All repairs and maintenance shall be possible without removing the valve from the line. To facilitate easy removal and replacement of the diaphragm assembly and to reduce unnecessary wear on the guide, for globe and angle configurations the stem shall be vertical when the valve is mounted in a horizontal line. For Y-pattern valves the stem shall be in a comparable position.

15. Each valve shall be air or hydraulically tested prior to shipment. The standard test shall include leakage test, seat leakage test, and stroke test. Where the set-point is provided, manufacturer will preset the pilot.
16. Control valves supplied shall be capable of operation by solenoid valve for purposes of remote actuation where so indicated in the plans.

2.3 ACCESSORIES

- A. All control valves shall have the following accessories, where included as standard or options.
 1. Opening Speed Control
 2. Closing Speed Control
 3. Tubing Isolation Valves
 4. Stainless Steel Tubing & Fittings
 5. Valve must vent to atmosphere
 6. Y-Strainer(s) on tubing
 7. Local Visual Position Indicator
 8. Valve Position Limit Switches (one (1) open, one (1) closed)
 9. Valve and fittings shall be configured with Heat Tracing & Insulation for outdoor installation when outdoor installation is indicated in the drawings.
 10. Pressure gauge on upstream and downstream sides.

2.4 SOLENOID

- A. All control valves shall have the following accessories, where included as standard or options.
- B. Where required, the electric solenoid(s) shall initiate hydraulic opening/closing of the valve. The valve shall conform to the following specifications:
 1. Configuration: 3-way or as required
 2. Enclosure: NEMA 4
 3. Power: 120Volt AC 60 Hz
 4. Energize/Fail Position: As indicated for individual valve function below
 5. Body & Cover: Stainless Steel

6. Pressure Rating: adequate to meet the working and transient / test pressures as shown on the drawings
7. Trim: Stainless Steel
8. Rubber Material: Buna-N
9. Adjustment Range 0-100 psi

2.5 LA ROSA PUMP STATION – PRESSURE RELIEF VALVE

- A. Furnish and install one (1) pressure relief valve at the La Rosa Pump Station.
- B. Equipment Tag: 14-PRV-201
 1. Size: 16-inch diameter
 2. Location: La Rosa Pump Station, Bypass Pipe
 3. Pressure Class: 150 psi
 4. Service: Potable Water
 5. Maximum Inlet Pressure (Working Pressure): 150 psig
 6. Control Range: 0 – 150 psig
 7. Pressure Setpoint: 150 psig
- C. Required Features
 1. Anti-cavitation trim
- D. Valve shall be designed to provide tight shutoff under conditions of no flow and shall not “hunt” under ordinary flow conditions. Valves shall be selected and sized as recommended by the valve manufacturer. Valve pressure setpoint shall be adjustable to at least 20 percent above and below the reduced pressure setpoint.
- E. Valve shall be pilot-operated. Valve shall be globe type with flanged ends.
- F. The valve will be Normally Closed, with the automatic operation determining the percent open based on operating conditions.

2.6 SPARE PARTS

- A. Furnish and deliver to Owner at site of work the following spare parts, all of which are identical and interchangeable with parts installed in system:
 1. Three (3) sets of spare gaskets, seals, o-rings, etc. (all types)
 2. One (1) spare speed controller
 3. One (1) spare transmitter
- B. Provide all other manufacturer's recommended spare parts necessary to maintain each unit in operation for period of one year.

- C. Pack in containers bearing labels clearly designating contents and pieces of equipment for which they are intended.
- D. Deliver spare parts at same time as equipment to which they pertain. CONTRACTOR shall properly store and safeguard such spare parts until completion of work, at which time they shall be delivered to Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all equipment in accordance with manufacturer's instructions and as indicated in plans.
- B. Prior to testing and start-up, inspect the installation to verify the system is ready for complete testing and calibration. Manufacturer factory representative to check and approve installation. On approval of installation, representative shall address a letter to the Owner stating that the valves are installed per the manufacturer's recommendations, and outlining all installation and start-up procedures.

3.2 CLEANING

- A. Carefully clean all installed equipment in a manner consistent with potable water service.
- B. Dismantle and clean new valves and other equipment before use. If packings are oily or dirty, repack valves with manufacturer's recommended packing.
- C. Clean all piping in a manner acceptable by the Owner prior to testing.

3.3 COORDINATION

- A. Coordinate with operations regarding all modifications to the existing facilities.
- B. Coordinate with Division 16 – Electrical regarding requirements of control valves.

3.4 STARTUP

- A. No form of energy shall be turned on to any part of the system prior to receipt by Owner of certified statement of approval of installation from CONTRACTOR containing his supplier's authorization to energize system, except that supplier's servicemen may do so for purposes of check-out.

3.5 TESTING

- A. After installation, and in presence of the Owner, test all components for tightness in acceptable manner. Furnish suitable testing plugs or caps, all necessary pipe connections, test fluids, gauges, other equipment and all labor required for these tests.

- B. Remove or isolate (valve off) from lines all instrumentation and appurtenant equipment which is incapable of withstanding the test pressures (e.g. rotometers).
- C. At the time of the tests make all adjustments necessary to place equipment in satisfactory working order.
- D. Repair or replace as necessary and retest all items failing to pass required tests at no additional cost to Owner.
- E. Clean, repair to satisfaction of the Owner, or replace all equipment or property damaged by testing procedures at no additional cost to the Owner.

3.6 TRAINING

- A. Furnish training to Owner's personnel on operation and maintenance of all installed components, to be provided by manufacturer's representative and at a time and place to be coordinated with Owner.

3.7 DEMONSTRATION/ACCEPTANCE

- A. After installation of equipment in the presence of the Owner, operate each unit to demonstrate its ability to operate without leakage and to perform its specified functions satisfactorily.

END OF SECTION

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SECTION 15121**ALTITUDE CONTROL VALVE****PART I – GENERAL****1.01 SCOPE OF WORK:**

- A. Provide a combination back pressure and solenoid shut-off valve with hydraulic check feature and shall automatically modulate to maintain upstream pressure above a preset minimum when activated by a solenoid control
- B. Furnish all materials, equipment, and labor and incidentals necessary to provide, install and put into operation one solenoid control valve as specified herein and shown on the plans.
- C. Equipment Tag: 100-AV-101

1.02 REFERENCES:

- A. American Society for Testing and Materials (ASTM).
- B. ASTM A48 Gray Iron Castings.
- C. ASTM A126 Gray Iron Castings for Valves, Flanges, and Pipe Fittings
- D. ASTM A436 Austenitic Gray Iron Casting.
- E. ASTM A536 Ductile Iron Casings.

1.03 SYSTEM DESCRIPTION:

- A. The arrangement shown on the plans is based upon the best information available to the Consultant at the time of design and is not intended to show exact dimensions to any specific equipment unless otherwise shown or specified. Therefore, it may be anticipated that the structural supports, foundations, and connected piping shown, in part or in whole, may have to be changed in order to accommodate the equipment furnished. No additional payment will be made for such changes. All necessary calculations and drawings for any related redesign shall be submitted to the Consultant for his approval prior to beginning the work.

1.04 QUALITY ASSURANCE:

- A. The valve shall be the product of a manufacturer regularly engaged in the manufacture of hydraulic valves having similar service and size. The valves covered by the specifications are intended to be standard equipment that has proven ability and shall be new, free from defects or contamination.
- B.

- C. The listing above does not imply that the manufacturer's standard product is acceptable. The successful manufacturer will be required to conform to all specifications.
- D. Unit Responsibility and Coordination:
The CONTRACTOR shall cause all equipment specified under this section to be furnished by the valve manufacturer who shall be responsible for the adequacy and compatibility of all unit components including but not limited to the valve, actuator and extension stems. Any component of each complete unit not provide by the valve manufacturer shall be designed, fabricated, tested, and installed by factory authorized representatives experienced in the design and manufacture of the equipment. This requirement, however, shall not be construed as relieving the CONTRACTOR of the overall responsibility for this portion of the work.

1.05 SUBMITTALS:

- A. Provide the following in conformance with applicable requirements contained in Section 01300 – Submittals. Shop drawings shall be complete with bill-of-materials showing kind and class of materials and catalog and engineering data showing compliance with the specified requirements.
- B. Submittals required after award of contract and prior to shipping:
 - 1. Technical bulletins and brochures.
 - 2. Certification of compliance with specifications.
 - 3. Fabrication drawings.
 - 4. Manufacturer specification.
 - 5. Cavitation chart showing flow rate, differential pressure, percentage of valve opening, Cv factor, and system velocity.
 - 6. Shop Test Reports.
 - 7. Complete Bill of Materials.
 - 8. Weight of Valve.
- C. Submittals required prior to final walk through:
 - 1. Operation and Maintenance Manual.

1.06 SPARE PARTS AND TOOLS:

- A. A spare speed controller and a spare transmitter shall be furnished and delivered to the Owner as spare parts.

1.07 OPERATING INSTRUCTIONS:

- A. A factory representative of all major component manufacturers, who has complete knowledge of proper operation and maintenance, shall be provided for one day to instruct representatives of the Owner on proper operation and maintenance. If there are difficulties in operation of the equipment during instruction sessions, additional sessions shall be provided at no cost to the Owner.
- B. Prior to scheduling instructions, submit outline of instructions to Consultant for approval.

- D. Operating and maintenance manual shall be explained during these instructions.

1.08 EQUIPMENT STORAGE AND HANDLING:

- A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.
- B. All equipment and parts must be properly protected against any damage during a prolonged period at the site.
- C. The finished surfaces of all exposed flanges shall be protected by wooden blank flanges, strongly built and securely bolted thereto.
- D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- E. Storage and Protection: Take special care to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, preventing any deformation.

1.09 WARRANTY:

- A. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no expense to the Owner. Warranty shall be for a period of two (2) years and begin from the date of Final Acceptance.

PART 2 - PRODUCTS

2.01 MANUFACTURER:

- A. Altitude valve shall be Model 58-01 combination back pressure & solenoid shut-off valve as manufactured by Cla-Val Co. No approved equals.

2.02 MAIN VALVE:

- A. The valve shall be hydraulically operated, single diaphragm actuated, globe pattern. The valve shall consist of three major components: the body with seat installed, the cover with bearing installed, and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls. Valve body and cover shall be of cast material manufactured and machined in North America. Y-pattern valves shall not be permitted. No fabrication or welding shall be used in the manufacturing process. Valve shall have NSF 61 approval.
- B. The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-section contained on three and one-half sides by a disc retainer and forming a tight seal against a

single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface. No hourglass-shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used.

- C. The diaphragm assembly containing a non-magnetic 303 stainless steel stem of sufficient diameter to withstand high hydraulic pressures shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one-piece design and shall have a minimum of a five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.
- D. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The diaphragm must withstand a Mullins burst test of a minimum of 600 psi per layer of nylon fabric and shall be cycle tested 100,000 times to insure longevity. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully open or fully closed position.
- E. Valve seat in eight inch and larger size valves shall be retained by flat head machine screws for ease of maintenance. The seat shall be of the solid, one piece design and shall have a minimum of a five degree taper on the seating surface for positive drip tight shut-off. Pressed-in bearings and/or multi-piece seats shall not be permitted. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline.
- F. The valve manufacturer shall be able to supply a complete line of equipment from 1-1/4 inch through 24 inch sizes and a complete selection of complimentary equipment. The valve manufacturer shall also provide a computerized cavitation chart which shows flow rate, differential pressure, percentage of valve opening, Cv factor, system velocity, and if there will be cavitation damage. An orifice plate shall be provided upon determination of system characteristics and evaluation of system requirements and analysis.

2.03 MATERIAL SPECIFICATION:

- 1. Valve size: 12 inch Full Port
- 2. Main Valve Body and Cover: Ductile Iron / ASTM A-536
- 3. Main Valve Trim: 316L Stainless Steel
- 4. Stem: 303 Stainless Steel
- 5. End Detail: ANSI B16.42 150 LB. FLG.
- 6. Pressure Rating: 200 PSI

7. Temperature Range: -40 to +180 Degrees F
8. Rubber Material: Buna "N"
9. Coating: Epoxy coated by baked on resin fusion method process 10 mils thick internal & external, with 3 mil polyurethane coating as identified in Technical Specification 09900.

2.04 OPTIONS:

- A. X101 Valve Position Indicator.
- B. Shutoff Isolation Valve – Isolates Pilot System
- C. Check Valves with Isolation Valves
- D. Valve and fittings shall be configured for exterior installation and freeze protected with heat trace cable and weatherproof insulation.
- E. Valve shall have brass isolation cocks.
- F. Valve shall NOT vent to atmosphere.
- G. Altitude valve shall be normally open and shall fail in the close position during a power outage.
- H. Valve shall include a pressure gauge on both the suction and discharge side of the valve. Pressure gauge must be stainless steel, liquid filled, reading pressure and feet of water. 0-200 psi inlet and 0-100 psi outlet.
- I. Opening and closing speed control.

A.05 PILOT CONTROL SYSTEM:

- A. The pressure relief/sustaining pilot shall be a direct-acting, adjustable, spring-loaded, diaphragm valve designed to permit flow when controlling pressure exceeds the adjustable spring setting. The pressure relief pilot control is normally held closed by the force of the compression in the spring above the diaphragm and it opens when the pressure acting on the underside of the diaphragm exceeds the spring setting. Pressure relief pilot control sensing shall be upstream of the pilot system strainer so accurate control may be maintained if the strainer is partially blocked. Pilot shall comply with NSF/ANSI 61 and certified lead free to NSF/ANSI 372 as a safe drinking water system component.
- B. The pilot control system shall include a strainer and needle valve, a fixed orifice closing speed and all required control accessories, equipment, control tubing and fittings. No variable orifice shall be permitted. The pilot system shall include an opening speed control on all valves sizes 3” and smaller as standard equipment. The pilot system shall include isolation ball valves on sizes 4” and larger as standard equipment. A full range of spring settings shall be available in ranges 0 to 400 psi. Pilots to be manufactured by control valve manufacturer.

- C. The electric solenoid pilot control shall be a direct acting three way solenoid valve controlling a two way hydraulic diaphragm valve. Solenoid is controlled by 120 volt AC with NEMA type 4 enclosure, which upon being powered shall hydraulically close the main valve. A direct factory representative shall be made available for start-up service, inspection and necessary adjustments.
- D. MATERIAL SPECIFICATION FOR PILOT CONTROL:
 - 1. Body & Cover: Cast Bronze ASTM B62
 - 2. Pressure Rating: 150 PSI
 - 3. Trim: 303 Stainless Steel
 - 4. Rubber Material: Buna "N"
 - 5. Tubing and Fittings: Stainless Steel
 - 6. Operating Fluids: Potable Water
 - 7. Voltage: 120 Volt AC 60 Hz
 - 8. Adjustment Range: 0-100 PSI
 - 9. Enclosure Type: Nema 4 Watertight

PART 3 - EXECUTION

3.01. INSTALLATION:

- A. The valve shall be installed in accordance with the instructions of the manufacturer and as shown on the drawings.
- B. Installation and adjustment shall be checked and approved by a manufacturer's direct factory representative. After acceptance, the representative shall address a letter to the Consultant outlining all installation and start up procedures. The letter shall include a statement that the valves are installed per the manufacturer's recommendations. The manufacturer or his qualified representative shall conduct training session for the Owner's personnel in the operation and maintenance of the valves.
- C. The valve manufacturer shall provide a direct factory representative to calibrate the valve and verify operation during start up.

3.02 PROTECTIVE COATINGS:

- A. All interior non-working ferrous surfaces other than stainless steel shall be given fusion bonded epoxy coatings. The interior waterway passages of all valves shall be given a shop applied coating system unless provided with a shop applied epoxy coating. The exterior surfaces shall have a coating system equal to the steel pipe exterior coating system.

3.04 COORDINATION WITH INSTRUMENTATION:

- A. The CONTRACTOR is responsible to coordinate with Division 16 regarding the requirements of control valves.

END OF SECTION

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SECTION 15140**PIPE SUPPORTS FOR PROCESS PIPING****PART 1 - GENERAL****1.01 DESCRIPTION****A. Scope of Work:**

1. Furnish all labor, materials, equipment and incidentals and install pipe hangers, supports, concrete inserts, and anchor bolts including all metallic hanging and supporting devices for supporting exposed piping.

B. Related Work Described Elsewhere:

1. Division 3 – Concrete
2. Division 5 – Metals
3. Section 09900 – Paintings and Coatings
4. Division 15 – Mechanical Pipe and Fittings

1.02 QUALITY ASSURANCE

- A. Hangers and supports shall be of approved standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for pipe supports shall be five (5) times the ultimate tensile strength of the material, assuming 10 feet of water filled pipe being supported.
- B. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, the Contractor shall submit a certification stating that such requirements have been complied with.

1.03 SUBMITTALS**A. Materials and Shop Drawings:**

1. Submit to the Engineer for approval, as provided in the General Requirements and Section 01300 – Submittals, shop drawings of all items to be furnished under this Section.
2. Product Data: submit manufacturer's catalog data including load capacity.
3. Shop Drawings: Indicate system layout with location – including critical dimensions, sizes, and pipe hanger and support locations – and detail of trapeze hangers, anchors, and guides.

4. Submit signed and sealed Shop Drawings with design calculations and assumptions for load carrying capacity of trapeze, multiple pipe, and riser support hangers.
 5. Submit calculations sealed by a registered professional engineer in the State of Texas.
- B. Submit to the Engineer, for approval, samples of all materials specified herein.
 - C. Manufacturer's Instructions: Submit special procedures and assembly of components.
 - D. Spare Parts: Furnish one set of manufacturer's recommended spare parts.

1.04 PRODUCT DELIVERY STORAGE AND HANDLING

- A. The equipment provided under this section shall be shipped, handled and stored in accordance with the Manufacturer's written instructions, and in accordance with requirements in Division 1 – General Requirements.

1.05 WARRANTY AND GUARANTEES

- A. Provide equipment warranty in accordance with Section 01600 – Materials and Equipment.
- B. Furnish two (2) year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All pipe and tubing shall be supported as required to prevent significant stresses in the pipe or tubing material, valves, and fittings and to support and cure the pipe in the intended position and alignment. All supports shall be designed to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact. All pipe supports shall be approved prior to installation.
- B. The Contractor shall select and design all piping support systems within the specified spans and component requirements. Structural design and selection of support system components shall withstand the dead loads imposed by the weight of the pipes filled with water, plus any insulation. Commercial pipe supports and hangers shall have a minimum safety factor of 5.
- C. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports and details on any drawings shall not relieve the Contractor of the responsibility for providing them throughout the plant.
- D. All support anchoring devices, including anchor bolts, inserts and other devices used to anchor the support onto a concrete base, roof, wall or structural steel works, shall be of

the proper size, strength and spacing to withstand the shear and pullout loads imposed by loading and spacing on each particular support.

- E. All materials used in manufacturing hangers and supports shall be capable of meeting the respective ASTM Standard Specifications with regard to tests and physical and chemical properties, and be in accordance with MSS SP-58.
- F. Hangers and supports shall be spaced in accordance with ANSI B31.1.0 except that the maximum unsupported span shall not exceed 10 feet unless otherwise specified herein.
- G. Unless otherwise specified herein, pipe hangers and supports shall be as manufactured by ITT Grinnel Co., Inc., Carpenter and Patterson, Inc., or equal. Any reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product, and shall not be considered as proprietary. Any item comparable in type, style, quality, design and performance will be considered for approval.

2.02 MATERIALS AND EQUIPMENT

A. Pipe Hangers and Supports for Metal Pipe:

- 1. Suspended single pipes shall be supported by hangers suspended by steel rods from galvanized concrete inserts, beam clamps, or ceiling mounting bolts as follows:

a. Hangers

<u>Pipe Size, Inches</u>	<u>Grinnel Fig. No.</u>
Less than 1/2	138R
1/2 through 1	97C
1-1/4 through 4	104
6 through 12	590
14 through 30	171

- b. Hanger rods shall be rolled steel machine threaded with load ratings conforming to ASTM Specifications and the strength of the rod shall be based on root diameter. Hanger rods shall have the following minimum diameters:

<u>Pipe Size, Inches</u>	<u>Min. Rod Diameter, In.</u>
Less than 2-1/2	3/8
2-1/2 to 3	1/2
4	5/8
6	3/4
8 to 12	7/8
14 to 18	1

- c. Where applicable, structural attachments shall be beam clamps. Beam clamps, for rod sizes 1/2-inch through 3/4-inch shall be equal to Grinnel Fig. No. 229, and for rod sizes 7/8-inch through 1-1/4 inches shall be equal to Grinnel Fig. No. 228, or equal.

- d. Concrete inserts for pipe hangers shall be; continuous metal inserts designed to be used in ceilings, walls or floors, spot inserts for individual pipe hangers, or ceiling mounting bolts for individual pipe hangers and shall be as manufactured by Unistrut Corp., Wayne, Michigan; Carpenter and Patterson, Inc., Laconia, New Hampshire; Richmond or equal and shall be as follows:
 - i. Continuous concrete inserts shall be used where applicable and/or as shown on the Drawings and shall be used for hanger rod sizes up to and including 3/4-inch diameter. Inserts to be used where supports are parallel to the main slab reinforcement shall be Series P3200 by Unistrut Corp., Fig 1480 Type 2 by Carpenter and Patterson, Inc., or equal. Inserts to be used where supports are perpendicular to the main slab reinforcement shall be Series P3300 by Unistrut Corp., Fig. 1480 Type I by Carpenter and Patterson, Inc. or equal.
 - ii. Spot concrete inserts shall be used where applicable and shall be used for hanger sizes up to and including 7/8-inch diameter. Inserts shall be Fig. 650 by Carpenter and Patterson, Inc. for hanger rod sizes 1/2-inch through and including 3/4-inch, and Fig. 266 by Carpenter and Patterson Inc., for 7/8-inch hanger rods.
 - iii. Ceiling mounting bolts shall be used where applicable and be for hanger rod sizes 1-inch through and including 1-1/4 inches and shall be Fig. 104M as manufactured by Carpenter and Patterson, Inc., or equal.
 - e. All pipe hangers shall be capable of vertical adjustment under load and after erection. Turnbuckles, as required and where applied, shall be equal to Grinnel Fig. No. 230.
2. Wall or column supported pipes shall be supported by welded steel brackets equal to Grinnel Fig. 194, 195 and 199 as required, for pipe sizes up to and including 20-inch diameter. Additional wall bearing plates shall be provided where required.
 - a. Where the pipe is located above the bracket, the pipe shall be supported by an anchor chair and U-bolt assembly supported by the bracket for pipes 4 inches and larger and by a U-bolt for pipes smaller than 4 inches. Anchor chairs shall be equal to Carpenter Patterson Fig. No. 127. U-bolts shall be equal to Grinnel Fig. No. 120 and 137.
 - b. Where the pipe is located below the bracket, the pipes shall be supported by pipe hangers suspended by steel rods from the bracket. Hangers and steel rods shall be as specified above.
 3. Floor supported pipes 3-inches and larger in diameter shall be supported by either cast-in-place concrete supports or adjustable pipe saddle supports as directed by the Engineer. In general, concrete supports shall be used when lateral displacement of the pipes is probable (unless lateral support is provided), and

adjustable pipe saddle type supports shall be used where later displacement of pipes is not probable.

- a. Each concrete support shall conform to the details shown on the Drawings. Concrete shall be poured after the pipe is in place with temporary supports. Concrete piers shall conform accurately to the bottom 1/3 to 1/2 of the pipe. Top edges and vertical corners of each concrete support shall have 1-inch bevels. Each pipe shall be secured on each concrete support by a wrought iron or steel anchor strap anchored to the concrete with cast-in-place bolts or with expansion bolts. Where directed by the Engineer, vertical reinforcement bars shall be grouted into drilled holes in the concrete floor to prevent overturning or lateral displacement of the concrete support. Unless otherwise approved by the Engineer, maximum support height shall be five (5) feet.
- b. Concrete piers used to support base elbows and tees shall be similar to that specified above. Piers may be square or rectangular.
- c. Each adjustable pipe saddle support shall be screwed or welded to the corresponding size 150 pound companion flanges or slip-on welding flanges respectively. Supporting pipe shall be of Schedule 40 steel pipe construction. Each flange shall be secured to the concrete floor by a minimum of two (2) expansion bolts per flange. Adjustable saddle supports shall be equal to Grinnel Fig. No. 264. Where used under base fittings, a suitable flange shall be substituted for the saddle.

4. Vertical piping shall be supported as follows:

- a. Where pipes change from horizontal to vertical, the pipes shall be supported on the horizontal runs within 2 feet of the change in direction by pipe supports as previously specified herein.
- b. For vertical runs exceeding 15 feet, pipes shall be supported by approved pipe collars, clamps, brackets, or wall rests at all points required to insure a rigid installation.
- c. Where vertical piping passes through a steel floor sleeve, the pipe shall be supported by a friction type pipe clamp which is supported by the pipe sleeve. Pipe clamps shall be equal to Grinnel Fig. 262.

5. Anchor bolts shall be equal to Kwik-Bolt as manufactured by the McCulloch Industries, Minneapolis, Minnesota, or Wej-it manufactured by Wej-it Expansion Products, Inc., Bloomfield, Colorado.

6. All rods, hangers, inserts, brackets, and components shall be furnished with galvanized finish.

B. Pipe Hangers and Supports for Plastic Pipe:

1. Single plastic pipes shall be supported by pipe supports as previously specified herein.

2. Multiple, suspended, horizontal plastic pipe runs, where possible, and rubber hose shall be supported by ladder type cable trays such as the Electray Ladder by Husky-Burndy, the Globetray by the Metal Products Division of United States Gypsum, or equal. Ladder shall be of mild steel construction. Rung spacing shall be approximately 18 inches for plastic pipe and 12 inches for rubber hose. Tray width shall be approximately 6-inch for single runs of rubber hose and 12 inches for double runs of rubber hose. Ladder type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc. required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps or fasteners equal to Globe Model M-CAC, Husky-Burndy Model SCR or approved equal. Spacing between clamps shall not exceed 9 feet. The cable trays shall provide continuous support along the length of the pipe.
3. Individual clamps, hangers, and supports in contact with plastic pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

C. Pipe Supports for Small Diameter PVC, CPVC and Steel Pipe:

1. Small diameter Schedule 80 PVC piping 3-inches in diameter and smaller, and steel piping 2-inches in diameter and smaller shall be supported with "SUSPORT" system arrangements as manufactured by Universal Suspension Systems Inc. of Gillette, New Jersey or an equal approved by the Engineer. Clamping halves for the pipe support shall be manufactured of molded polypropylene and shall support and fit closely for 360° around the pipe. To support piping carrying non-corrosive fluids or gases and located in noncorrosive, indoor environments, all hardware for the "SUSPORT" system shall be nickel chrome plated carbon steel. To support piping carrying corrosive fluids or gases, piping located in corrosive environments or piping located outdoors, all hardware for the system shall be as indicated in the contract drawings.
2. In some cases, to adequately support small diameter PVC or steel piping, a metal frame support structure may be required for support of the "SUSPORT" system specified above. Where required, metal frame support structures shall be constructed using channels, fittings, brackets, hardware and other accessories as manufactured by B-Line Systems, Inc. of Highland, Illinois, or an equal approved by the Engineer. If located in indoor, non-corrosive environments, the materials for the frame structure shall be carbon steel with an epoxy coating applied by a cathodic, electro-deposition process which is equal to "Dura-a-Green" by B-Line Systems, Inc. For corrosive or outdoor environments, the materials for the frame structure be Type 316 stainless steel unless otherwise noted on the Drawings. Hardware used to construct the frame support structure shall be cadmium plated for carbon steel supports or Type 316 stainless steel for stainless steel supports.
3. Pipe supports for small diameter PVC and steel piping shall be located wherever necessary in the opinion of the Engineer to adequately support the pipe, however, they shall have a maximum spacing as specified below for straight pipe runs.

Adequate supports shall especially be used adjacent to valves and fittings in pipelines. The following table is based on spacing requirements for Schedule 80 PVC or Standard Weight (Schedule 40) steel pipe carrying a fluid with a Specific Gravity of 1.0 at a temperature not exceeding 120°F. Support spacing for PVC or steel piping carrying fluids with Specific Gravities or temperatures exceeding those stated above shall be approved by the Engineer.

Nominal Pipe Diameter, Inches	Support Spacing, Feet	
	PVC Pipe	Steel Pipe
1/2"	3.5	4.5
3/4"	4.0	5.0
1"	4.5	5.5
1-1/4"	5.0	6.5
1-1/2"	5.0	7.5
2"	5.5	8.0
2-1/2"	5.5	-
3"	6.0	-

- D. Fluoride Feed 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. Stainless Steel 304 or 316 is not acceptable. 6. All hardware to be fiber-reinforced plastic made from vinylester resin.
 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 equal.

2.03 QUALITY CONTROL

- A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Prior to prime coating, all pipe hangers and supports shall be thoroughly clean, dry and free from all mill-scale, rust, grease, dirt, paint and other foreign substances to the satisfaction of the Engineer.
- B. All submerged pipe supports shall be prime coated with Koppers 654 Epoxy Primer or approved equal. All other pipe supports shall be prime coated with Rustinhibitive Primer No. 621 as manufactured by Koppers Company, Inc., Pittsburgh, Pa., or equal.

- C. Finish coating shall be compatible with the prime coating used and shall be applied as specified in Section 09900 – Paintings and Coatings.

3.02 INSTALLATION

- A. All pipes, horizontal and vertical, shall be rigidly supported from the building structure by approved supports. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or specified herein. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless it is so indicated on the Drawings, or specifically directed or authorized by the Engineer.
- B. All pipe supports shall be designed with liberal strength and stiffness to support the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement, and pressure forces, thermal expansion and contraction, vibrations, and all probable externally applied forces. Prior to installation, all pipe supports shall be approved by the Engineer.
- C. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings, and sleeve type couplings and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.
- D. Pipe supports shall be provided as follows:
 - 1. Cast iron and ductile iron shall be supported at a maximum support spacing of 10 feet, 0-inches with minimum of one support per pipe section at the joints.
 - 2. All vertical pipes shall be supported at each floor or at intervals of at least 15 feet by approved pipe collars, clamps brackets or wall rests, and at all points necessary to insure rigid construction.
- E. Effects of thermal expansion and contraction of the pipe shall be accounted for in pipe support selection and installation.
- F. Inserts for pipe hangers and supports shall be installed on forms before concrete is poured. Before setting these items, all Drawings and figures shall be checked which have a direct bearing on the pipe location. Responsibility for the proper location of pipe supports is included under this Section.
- G. Continuous metal inserts shall be embedded flush with the concrete surface.
- H. Standard Pipe Supports:
 - 1. Horizontal Suspended Piping:
 - a. Single Pipes: Adjustable swivel-ring, splint-ring, or clevis hangers.
 - b. Grouped Pipes: Trapeze hanger systems.
 - c. Furnish galvanized steel protection shield and oversized hangers for all insulated pipe.

- d. Furnish precut sections of rigid insulation with vapor barrier at hangers for all insulated pipe.
2. Horizontal Piping Supported From Walls:
- a. Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.
 - b. Stacked Piping:
 - 1) Wall mounted framing system and clips acceptable for piping smaller than 3-inch minimal diameter.
 - 2) Piping clamps which resist axial movement of pipe through support not acceptable.
 - c. Wall mounted piping clips not acceptable for insulated piping.
3. Horizontal Piping Supported From Floors:
- a. Stanchion Type:
 - 1) Pedestal type; adjustable with stanchion, saddle, and anchoring flange.
 - 2) Use yoke saddles for piping whose centerline elevation is 18 inches or greater above the floor and for all exterior installations.
 - 3) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.
 - b. Floor Mounted Channel Supports:
 - 1) Use for piping smaller than 3-inch nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.
 - 2) Attach channel framing to floors with anchor bolts.
 - 3) Attach pipe to channel with clips or pipe clamps.
 - c. Concrete Cradles: Use for piping larger than 3-inch along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.
4. Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.
5. Standard Attachments:

- a. To Concrete Ceilings: Concrete inserts.
 - b. To Steel Beams: I-beam clamp or welded attachments.
 - c. To Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
 - d. To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.
6. Existing Walls and Ceilings: Install as specified for new construction, unless shown otherwise.

END OF SECTION

SECTION 15141**COUPLINGS, CONNECTORS, AND ADAPTERS****PART 1 GENERAL****1.01 DESCRIPTION**

- A. Section includes:
1. Dismantling Joints
 2. Flanged Coupling Adapters with thrust harness
 3. Mechanical Couplings
 4. Grooved Joint Couplings
 5. Flexible Couplings
 6. Transition Coupling
 7. Expansion Joint
- B. Scope of Work: Furnish and install couplings and connectors of the type(s) and size(s) in the location(s) shown on the Drawings and as specified herein. Pipe supports shall be placed where shown on the Drawings. The Contractor may install additional pipe supports and flexible couplings to facilitate piping installation, provided that complete details describing their location, the pipe supports and hydraulic thrust protection are submitted. Thrust protection shall be adequate to sustain the force developed by 150% of the design operating pressures specified.
- C. Related Work Described Elsewhere:
1. Section 15000 – Mechanical General Requirements
 2. Section 15085 – Water Pipeline Testing
- D. General Design: shall meet or exceed the following design criteria:
1. Working pressure: Working pressure shall be equivalent to working pressure designated under Section 15055- Steel Pipe.
 2. Coating requirement: Fusion bonded epoxy Coating
 3. Buried and submerged – Type 316 Stainless Steel conforming to ASTM F593 bolts and ASTM F594 nuts.
 4. Apply paint to steel coupling as required for adjoining pipe.
 5. Flanges shall be Class D in accordance with AWWA C207.

1.02 QUALITY ASSURANCE

- A. Minimum pressure rating equal to that of the pipeline in which they are to be installed.

- B. Couplings and connectors, other than those specified herein, are subject to the Engineer's approval.

1.03 SUBMITTALS

- A. Materials and Shop Drawings
 - 1. Submit shop drawings in accordance with the Section 01300 – Submittals.
 - 2. Submit manufacturer's catalog data on couplings and connectors. Show manufacturer's model or figure number for each type of coupling or joint for each type of pipe material for which couplings are used.
 - 3. Submit manufacturer's recommended torques to which the coupling bolts shall be tightened for the flexible gasketed sleeve-type compression pipe couplings.
 - 4. Show materials of construction by ASTM reference and grade. Show dimensions.
 - 5. Show number, size and material of construction of the rods and lugs for each thrust harness on the project.

1.04 PRODUCT DELIVERY STORAGE AND HANDLING

- A. Equipment shall be handled, shipped and stored in accordance with Section 01600 – Material and Equipment.

1.05 WARRANTY AND GUARANTEES

- A. Provide equipment warranty in accordance with Section 01600 – Material and Equipment.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. All Couplings and Connectors
 - 1. Gasket Materials: Composition suitable for exposure to the liquids to be contained within the pipes.
 - 2. Diameters to properly fit the specified types of pipes on which couplings and connectors are to be installed.
- B. Dismantling Joints for Steel Piping
 - 1. Manufacturers:
 - a. Romac Industries, Inc., Style DJ400.
 - b. Dresser Style 131
 - c. Viking Johnson.
 - d. Smith Blair 975.
 - 2. Materials:

- a. Flanged spool:
 - i. C207 Schedule 40 pipe in accordance with ASTM A 53 for sizes 2 to 12 inches.
 - ii. Steel for pipe in accordance with ASTM A 36 or A53 for sizes 14 inches to 72 inches.
 - b. Bolts and hex nuts:
 - i. Aboveground: High strength, low alloy steel in accordance with AWWA C111.
 - ii. Buried and underwater: Type 316 stainless Steel bolts in accordance with ASTM F593.
 - c. Tie rods: High tensile steel in accordance with ASTM A 193 grade B7.
 - d. Coating and lining: Fusion bonded epoxy certified in accordance with NSF 61.
- C. Flanged Coupling Adapters with Thurst Harness:
- 1. For joining plain end or grooved end pipe to flanged pipes and fittings.
 - 2. Adapters shall conform in size and bolt hole placement to ANSI standards for steel and/or cast iron flanges 125 or 150 pound standard unless otherwise required for connections.
- 1. Manufacturers:
 - a. Dresser, Inc., Style 128.
 - b. Smith-Blair, Inc, Series 913
 - c. Viking Johnson.
 - 2. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
 - 3. Exposed Sleeve Type (Steel Piping):
 - a. Constructed from steel
 - b. Coating: Enamel
 - c. Bolts: Carbon steel
 - 4. Buried Sleeve Type (Steel Piping):
 - a. Construction: Fabricated from carbon steel w/ANSI flanges to match the connecting piping.
 - b. Finish: Pickled & Passivated or Electropolished to match connected stainless steel piping.
 - c. Bolts: Type 316 Stainless Steel as specified within Section 15055 –Steel Pipe and Fittings
- D. Sleeve-Type Couplings for Steel Pipe
- 1. Exposed couplings (when applicable):
 - a. Steel middle ring
 - b. Two steel follower rings

- c. Two wedge-section gaskets
 - d. Sufficient steel bolts to properly compress the gaskets
 - e. Acceptable manufacturers
 - (1) Dresser Manufacturing Co. - Style 38
 - (2) Smith - Blair, Inc. - Style 411
 - (3) Or equal
2. Buried Couplings (when applicable):
- a. Cast - iron middle rings with pipe stops removed.
 - b. Two malleable iron follower rings with ribbed construction.
 - c. Two wedge-section gaskets.
 - d. Bolts and nuts for buried couplings, shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8 for bolts, and ASTM A 194, Grade 8 for nuts. Bolts and nuts greater than 1 1/8 inches shall be carbon steel, ASTM A 307, Grade B, with cadmium plating, ASTM A 165, Type NS.
 - e. Except as otherwise specified, couplings for buried service shall have all metal parts painted with Epoxy paint and conform to AWWA C219.
 - f. Acceptable manufacturers:
 - (1) Dresser Manufacturing Co. - Style 53
 - (2) Smith-Blair, Inc. - Style 411
 - (3) Baker Style 200
 - (4) Or equal
- E. Insulating Mechanical Coupling (connecting existing pipe to new pipe as indicated on the Drawings) and shall be double insulated.
- 1. The insulating coupling shall stop electrolytic action by physically and electrically isolating the existing pipe from the new pipe.
 - 2. Insulating washers on the nuts shall be used for the restraining roads and to provide a complete dielectric coupling.
 - 3. Bolts and nuts for buried couplings, shall be Type 316 stainless steel to ASTM A 193, Grade B8 for bolts, and ASTM A 194, Grade 8 for nuts.
 - 4. Insulating Mechanical Coupling for Steel Pipe
 - a. Double insulated
 - b. Acceptable Manufacturers
 - (1) Smith Blair Style 416

- (2) Baker Style 216
 - (3) Or equal
- 5. Mechanical couplings shall be rated to meet or exceed the working pressures and surge pressure of the pipe.
 - 6. Pipe ends for mechanical couplings shall conform to AWWA C200 and M-11. The shop applied outside coating shall be held back as required for field assembly of the mechanical coupling or to the harness lugs or rings. Harness lugs or rings and pipe ends shall be painted with one shop coat of epoxy conforming to AWWA C210. The inside lining shall be continuous to the end of the pipe.
 - 7. Insulating mechanical couplings shall be as specified in Section 13110 – Cathodic Protection.
- F. Split Type (Grooved End) Couplings (when applicable):
- 1. Constructed from malleable or ductile iron.
 - 2. For use with grooved or shouldered end pipe with minimum wall thickness as required so as not to weaken pipe.
 - 3. Cast in two segments for 3/4-inch through 14-inch pipe sizes, four segments for 15-inch through 24-inch pipe sizes, and six segments for pipe sizes over 24-inch.
 - 4. Coating: Enamel
 - 5. Bolts: Carbon steel
 - 6. Acceptable manufacturers:
 - a. Victaulic Company of America, Style 77
 - b. Gustin-Bacon Co.
 - c. Or equal
 - 7. Buried Sleeve Type:
 - a. Constructed from cast iron
 - b. Bolts and nuts for buried sleeves shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8 for bolts, and ASTM A 194, Grade 8 for nuts and washers. Bolts and nuts greater than 1 1/8 inches shall be carbon steel, ASTM A 307, Grade B, with cadmium plating, ASTM A 165, Type NS
 - c. Acceptable manufacturers:
 - (1) Dresser Manufacturing Co. - Style 127 locking type for cast iron, ductile iron, asbestos cement and steel pipes with diameters of 3 inches through 12 inches.
 - (2) Or equal

8. Split Type (Ferrous Piping):
 - a. Constructed from malleable or ductile iron
 - b. For use with grooved or shouldered end pipe
 - c. Coating: Enamel
 - d. Acceptable manufacturers:
 - (1) Victaulic Company of America - Style 741 for pipe diameters of 2 inches through 12 inches
 - (2) Victaulic Company of America - Style 742 for pipe diameters of 14 inches through 16 inches.
 - (3) Or equal
9. Split Type (Stainless Steel Piping):
 - a. Construction: Cast Type 316 Stainless Steel, ASTM A 351 Grade CF-8M w/ EPDM gasket material.
 - b. For use with grooved or shouldered end pipe
 - c. Finish: Smooth Electropolished
 - d. Acceptable manufacturers:
 - (1) Victaulic Company of America - Style 77S for pipe diameters of 2 inches through 12 inches with pressures less than 300 psi.
 - (2) Piedmont Pacific Corporation - Style K for pipe diameters of 2 inches through 8 inches with pressures less than 200 psi, Style B for pipe diameters of 2 inches through 4 inches with pressures less than 300 psi.
- G. Deflection Joints:
 1. Joints designed to permit a nominal maximum deflection of 15 degrees in all directions from the axis of the adjacent pipe length, will prevent pulling apart, and will remain watertight at any angle of deflection under 15 degrees.
 2. Material to be manufactured from a composition material suitable for exposure to the liquid, pressure and temperature to be contained within the pipe.
 3. Supplied with control rods as required.
- H. Transition Couplings: Transition couplings for connecting different pipes having different outside diameters shall be steel: Dresser Style 62 or 162, Rockwell Series 413, Baker Series 212 or 240, or equal.

2.02 ACCESSORIES

A. Joint Harnesses:

1. Tie bolts or studs shall be as shown in the following table. Bolt or stud material shall conform to ASTM B 193, Grade B7. Nuts shall conform to ASTM A 194, Grade 2H. Lug material shall conform to ASTM A 36, ASTM A 283, Grade B, C, or D, or ASTM A 285, Grade C. Lug dimensions shall be as shown in AWWA Manual M11, Table 19.7.

TIE BOLTS OR STUD REQUIREMENTS FOR FLEXIBLE PIPE COUPLINGS

Tie Bolt or Stud Minimum Requirements

Nominal Pipe Size (Inches)	150 psi		300 psi	
	No. Bolts or Studs	Size (Inches)	No. Bolts or Studs	Size (Inches)
2	2	5/8	2	5/8
3	2	5/8	2	5/8
4	2	5/8	2	4/8
6	2	5/8	2	5/8
8	2	5/8	2	5/8
10	2	5/8	2	5/8
12	2	3/4	2	7/8
14	2	3/4	2	1
16	2	7/8	2	1-1/4
18	2	1	2	1-3/8
20	2	1	2	1-1/2
24	4	1	4	1-1/4
30	4	1-1/8	4	1-1/2
36	4	1-1/4	4	1-3/4
42	4	1-1/2	6	1-5/8
48	6	1-3/8	6	1-7/8
54	6	1-1/2	6	2-1/4
60	6	1-5/8	8	2
66	6	1-3/4	8	2-1/4
72	6	1-7/8	10	2-1/4
84	6	2-1/4	12	2-1/4
96	8	2-1/4	14	2-1/4

2. Select number and size of bolts based on the test pressure shown in Section 15085 – Water Pipeline Testing. For test pressures less than or equal to 150 psi, use the 150-psi design in the table above.
3. Provide washer for each lug. Washer material shall be the same as the nuts. Minimum washer thickness shall be 1/8-inch.

- B. Bolts and Nuts for Flanges:
1. Bolts and nuts for flanges located indoors and in enclosed vaults and structures shall be carbon steel, ASTM A 307, Grade B.
 2. Bolts and nuts for buried and submerged flanges, flanges in open vaults and structures, and flanges located outdoors above ground shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M for bolts, and ASTM A 194, Grade 8M for nuts. Bolts and nuts greater than 1 1/8-inches shall be carbon steel, ASTM A 307, Grade B., with cadmium plating, ASTM A 165, Type NS.
 3. Bolts used in flange insulation kits shall conform to ASTM B 193, Grade B7. Nuts shall comply with ASTM A 194, Grade 2H.
 4. Provide washers for each unit. Washers shall be of the same material as the nuts.

2.03 QUALITY CONTROL

- A. CONTRACTOR shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Sleeve Type Couplings (when applicable):
1. Thoroughly clean pipe ends for a distance of 8 inches from the ends prior to installing couplings, and use soapy water as a gasket lubricant.
 2. Slip a follower ring and gasket (in that order) over each pipe and place the middle ring centered over the joint.
 3. Insert the other length into the middle ring the proper distance.
 4. Press the gaskets and followers evenly and firmly into the middle ring flares.
 5. Insert the bolts, finger tighten and progressively tighten diametrically opposite nuts uniformly around the adapter with a torque wrench applying the torque recommended by the manufacturer.
 6. Insert and tighten the tapered threaded lock pins.
 7. Insert the nuts and bolts for the flange, finger tighten and progressively tighten diametrically opposite bolts uniformly around the flange to the torque recommended by the manufacturer.
- B. Buried Couplings, Adapters and Connectors (when applicable): Thoroughly coat all exterior surfaces, including nuts and bolts, after assembly and inspection by the Engineer with a heavy-bodied bituminous mastic as approved by the Engineer.

- C. Install thrust rods, supports, and other provisions to properly support pipe weight and axial equipment loads.
- D. Split Type Flange Adapters (when applicable): Install in the same manner as Split Type Couplings.

3.02 INSPECTION AND TESTING

- A. Hydrostatically test pipe couplings and joints in place with the pipe being tested. Test in accordance with Section 15085 – Water Pipeline Testing.

END OF SECTION

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SECTION 15142**FLEXIBLE JOINTS AND FLEXIBLE COUPLINGS****PART 1 GENERAL****1.01 SCOPE OF WORK**

- A. Furnish all labor, materials, equipment and incidentals required to completely install and put into service flexible couplings and expansion joints as specified herein and shown on the plans.

1.02 QUALITY ASSURANCE

- A. References:
 - 1. AWWA 219 - Bolted, Sleeve-Type Couplings for Plain End Pipe ANSI/NSF Standard 61 - Drinking Water System Components

1.03 SUBMITTALS

- A. Submittals required after award of contract and prior to installation:
 - 1. Technical bulletins and brochures on flexible couplings and expansion joints.
 - 2. Shop drawings detailing dimensions and materials.
 - 3. Manufacturer's published installation instructions.

1.04 SHIPPING INSTRUCTIONS

- A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.
- B. All equipment and parts must be properly protected against any damage during a prolonged period at the site.
- C. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- D. Storage and Protection: Take special care to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, preventing any deformation.

1.05 WARRANTY

- A. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no expense to the Owner. Warranty shall be for a period of two (2) years and begin on the Date of Substantial Completion.

PART 2 PRODUCTS**2.01 FLEXIBLE STEEL COUPLINGS AND COUPLING ADAPTERS**

- A. Bolted steel couplings shall meet or exceed the following design criteria:
 - 1. Working pressure.
 - a. Working pressure shall be equivalent to working pressure designated under Section 15055 – Steel Pipe.
 - 2. Coating requirement = fusion bonded epoxy coating.
- B. Control rods, washers and bolts:
 - 1. Indoors, outdoors aboveground, and in enclosed vaults and structures – carbon steel, ASTM A 193 grade B7 with ASTM A194, grade 2 H, heavy hex, nuts.
 - 2. Buried and submerged – Type 316 stainless steel conforming to ASTM F593 bolts and ASTM F594 nuts.
- C. Apply paint to steel couplings as required for adjoining pipe.
- D. Flanges shall be Class D in accordance with AWWA C207.
- E. Acceptable Manufacturers – JCM Industries, Inc., Smith-Blair Inc., Dresser Inc., or approved equal.

2.02 EXPANSION JOINTS

- A. Expansion joints shall meet or exceed the following design criteria:
 - 1. Working pressure.
 - a. Working pressure shall be equivalent to working pressure designated under Section 15055 – Steel Pipe.
 - 2. Material = stainless steel
- B. Flanges shall be Class D in accordance with AWWA C207.
- C. Acceptable Manufacturers – JCM Industries, Inc., Smith-Blair Inc., Dresser Inc., or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All flexible couplings and expansion joints shall be installed in accordance with the instructions of the manufacturer and as shown on the plans.

3.02 INSPECTION AND TESTING

- A. Hydrostatically test flexible pipe couplings, and joints, in place with the pipe being tested. Test in accordance with Section 15085 – Water Pipeline Testing as applicable.

END OF SECTION

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SECTION 15410**COMMON WORK RESULTS FOR PLUMBING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Plumbing demolition.
 - 9. Equipment installation requirements common to equipment sections.
 - 10. Painting and finishing.
 - 11. Concrete bases.
 - 12. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.
- C. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epcos Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
 - 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
 - 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: [Polished chrome-plated].
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: [Polished chrome-plated].
- E. One-Piece, Stamped-Steel Type: With [set screw or spring clips] and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With [exposed-rivet] hinge, [set screw or spring clips], and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

- A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: [One-piece], cast-brass type with polished chrome-plated finish.

- g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with [polished chrome-plated] finish.
 - h. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with [set screw or spring clips].
 - i. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
2. Existing Piping: Use the following:
- a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with [concealed or exposed-rivet] hinge and spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
 - g. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with [polished chrome-plated] finish.
 - h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with [concealed or exposed-rivet] hinge and set screw or spring clips.
 - i. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
 - j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
 - k. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

- a. [Steel] Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
 - b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- G. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Dry Piping Systems: Install dielectric unions to connect piping materials of dissimilar metals.
 3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 9 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

END OF SECTION

SECTION 15411**PLUMBING FIXTURES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Refer to Plumbing Fixture Connection Schedule on sheet P-402 for fixture selections.

1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 - 1. Faucets for lavatories and sinks.
 - 2. Toilet seats.
 - 3. Fixture supports.
 - 4. Water closets.
 - 5. Urinals.
 - 6. Lavatories.
- B. Related Sections include the following:
 - 1. Division 10 Section "Toilet and Bath Accessories."
 - 2. Division 15 Section "Plumbing Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- F. FRP: Fiberglass-reinforced plastic.

- G. PMMA: Polymethyl methacrylate (acrylic) plastic.
- H. PVC: Polyvinyl chloride plastic.
- I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
 - 2. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 - 3. Stainless-Steel Residential Sinks: ASME A112.19.3.
 - 4. Vitreous-China Fixtures: ASME A112.19.2M.
 - 5. Water-Closet, Flushometer Tank Trim: ASSE 1037.

- H. Comply with the following applicable standards and other requirements specified for lavatory faucets:
 - 1. Faucets: ASME A112.18.1.
 - 2. NSF Potable-Water Materials: NSF 61.
 - 3. Pipe Threads: ASME B1.20.1.
 - 4. Supply Fittings: ASME A112.18.1.
 - 5. Brass Waste Fittings: ASME A112.18.2.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 - 1. Brass and Copper Supplies: ASME A112.18.1.
 - 2. Brass Waste Fittings: ASME A112.18.2.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Flexible Water Connectors: ASME A112.18.6.
 - 2. Floor Drains: ASME A112.6.3.
 - 3. Off-Floor Fixture Supports: ASME A112.6.1M.
 - 4. Pipe Threads: ASME B1.20.1.
 - 5. Plastic Toilet Seats: ANSI Z124.5.
 - 6. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

- A. Lavatory Faucets,
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Chicago Faucets.
 - c. Delta Faucet Company.
 - d. Eljer.
 - 3. Description: [Two-handle mixing] valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate
 - c. Maximum Flow Rate: 0.5 gpm (1.5 L/min.)
 - d. Centers: 4 inches (102 mm)
 - e. Mounting: Deck, exposed
 - f. Valve Handle(s): Wrist blade, 4 inches (102 mm)
 - g. Inlet(s): NPS 3/8 (DN 10) tubing, plain end
 - h. Spout: Rigid

- i. Spout Outlet: Aerator 0.5 gpm (1.5 L/min.).
- j. Operation: Compression, manual.
- k. Drain: Grid
- l. Tempering Device: Not required.

2.2 FLUSHOMETERS

A. Flushometers

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Delta Faucet Company
 - b. Sloan Valve Company
 - c. Zurn Plumbing Products Group; Commercial Brass Operation
 - d. TOTO USA, Inc.

Description: Flushometer water closet type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

- a. Internal Design: Diaphragm operation.
- b. Style: Exposed.
- c. Inlet Size: NPS 1 (DN 25).
- d. Trip Mechanism: Oscillating, lever-handle actuator.
- e. Consumption: 1.6 gal./flush

2.3 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Bemis Manufacturing Company.
 - c. Church Seats.
 - d. Kohler Co.
 - e. Olsonite Corp.
3. Description: Toilet seat for water-closet-type fixture.
 - a. Material: Molded, solid plastic with antimicrobial agent.

- b. Configuration: Open front without\ cover.
- c. Size: Elongated.
- d. Hinge Type: CK, check.
- e. Class: Standard commercial, Heavy-duty commercial.
- f. Color: White.

2.4 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers,:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Engineered Brass Co.
 - b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
 - c. McGuire Manufacturing Co., Inc.
 - d. Plumberex Specialty Products Inc.
 - e. TCI Products.
 - f. TRUEBRO, Inc.
 - g. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
- 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.5 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Josam Company.
- 2. MIFAB Manufacturing Inc.
- 3. Smith, Jay R. Mfg. Co.
- 4. Tyler Pipe; Wade Div.
- 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
- 6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Water Closets:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Crane Plumbing, L.L.C./Fiat Products.
 - b. Eljer.
 - c. Kohler Co.
 - d. American Standard Companies, Inc.
 - e. Eljer.

- f. American Standard Companies, Inc.
- g. Crane Plumbing, L.L.C./Fiat Products.

2.6 LAVATORIES

A. Lavatories:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Eljer.
 - c. Kohler Co.
 - d. Crane Plumbing, L.L.C./Fiat Products.
 - e. Kohler Co.
 - f. TOTO USA, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install counter-mounting fixtures in and attached to casework.
- C. Install fixtures level and plumb according to roughing-in drawings.
- D. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- E. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

- F. Install flushometer valves for accessible urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- G. Install toilet seats on water closets.
- H. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- I. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- J. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
- K. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- L. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

- B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.

END OF SECTION

SECTION 15475**IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Valve tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS**2.1 EQUIPMENT LABELS**

- A. Metal Labels for Equipment:
1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches , 1/2 inch for viewing distances up to 72 inches , and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches high.

2.3 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link or beaded chain; or S-hook.

PART 3 - EXECUTION**3.1 PREPARATION**

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 9 Section "Interior Painting."
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label Color Schedule:
 - 1. Domestic Cold Water Piping:
 - a. Background Color: Blue.
 - b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 2. Valve-Tag Color:
 - a. Cold Water: Blue.
 3. Letter Color:
 - a. Cold Water: White.

END OF SECTION

SECTION 15478**HEAT TRACING FOR PLUMBING PIPING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes plumbing piping heat tracing for freeze prevention with the following electric heating cables:
 - 1. Self-regulating, parallel resistance.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
 - 1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- B. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. BH Thermal Corporation.
 - 2. Chromalox, Inc.; Wiegard Industrial Division; Emerson Electric Company.
 - 3. Delta-Therm Corporation.
 - 4. Easy Heat Inc.
 - 5. Nelson Heat Trace.
 - 6. Pyrotenax; a division of Tyco Thermal Controls.
 - 7. Raychem; a division of Tyco Thermal Controls.
 - 8. Thermon Manufacturing Co.
 - 9. Trasor Corp.
- B. Heating Element: Pair of parallel No. 16 AWG, nickel-coated stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
- C. Electrical Insulating Jacket: Flame-retardant polyolefin.
- D. Cable Cover: Tinned-copper braid and polyolefin outer jacket with UV inhibitor.
- E. Maximum Operating Temperature (Power On): 40 deg F.
- F. Maximum Exposure Temperature (Power Off): 185 deg F.
- G. Maximum Operating Temperature: 150 deg F.
- H. Capacities and Characteristics:
 - 1. Maximum Heat Output: 5 W/ft.
 - 2. Piping Diameter: 1-1/4" NPS.
 - 3. Number of Parallel Cables: None
 - 4. Volts: 120.
 - 5. Phase: Single.
 - 6. Hertz: 60.
 - 7. Full-Load Amperes: 20.
 - 8. Minimum Circuit Ampacity: 20.
 - 9. Maximum Overcurrent Protection: 20.

2.2 CONTROLS

- A. Pipe-Mounting Thermostats for Freeze Protection:
 - 1. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Labels: Refer to Division 15 Section "Identification for Plumbing Piping and Equipment."
- C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
 - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch (19 mm) minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written recommendations using cable protection conduit and slack cable to allow movement without damage to cable.
- B. Electric Heating Cable Installation for Freeze Protection for Piping:
 - 1. Install electric heating cables after piping has been tested and before insulation is installed.
 - 2. Install electric heating cables according to IEEE 515.1.
 - 3. Install insulation over piping with electric cables according to Division 15 Section "Plumbing Insulation."
 - 4. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- C. Set field-adjustable switches and circuit-breaker trip ranges.

- D. Protect installed heating cables, including non-heating leads, from damage.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 - 1. Test cables for electrical continuity and insulation integrity before energizing.
 - 2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.
- C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 15482**PLUMBING INSULATION****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 2. Insulating cements.
 3. Adhesives.
 4. Mastics.
 5. Lagging adhesives.
 6. Sealants.
 7. Factory-applied jackets.
 8. Field-applied fabric-reinforcing mesh.
 9. Field-applied cloths.
 10. Field-applied jackets.
 11. Tapes.
 12. Securements.
 13. Corner angles.
- B. Related Sections include the following:
1. Division 15 Section "HVAC Insulation."

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

3. Detail removable insulation at piping specialties, equipment connections, and access panels.
 4. Detail application of field-applied jackets.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
1. Sample Sizes:
 - a. Preformed Pipe Insulation Materials: 6 inches long by NPS $\frac{3}{4}$ "
 - b. Jacket Materials for Pipe: 6 inches long by NPS $\frac{3}{4}$ "
 - c. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.
- D. Qualification Data: For qualified Installer.
- E. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- F. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."

- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 - 5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; All-Service Duct Wrap.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000(Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Insulco, Division of MFS, Inc.; Triple I.
 - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Insulco, Division of MFS, Inc.; SmoothKote.
 - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
 - c. Rock Wool Manufacturing Company; Delta One Shot.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA Inc.; Aeroseal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-30.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-35.
 - c. ITW TACC, Division of Illinois Tool Works; CB-25.
 - d. Marathon Industries, Inc.; 501.
 - e. Mon-Eco Industries, Inc.; 55-10.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 - 3. Service Temperature Range: 0 to 180 deg F.
 - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 5. Color: White.
 - 6. Color: White.
- D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
 - d. Marathon Industries, Inc.; 550.
 - e. Mon-Eco Industries, Inc.; 55-50.

- f. Vimasco Corporation; WC-1/WC-5.
- 2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 200 deg F.
- 4. Solids Content: 63 percent by volume and 73 percent by weight.
- 5. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-52.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
 - c. Marathon Industries, Inc.; 130.
 - d. Mon-Eco Industries, Inc.; 11-30.
 - e. Vimasco Corporation; 136.
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 3. Service Temperature Range: Minus 50 to plus 180 deg F.
 - 4. Color: White.

2.6 SEALANTS

- A. Joint Sealants:
 - 1. Joint Sealants for Cellular-Glass and Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 - f. Vimasco Corporation; 750.
 - 2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-70.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.

- e. Vimasco Corporation; 750.
 3. Materials shall be compatible with insulation materials, jackets, and substrates.
 4. Permanently flexible, elastomeric sealant.
 5. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
 6. Color: White or gray.
- B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-76.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
 5. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: [White] [Color-code jackets based on system.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches (75 mm).
 3. Thickness: 11.5 mils (0.29 mm).
 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.11 SECUREMENTS

- A. Bands:
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, 304 or Type 316; 0.015 inch (0.38 mm) thick, [1/2 inch (13 mm)] wide with wing or closed seal.

3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, [1/2 inch (13 mm)] wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [4 inches (100 mm)] o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, and Unions:
 - 1. Install insulation over fittings, valves, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 7. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 8. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

- C. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - 2. When union covers are made from sectional pipe insulation, extend insulation from union long at least two times the insulation thickness over adjacent pipe insulation on each side of union. Select band material compatible with insulation and jacket.
 - 3. Construct removable valve insulation
 - 4. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 CELLULAR-GLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
 - 4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 - 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.8 FINISHES

- A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, [two] locations of threaded strainers, [two] locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Cold:
1. $\frac{3}{4}$ " and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1 inch (25mm) thick.
 - b. Flexible Elastomeric: 1 inch (25 mm) thick
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick
 - d. Phenolic: 1 inch (25 mm) thick.
 - e. Polyolefin: 1 inch (25 mm) thick
- B. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
1. All Pipe Sizes: Insulation shall be one of the following:
 2.
 - a. Flexible Elastomeric: 1 inch (25 mm) thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. 20 mils (0.5 mm) thick.
 - 2. ASJ Jacket
- D. Insulation material.

END OF SECTION

SECTION 15530**REFRIGERANT PIPING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications, including pipes, tubing, fittings, and specialties; special-duty valves; and refrigerants.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 15 Section "Mechanical Identification" for labeling and identifying refrigerant piping.
 - 2. Division 15 Section "Mechanical Insulation" for pipe insulation.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each valve type and refrigerant piping specialty specified.
- C. Refrigerant piping indicated is schematic only. Size and design the layout and installation of the piping, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and conformance with warranties of connected equipment.
- D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience.
- E. Maintenance data for refrigerant valves and piping specialties to include in the operation and maintenance manual specified in Division 1 Sections and Division 15 Section "Basic Mechanical Requirements."

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Qualify brazing and welding processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
- B. Regulatory Requirements: Comply with provisions of the following codes:
 - 1. ASME B31.5, "Refrigeration Piping."
 - 2. ASHRAE 15, "Safety Code for Mechanical Refrigeration."

- C. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves."
- D. Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
 - 1. Refrigerants:
 - a. Allied Signal Inc.; Genetron Refrigerants.
 - b. DuPont Company; Fluorochemicals Div.
 - 2. Refrigerant Valves and Specialties:
 - a. Danfoss Electronics, Inc.
 - b. Eaton Corporation; Industrial Control Div.
 - c. Emerson Electric Company; Alco Controls Div.
 - d. Henry Valve Company.
 - e. Sporlan Valve Company.

2.2 PIPES AND TUBES

- A. Hard Copper Tube: ASTM B 280, Type ACR, drawn temper.
- B. Soft Copper Tube: ASTM B 280, Type ACR, annealed temper.

2.3 PIPE AND TUBE FITTINGS

- A. Copper Fittings: ASME B16.22, wrought-copper streamlined pattern.

2.4 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (Silver).

2.5 VALVES

- A. Diaphragm Packless Valves: 500-psig (3450-kPa) working pressure and 275 deg F (135 deg C) working temperature, globe or angle pattern, forged-brass or bronze body and bonnet, phosphor bronze and stainless-steel diaphragms, rising stem and handwheel, stainless-steel spring, nylon seat disc, with solder-end connections.
- B. Packed-Angle Valves: 500-psig (3450-kPa) working pressure and 275 deg F (135 deg C) working temperature, forged-brass or bronze body, forged-brass seal caps with copper gasket, back seating, rising stem and seat, molded stem packing, with solder-end connections.

- C. Check Valves--Smaller than 1-Inch NPS (DN25): 500-psig (3450-kPa) operating pressure, 300 deg F (149 deg C) operating temperature; cast-brass body, with removable piston, PTFE seat, and stainless-steel spring; straight-through globe design. Valve shall be straight-through pattern, with solder-end connections.
- D. Check Valves--Larger than 1-Inch NPS (DN25): 450-psig (3100-kPa) operating pressure, 300 deg F (149 deg C) operating temperature; cast-bronze body, with cast-bronze or forged-brass bolted bonnet; floating piston with mechanically retained PTFE seat disc. Valve shall be straight-through or angle pattern, with solder-end connections.
- E. Service Valves: 500-psig (3450-kPa) pressure rating, forged-brass body with copper stubs, brass caps, removable valve core, integral ball check valve, with solder-end connections.
- F. Solenoid Valves: Conform to ARI 760; 250 deg F (121 deg C) temperature rating, 400-psig (2760-kPa) working pressure; forged brass, with PTFE valve seat, 2-way straight-through pattern, and solder-end connections; with NEMA 250, Type 1 solenoid enclosure with 1/2-inch (13-mm) conduit adapter, and 24-V normally closed holding coil.
- G. Pressure-Regulating Valves: Conform to ARI 770; pilot operated, forged brass or cast bronze with pilot operator, stainless-steel bottom spring, pressure-gage tappings, 24-V dc standard coil, and wrought-copper fittings for solder-end connections.
- H. Thermal Expansion Valves: Conform to ARI 750; thermostatic-adjustable, modulating type; size as required and factory set for superheat requirements; solder-end connections; with sensing bulb, distributor having side connection for hot-gas bypass line, and external equalizer line.
- I. Hot-Gas Bypass Valve: Adjustable, sized for capacity equal to last step of compressor unloading; solder-end connections.

2.6 REFRIGERANT PIPING SPECIALTIES

- A. Straight, Non-Cleanable-Type Strainers: 500-psig (3450-kPa) working pressure; steel shell with stainless-steel screen, with solder-end connections.
- B. Moisture/Liquid Indicators: 500-psig (3450-kPa) operating pressure, 200 deg F (93 deg C) operating temperature; forged-brass body, with replaceable, polished, optical viewing window with color-coded moisture indicator, and solder-end connections.
- C. Replaceable-Core Filter-Dryers: 500-psig (3450-kPa) operating pressure; steel shell, flange ring, and spring, ductile-iron cover plate with steel cap screws, and wrought-copper fittings for solder-end connections; with replaceable-core kit, including gaskets, as follows:
 - 1. Filter-Dryer Cartridge: Pleated media with solid-core sieve with activated alumina, ARI 730 rated for capacity.
- D. Permanent Filter-Dryer: 350-psig (2140-kPa) maximum operating pressure, 225 deg F (107 deg C) maximum operating temperature; steel shell, and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.

- E. Flanged Unions: 400-psig (2760-kPa) working pressure, 330 deg F (165 deg C) maximum operating temperature; 2 brass tailpiece adapters for solder-end connections to copper tubing; forged-steel flanges for 1- to 1-1/2-inch (22- to 41-mm) nominal copper-tube size and ductile iron for 2- to 3-inch (54- to 79-mm) nominal copper-tube size with 4 plated steel bolts, with silicon bronze nuts and fiber gasket; factory-applied rust-resistant coating on flanges and bolts.
- F. Flexible Connectors: 500-psig (3450-kPa) operating pressure; seamless tin-bronze or stainless-steel core, high-tensile bronze-braid covering, solder-end connections, and synthetic covering; dehydrated, pressure tested, minimum 7 inches (180 mm) long.
- G. Mufflers: 500-psig (3450-kPa) operating pressure, brazed-steel construction with fusible plug, sized for refrigeration capacity.

2.7 RECEIVERS

- A. 6-Inch (150-mm) Diameter and Smaller: ARI 495, UL listed, steel, brazed; 400-psig (2760-kPa) pressure rating, with tappings for inlet, outlet, and pressure relief valve.
- B. More than 6-Inch (150-mm) Diameter: ARI 495, welded steel, tested and stamped according to ASME Boiler and Pressure Vessel Code, Section 8D; 400 psig (2760 kPa) with tappings for liquid inlet and outlet valves, pressure relief valve, and liquid-level indicator.

2.8 REFRIGERANT

- A. ASHRAE 34, R-123: Dichlorotrifluoroethane.
- B. ASHRAE 34, R-134a: Tetrafluoroethane.
- C. ASHRAE 34, R-22: Monochlorodifluoromethane.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for compliance with requirements for installation tolerances and other conditions affecting performance of refrigerant piping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- Aboveground, within Building: Type ACR drawn-copper tubing.
 - A. Aboveground, within Building: Type L (Type B) drawn-copper tubing.
 - B. Belowground for 2-Inch NPS (DN50) and Smaller: Type L (Type B) annealed-copper tubing.
 - C. Belowground for Larger than 2-Inch NPS (DN50): Type K (Type A) annealed-copper tubing.

3.3 INSTALLATION

- A. Install refrigerant piping according to ASHRAE 15.
- B. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- C. Install piping in short and direct arrangement, with minimum number of joints, elbows, and fittings.
- D. Arrange piping to allow normal inspection and service of condensing units. Install valves and specialties in accessible locations to allow for service and inspection.
- E. Install piping with adequate clearance between pipe and adjacent walls and hangers, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- F. Belowground, install copper tubing in conduit. Vent conduit outdoors.
- G. Insulate suction lines; do not install insulation until system testing has been completed and all leaks have been eliminated.
- H. Install branch lines to parallel compressors of equal length, and pipe identically and symmetrically.
- I. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.
- J. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope of 0.4 percent downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope of 0.4 percent downward to compressor.
 - 3. Install traps and double risers where indicated and where required to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- K. Use fittings for changes in direction and branch connections.
- L. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- M. Reduce pipe sizes using eccentric reducer fittings installed with level side down.
- N. Provide bypass around moisture-liquid indicators in lines larger than 2-inch NPS (DN50).
- O. Install unions to allow removal of solenoid valves, pressure-regulating valves, expansion valves, and at connections to compressors and evaporators.

- P. Install flexible connectors at the inlet and discharge connection, at right angles to axial movement of compressor, parallel to crankshaft.
- Q. Install replaceable-core filter-dryers, with isolation valves and valved bypass.
- R. Install refrigerant valves according to manufacturer's written instructions.
- S. When brazing, remove solenoid-valve coils; remove sight glasses; and remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties. Do not apply heat near bulb of expansion valve.
- T. Electrical wiring for solenoid valves is specified in Division 16 Sections. Coordinate electrical requirements and connections.
- U. Mount thermostatic expansion valves in any position, close to evaporator.
 - 1. Where refrigerant distributors are used, mount directly on expansion-valve outlet.
 - 2. Install valve so diaphragm case is warmer than bulb.
 - 3. Secure bulb to clean, straight, horizontal section of suction line using 2 bulb straps. Do not mount bulb in a trap or at the bottom of the line.
 - 4. Where external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- V. Install pressure relief valves as required by ASHRAE 15. Pipe pressure relief valves on receivers to outdoors.
- W. Charge and purge systems, after testing, and dispose of refrigerant following ASHRAE 15 procedures.
- X. Charge system as follows:
 - 1. Install filter-dryer core after leak test, but before evacuation.
 - 2. Evacuate refrigerant system with vacuum pump, until temperature of 35 deg F (1.7 deg C) is indicated on vacuum dehydration indicator.
 - 3. Maintain vacuum for a minimum of 5 hours.
 - 4. Break vacuum with refrigerant gas and charge to 2 psig (14 kPa).

3.4 HANGERS AND SUPPORTS

- A. General: Hangers, supports, and anchors are specified in Division 15 Section "Hangers and Supports." Provide according to ASME B31.5 and MSS SP-69.
- B. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) in length.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes. Tube sizes are nominal or standard tube sizes as expressed in ASTM B 88 (ASTM B 88M).
 - 1. 1/2 Inch (15 mm): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.3 mm).

2. 5/8 Inch (18 mm): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.3 mm).
3. 1 Inch (28 mm): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.3 mm).
4. 1-1/4 Inches (35 mm): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.3 mm).
5. 1-1/2 Inches (42 mm): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
6. 2 Inches (54 mm): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
7. 2-1/2 Inches (67 mm): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
8. 3 Inches (79 mm): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
9. 4 Inches (105 mm): Maximum span, 12 feet (3.6 m); minimum rod size, 1/2 inch (12.7 mm).

D. Support vertical runs at each floor.

3.5 PIPE JOINT CONSTRUCTION

- A. Basic pipe and tube joint construction is specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent formation of scale.

3.6 VALVE INSTALLATIONS

- A. Install refrigerant valves according to manufacturer's written instructions.
- B. Install valves on suction and discharge of compressor, for gage taps at compressor inlet and outlet, for gage taps at hot-gas bypass regulators, on inlet and outlet, and on each side of strainers.
- C. Install check valves on compressor discharge and on condenser liquid lines on multiple condenser systems.
- D. Install refrigerant-charging (packed-angle) valve in liquid line between receiver shutoff valve and expansion valve.
- E. Install globe valves on each side of strainers and dryers, in liquid and suction lines at evaporators, and elsewhere as indicated.
- F. Install a full-sized, 3-valve bypass around each dryer.
- G. Install solenoid valves ahead of each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
 1. Electrical wiring for solenoid valves is specified in Division 16 Sections. Coordinate electrical requirements and connections.
- H. Mount thermostatic expansion valves in any position, close to evaporator.

1. Where refrigerant distributors are used, mount directly on expansion-valve outlet.
 2. Install valve so diaphragm case is warmer than bulb.

 3. Secure bulb to clean, straight, horizontal section of suction line using 2 bulb straps. Do not mount bulb in a trap or at the bottom of the line.
 4. Where external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- I. Install pressure-regulating and relief valves as required by ASHRAE 15.

3.7 SPECIALTIES APPLICATION AND INSTALLATION

- A. Install liquid indicators in liquid line leaving condenser, in liquid line leaving receiver, and on leaving side of liquid solenoid valves.
- B. Install strainers immediately upstream of each automatic valve, including expansion valves, solenoid valves, hot-gas bypass valves, and compressor suction valves.
- C. Install strainers on main liquid line where multiple expansion valves with integral strainers are used.
- D. Install strainers in suction line of steel pipe.
- E. Install moisture-liquid indicators in liquid lines between filter-dryers and thermostatic expansion valves and in liquid line to receiver.
- F. Install pressure relief valves on ASME receivers, and pipe to outdoors.
- G. Install replaceable-core filter-dryers in accordance with manufacturer's recommendations.
- H. Install permanent filter-dryers in accordance with manufacturer's recommendations.
- I. Install solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.
- J. Install receivers on systems 5 tons (18 kW) and larger, and on systems with long piping runs, sized to accommodate pump-down charge.
- K. Install flexible connectors at or near compressors where piping configuration does not absorb vibration.

3.8 CONNECTIONS

- A. Electrical: Conform to applicable requirements of Division 16 Sections for electrical connections.

3.9 FIELD QUALITY CONTROL

- A. Inspect and test refrigerant piping according to ASME B31.5, Chapter VI.
 - 1. Pressure test with nitrogen to 200 psig (1380 kPa). Perform final tests at 27-psig (186-kPa) vacuum and 200 psig (1380 kPa) using halide torch or electronic leak detector. Test to no leakage.
- B. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- C. Repair leaks using new materials; retest.

3.10 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

3.11 COMMISSIONING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryer after leak test, but before evacuation.
 - 2. Evacuate refrigerant system with vacuum pump until temperature of 35 deg F (1.67 deg C) is indicated on vacuum dehydration indicator.
 - 3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
 - 4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
 - 5. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
 - 6. Complete charging of system, using new filter-dryer core in charging line. Provide full-operating charge.

END OF SECTION

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SECTION 15736**PACKAGED AIR CONDITIONING UNITS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes packaged air conditioning units (rooftop units) with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Electric-heating coils.
 - 3. Integral, space temperature controls.
 - 4. Roof curbs.

1.3 DEFINITIONS

- A. ECM: Electrically commutated motor.
- B. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged air conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- C. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- D. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design RTU supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
 - 2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - 3. Wind-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
- D. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which RTUs will be attached.
 - 2. Roof openings
 - 3. Roof curbs and flashing.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. ARI Compliance:
 - 1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
 - 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 15 for refrigeration system safety.
 - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 - 3. Comply with ASHRAE/IESNA 90.1 for minimum efficiency of heating and cooling.

- C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- D. UL Compliance: Comply with UL 1995.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
 - 3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: One set for each belt-driven fan.
 - 2. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Carrier Corporation.
 - 2. Engineered Air.
 - 3. Lennox Industries Inc.
 - 4. McQuay International.
 - 5. Trane; American Standard Companies, Inc.
 - 6. YORK International Corporation.

2.2 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - 1. Exterior Casing Thickness: 0.052 thick.
- C. Inner Casing Fabrication Requirements:
 - 1. Inside Casing: Galvanized steel, 0.034 inch thick.
- D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - 1. Materials: ASTM C 1071, Type I.
 - 2. Thickness: 1/2 inch.
 - 3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
 - 4. Liner Adhesive: Comply with ASTM C 916, Type I.
- E. Condensate Drain Pans: Formed sections of galvanized steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.
 - 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 - 2. Drain Connections: Threaded nipple both sides of drain pan.
 - 3. Pan-Top Surface Coating: Corrosion-resistant compound.

2.3 FANS

- A. Direct-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, ECM motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- D. Fan Motor: Comply with requirements in Division 15 Section "Motors."

2.4 COILS

- A. Supply-Air Refrigerant Coil:

1. Aluminum -plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Baked phenolic coating.
5. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating formed with pitch and drain connections complying with ASHRAE 62.

B. Electric-Resistance Heating:

1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
2. Over temperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
4. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
 - a. Magnetic contactors.
 - b. Step Controller: Pilot lights and override toggle switch for each step.
 - c. SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
 - d. Time-delay relay.
 - e. Airflow proving switch.

2.5 REFRIGERANT CIRCUIT COMPONENTS

- A. Number of Refrigerant Circuits: One.
- B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.
- C. Refrigeration Specialties:
1. Refrigerant Charge: R-410A.
 2. Expansion valve with replaceable thermostatic element.
 3. Refrigerant filter/dryer.
 4. Manual-reset high-pressure safety switch.
 5. Automatic-reset low-pressure safety switch.
 6. Minimum off-time relay.
 7. Automatic-reset compressor motor thermal overload.
 8. Brass service valves installed in compressor suction and liquid lines.
 9. Low-ambient kit high-pressure sensor.
 10. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.6 AIR FILTRATION

- A. Minimum resistance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

2.7 DAMPERS

- A. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with manual damper filter.

2.8 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with control-circuit transformer with built-in overcurrent protection.

2.9 CONTROLS

- A. Basic Unit Controls:
 - 1. Wall-mounted thermostat or sensor with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. Automatic changeover.
 - e. Adjustable deadband.
 - f. Exposed set point.
 - g. Exposed indication.
 - h. Degree F indication.
 - i. Unoccupied-period-override push button.
 - j. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.

2.10 ACCESSORIES

- A. Low-ambient kit using staged condenser fans for operation down to 35 deg F.
- B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- C. Coil guards of painted, galvanized-steel wire.
- D. Hail guards of galvanized steel, painted to match casing.

2.11 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 15 Section "Vibration Controls for HVAC Equipment."
- B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or II.
 - b. Thickness: 1-1/2 inches.
 - 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- C. Curb Height: 14 inches.
- D. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for wind-load requirements.

2.12 CAPACITIES AND CHARACTERISTICS

- A. Refer to Packaged Roof Top Unit Schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. **Roof Curb:** Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 7 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Install piping adjacent to RTUs to allow service and maintenance.
- C. Duct installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at top of roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 15 Section "Duct Accessories."
 - 4. Install return-air duct continuously through roof structure.
 - 5. Install normal-weight, 3000-psi compressive strength (28-day) concrete mix inside roof curb, 4 inches thick. Concrete, formwork, and reinforcement are specified in Division 3.

3.4 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.
- C. **Tests and Inspections:**
 - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. **Operational Test:** After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 1. Inspect for visible damage to unit casing.
 2. Inspect for visible damage to compressor, coils, and fans.
 3. Inspect internal insulation.
 4. Verify that labels are clearly visible.
 5. Verify that clearances have been provided for servicing.
 6. Verify that controls are connected and operable.
 7. Verify that filters are installed.
 8. Clean condenser coil and inspect for construction debris.
 9. Remove packing from vibration isolators.
 10. Verify lubrication on fan and motor bearings.
 11. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 12. Adjust fan belts to proper alignment and tension.
 13. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
 14. Inspect and record performance of interlocks and protective devices; verify sequences.
 15. Operate unit for an initial period as recommended or required by manufacturer.
 16. Calibrate thermostats.
 17. Adjust and inspect high-temperature limits.
 18. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
 19. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
 20. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
 21. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

- a. Supply-air volume.
 - b. Return-air volume.
 - c. Outdoor-air intake volume.
22. Simulate maximum cooling demand and inspect the following:
- a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
23. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
- a. High-temperature limit on gas-fired heat exchanger.
 - b. Low-temperature safety operation.
 - c. Filter high-pressure differential alarm.
 - d. Smoke and firestat alarms.
24. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

SECTION 15738**SPLIT-SYSTEM AIR-CONDITIONING UNITS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.
- B. Related Sections include the following:
 - 1. Division 15 Section "Vibration Control for HVAC equipment" for isolation pads, spring isolators, and seismic restraints.

1.3 DEFINITIONS

- A. Evaporator-Fan Unit: The part of the split-system air-conditioning unit that contains a coil for cooling (heat rejection for heating operation in heat pump units) and a fan to circulate air to conditioned space.
- B. Compressor-Condenser Unit: The part of the split-system air-conditioning unit that contains a refrigerant compressor and a coil for condensing refrigerant (evaporator for heating operation in heat pump units).

1.4 SUBMITTALS

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Samples for Initial Selection: Manufacturer's color charts consisting of units of sections of units showing the full range of colors available for units with factory-applied color finishes.
- D. Maintenance Data: For split-system air-conditioning units to include in maintenance manuals specified in Division 1.

- E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."
- B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 7 Section "Roof Accessories."

1.7 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
- C. Warranty Period: Five years (compressor) from date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Air Conditioning; Div. of Carrier Corp.
 - 2. Lennox Industries Inc. Mitsubishi Electric Sales Canada, Inc.
 - 3. Trane Co. (The); Unitary Products Group.
 - 4. York International Corp.

2.2 CONCEALED EVAPORATOR-FAN COMPONENTS

- A. Cabinet: Enameled steel with removable panels on all sides.
- B. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 - 1. Insulation: Faced, glass-fiber duct liner.
 - 2. Drain Pans: Galvanized steel, with connection for drain; insulated.
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- D. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm); leak tested to 300 psig (2070 kPa) underwater; and having a two-position control valve.
- E. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
- F. Fan: Forward-curved, double-width wheel of galvanized steel; belt-drive connection to motor.
- G. Fan Motor: Multispeed, PSC type.
- H. Wiring Terminations: Connect motor to chassis wiring with plug connection.

2.3 FLOOR-MOUNTED, EVAPORATOR-FAN COMPONENTS

- A. Cabinet: Enameled steel with removable panels on front and ends.
 - 1. Discharge Grille: Steel with surface-mounted frame.
 - 2. Insulation: Faced, glass-fiber, duct liner.
 - 3. Drain Pans: Galvanized steel, with connection for drain; insulated.
- B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
- D. Fan and Motor: Centrifugal fan, directly driven by multispeed, electric motor with integral overload protection; resiliently mounted.
- E. Filters: Permanent frame, replaceable media.

2.4 WALL- OR CEILING-MOUNTED, EVAPORATOR-FAN COMPONENTS

- A. Cabinet: Enameled steel with removable panels on front and ends, and discharge drain pans with drain connection.
- B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
- D. Fan and Motor: Centrifugal fan, directly driven by multispeed, electric motor with integral overload protection; resiliently mounted.
- E. Filters: Permanent, cleanable.

2.5 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

- A. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - 1. Compressor Type: Reciprocating.
 - 2. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
- D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.
- E. Fan: Aluminum-propeller type, directly connected to motor.
- F. Motor: Permanently lubricated, with integral thermal-overload protection.
- G. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
- H. Mounting Base: Polyethylene.

2.6 ACCESSORIES

- A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
 - 1. Compressor time delay.
 - 2. 24-hour time control of system stop and start.

3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 4. Fan-speed selection, including auto setting.
- B. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install emergency overflow drain pan under unit extending 6 inches beyond all sides of unit. Route drain piping as indicated on drawings.
- D. Install ground-mounted, compressor-condenser components on 4-inch- (100-mm-) thick, reinforced concrete base; 4 inches (100 mm) larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 3, "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- E. Install roof-mounted compressor-condenser components on equipment supports specified in Division 7 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- F. Connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to unit to allow service and maintenance.
- C. Refer to piping system Sections for specific valve and specialty arrangements.
- D. Ground equipment.
1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- B. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 COMMISSIONING

- A. Verify that units are installed and connected according to the Contract Documents.
- B. Lubricate bearings, adjust belt tension, and change filters.
- C. Perform startup checks according to manufacturer's written instructions and do the following:
 - 1. Fill out manufacturer's checklists.
 - 2. Check for unobstructed airflow over coils.
 - 3. Check operation of condenser capacity-control device.
 - 4. Verify that vibration isolation devices and flexible connectors dampen vibration transmission to structure.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining units.
 - 2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
 - 3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
 - 4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION

SECTION 15810**HVAC DUCTS AND CASINGS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg. Metal ducts include the following:
 - 1. Rectangular ducts and fittings.
 - 2. Single-wall, round, and flat-oval spiral-seam ducts and formed fittings.
 - 3. Duct liner.
- B. Related Sections include the following:
 - 1. Division 15 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. NUSIG: National Uniform Seismic Installation Guidelines.

1.4 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 SUBMITTALS

- A. Shop Drawings: CAD-generated and drawn to 1/4 inch equals 1 foot scale. Show fabrication and installation details for metal ducts.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 2. Duct layout indicating sizes and pressure classes.
 3. Elevations of top and bottom of ducts.
 4. Dimensions of main duct runs from building grid lines.
 5. Fittings.
 6. Reinforcement and spacing.
 7. Seam and joint construction.
 8. Penetrations through fire-rated and other partitions.
 9. Equipment installation based on equipment being used on Project.
 10. Duct accessories, including access doors and panels.
 11. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Ceiling suspension assembly members.
 2. Other systems installed in same space as ducts.
 3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
 4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- C. Welding certificates.
- D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. NFPA Compliance:
1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- C. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 DUCT LINER

- A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.
 1. Available Manufacturers:
 - a. CertainTeed Corp.; Insulation Group.
 - b. Johns Manville International, Inc.
 - c. Knauf Fiber Glass GmbH.
 - d. Owens Corning.
 2. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.
 - a. Thickness: 1 inch.
 - b. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
 - c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
 - d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
 - 1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.

- 2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
- 3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

2.4 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
- B. Joint and Seam Tape: 2 inches wide; glass-fiber-reinforced fabric.
- C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
- D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- E. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.
- F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 1. Hangers Installed in Corrosive Atmospheres: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
 3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.6 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
 1. Available Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Nexus Inc.
 - c. Ward Industries, Inc.
- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
 1. Available Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Lockformer.
 2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
 3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.7 ROUND DUCT AND FITTING FABRICATION

- A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
- B. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

C. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

a. Available Manufacturers:

- 1) Ductmate Industries, Inc.
- 2) Lindab Inc.

D. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

E. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

F. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg
 - a. Ducts 3 to 36 Inches in Diameter: 0.034 inch
 - b. Ducts 37 to 50 Inches in Diameter: 0.040 inch
 - c. Ducts 52 to 60 Inches in Diameter: 0.052 inch
 - d. Ducts 62 to 84 Inches in Diameter: 0.064 inch
3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
 - a. Ducts 3 to 26 Inches in Diameter: 0.034 inch
 - b. Ducts 27 to 50 Inches in Diameter: 0.040 inch
 - c. Ducts 52 to 60 Inches in Diameter: 0.052 inch
 - d. Ducts 62 to 84 Inches in Diameter: 0.064 inch
4. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
5. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate

- nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
6. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 7. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
 8. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
 9. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
 10. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg 0.022 inch

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
 1. Supply Ducts: 2-inch wg.
 2. Supply Ducts (in Mechanical Equipment Rooms): 3-inch wg.
 3. Return Ducts (Negative Pressure): 1-inch wg.
 4. Exhaust Ducts (Negative Pressure): 1-inch wg.

3.2 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.
- C. Install ducts with fewest possible joints.
- D. Install fabricated fittings for changes in directions, size, and shape and for connections.
- E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

- I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 15 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Through-Penetration Firestop Systems."
- O. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Refer to SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- P. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."
- Q. Paint interiors of metal ducts, that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.

3.3 SEAM AND JOINT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
 - 1. For pressure classes lower than 2-inch wg, seal transverse joints.
- B. Seal ducts before external insulation is applied.

3.4 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- D. Install concrete inserts before placing concrete.
- E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 15 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
 - 1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
 - 3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg .
 - 4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.7 CLEANING NEW SYSTEMS

- A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
- B. Use service openings, as required, for physical and mechanical entry and for inspection.
 - 1. Create other openings to comply with duct standards.
 - 2. Disconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling sections to gain access during the cleaning process.

- C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.
- D. Clean the following metal duct systems by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
 - 6. Supply-air ducts, dampers, actuators, and turning vanes.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 - 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.
 - 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
- F. Cleanliness Verification:
 - 1. Visually inspect metal ducts for contaminants.
 - 2. Where contaminants are discovered, re-clean and reinspect ducts.

END OF SECTION

SECTION 15813**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.
- B. Related Sections:
 - 1. Division 15 Section "Vibration Controls for HVAC Equipment" for vibration isolation devices.
 - 2. Division 15 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

- A. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Pipe Welding Qualifications: Qualify procedures and operators according to AWS D1.1.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. Non-MFMA Manufacturer Metal Framing Systems:
 - 1. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 - 2. Standard: Comply with MFMA-4.
 - 3. Channels: Continuous slotted steel channel with intumed lips.
 - 4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 - 6. Coating: Zinc.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- C. For Trapeze and/or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal *movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

- F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 5. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 10. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 11. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 12. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 - 13. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 - 14. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 6. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 7. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 8. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 3. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 4. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 5. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected

equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

- a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
 - P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
 - Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 15820**AIR DUCT ACCESSORIES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Backdraft dampers.
 - 2. Volume dampers.
 - 3. Motorized control dampers.
 - 4. Turning vanes.
 - 5. Duct-mounting access doors.
 - 6. Flexible connectors.
 - 7. Flexible ducts.
 - 8. Duct accessory hardware.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Backdraft dampers.
 - 2. Volume dampers.
 - 3. Motorized control dampers.
 - 4. Turning vanes.
 - 5. Duct-mounting access doors.
 - 6. Flexible connectors.
 - 7. Flexible ducts.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Special fittings.
 - 2. Manual-volume damper installations.
 - 3. Motorized-control damper installations.
 - 4. Wiring Diagrams: Power, signal, and control wiring.

- C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Aluminum Sheets: ASTM B 209 alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: ASTM B 221 alloy 6063, temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

- A. Available Manufacturers:
 - 1. Air Balance, Inc.
 - 2. American Warming and Ventilating.
 - 3. CESCO Products.
 - 4. Duro Dyne Corp.
 - 5. Greenheck.
 - 6. Penn Ventilation Company, Inc.
 - 7. Prefco Products, Inc.
 - 8. Ruskin Company.
 - 9. Vent Products Company, Inc.
- B. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.
- C. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners and mounting flange.
- D. Blades: 0.025-inch- thick, roll-formed aluminum.
- E. Blade Seals: Neoprene.
- F. Blade Axles: Nonferrous.
- G. Tie Bars and Brackets: Aluminum.
- H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

- A. Available Manufacturers:
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill AirFlow Corporation.
 - 3. METALAIRE, Inc.
 - 4. Nailor Industries Inc.
 - 5. Penn Ventilation Company, Inc.
 - 6. Ruskin Company.
- B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
 3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 6. Blade Axles: Galvanized steel.
 7. Bearings: Stainless-steel sleeve.
 8. Tie Bars and Brackets: Aluminum.
 9. Tie Bars and Brackets: Galvanized steel.
- D. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
- E. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 MOTORIZED CONTROL DAMPERS

- A. Available Manufacturers:
1. CESCO Products.
 2. Duro Dyne Corp.
 3. Greenheck.
 4. McGill AirFlow Corporation.
 5. METALAIRE, Inc.
 6. Nailor Industries Inc.
 7. Penn Ventilation Company, Inc.
 8. Ruskin Company.
- B. General Description: AMCA-rated, parallel or opposed-blade design; minimum of 0.1084-inch-thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch- thick, galvanized-steel damper blades with maximum blade width of 8 inches.
1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed

against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.

2. Operating Temperature Range: From minus 40 to plus 200 deg F
3. Provide parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is being held by torque of 50 in. x lbf when tested according to AMCA 500D.

2.6 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
- B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, double-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.
 1. Available Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Duro Dyne Corp.
 - c. METALAIRE, Inc.
 - d. Ward Industries, Inc.
- C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.7 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class.
- B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.
 1. Available Manufacturers:
 - a. American Warming and Ventilating.
 - b. CESCO Products.
 - c. Ductmate Industries, Inc.
 - d. Flexmaster U.S.A., Inc.
 - e. Greenheck.
 - f. McGill AirFlow Corporation.
 - g. Nailor Industries Inc.
 - h. Ventfabrics, Inc.
 - i. Ward Industries, Inc.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Provide number of hinges and locks as follows:

- a. Less Than 12 Inches Square: Secure with two sash locks.
 - b. Up to 18 Inches Square: Two hinges and two sash locks.
 - c. Up to 24 by 48 Inches Three hinges and two compression latches with outside and inside handles.
 - d. Sizes 24 by 48 Inches and Larger: One additional hinge.
- C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.
1. Available Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Flexmaster U.S.A., Inc.
 2. Frame: Galvanized sheet steel, with spin-in notched frame.

2.8 FLEXIBLE CONNECTORS

- A. Available Manufacturers:
1. Ductmate Industries, Inc.
 2. Duro Dyne Corp.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.
- B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd.
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd.
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F
- F. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd.
 2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg F

2.9 FLEXIBLE DUCTS

- A. Available Manufacturers:
 - 1. Flexmaster U.S.A., Inc.
 - 2. Hart & Cooley, Inc.
 - 3. McGill AirFlow Corporation.

- B. Insulated-Duct Connectors: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor barrier film.
 - 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm
 - 3. Temperature Range: Minus 20 to plus 175 deg F

- C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches suit duct size.

2.10 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

- B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

- C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

- D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

- E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

- F. Provide test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire dampers, with fusible links, according to manufacturer's UL-approved written instructions.
- H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 - 1. On both sides of duct coils.
 - 2. Downstream from volume dampers, turning vanes, and equipment.
 - 3. Adjacent to fire dampers, providing access to reset or reinstall fusible links.
 - 4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
 - 5. On sides of ducts where adequate clearance is available.
- I. Install the following sizes for duct-mounting, rectangular access doors:
 - 1. One-Hand or Inspection Access: 8 by 5 inches
 - 2. Two-Hand Access: 12 by 6 inches
 - 3. Head and Hand Access: 18 by 10 inches
 - 4. Head and Shoulders Access: 21 by 14 inches
 - 5. Body Access: 25 by 14 inches
 - 6. Body Plus Ladder Access: 25 by 17 inches
- J. Install the following sizes for duct-mounting, round access doors:
 - 1. One-Hand or Inspection Access: 8 inches in diameter.
 - 2. Two-Hand Access: 10 inches in diameter.
 - 3. Head and Hand Access: 12 inches in diameter.
 - 4. Head and Shoulders Access: 18 inches in diameter.
 - 5. Body Access: 24 inches in diameter.
- K. Install the following sizes for duct-mounting, pressure relief access doors:
 - 1. One-Hand or Inspection Access: 5 inches in diameter.
 - 2. Two-Hand Access: 10 inches in diameter.
 - 3. Head and Hand Access: 13 inches in diameter.
 - 4. Head and Shoulders Access: 19 inches in diameter.
- L. Label access doors according to Division 15 Section "Mechanical Identification."
- M. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- N. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- O. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

- P. Connect diffusers or light troffer boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- Q. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- R. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing."

END OF SECTION

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SECTION 15830**HVAC FANS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Ceiling-mounting ventilators.
 - 2. In-line centrifugal fans.
 - 3. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
- C. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 1. Roof framing and support members relative to duct penetrations.
 2. Ceiling suspension assembly members.
 3. Size and location of initial access modules for acoustical tile.
 4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - D. Field quality-control test reports.
 - E. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Greenheck.
 - 2. Loren Cook Company.
 - 3. Penn Ventilation.
- B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 4. Fan and motor isolated from exhaust airstream.
- F. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 - 3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
 - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

- G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Built-in cant and mounting flange.
 2. Overall Height: 9-1/2 inches (240 mm).
 3. Sound Curb: Curb with sound-absorbing insulation matrix.
 4. Pitch Mounting: Manufacture curb for roof slope.
 5. Metal Liner: Galvanized steel.
 6. Mounting Pedestal: Galvanized steel with removable access panel.
 7. Vented Curb: Unlined with louvered vents in vertical sides.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support units using spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 15 Section "Vibration Controls."
1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
- C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- D. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."
- E. Install units with clearances for service and maintenance.
- F. Label units according to requirements specified in Division 15 Section "Mechanical Identification."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 16 Section "Grounding and Bonding."
- D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 3. Verify that cleaning and adjusting are complete.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 5. Adjust belt tension.
 6. Adjust damper linkages for proper damper operation.
 7. Verify lubrication for bearings and other moving parts.
 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 10. Shut unit down and reconnect automatic temperature-control operators.
 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION

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SECTION 15850**AIR OUTLETS AND INLETS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.
- B. Related Sections include the following:
 - 1. Division 15 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

- A. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- C. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
- D. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Products: Subject to compliance with requirements, provide one of the products specified.
 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 GRILLES AND REGISTERS

- A. Adjustable Bar Grille.
1. Available Manufacturers:
 - a. Carnes;
 - b. Krueger;
 - c. METALAIRE, Inc., Metal Industries Inc.;
 - d. Nailor Industries of Texas Inc.;
 - e. Price Industries;
 - f. Titus; Tuttle & Bailey;
 2. Material: Aluminum.
 3. Finish: Baked enamel, color selected by Architect.
 4. Face Blade Arrangement: Adjustable vertical spaced 3/4 inch apart.
 5. Rear Blade Arrangement: Fixed horizontal spaced 3/4 inch apart.
 6. Frame: 1-1/4 inches wide.
 7. Mounting Frame: Filter.
 8. Mounting: Countersunk screw.
 9. Damper Type: Adjustable opposed-blade assembly.
 10. Accessories: Front-blade gang operator.
- B. Fixed Face Grille.
1. Available Products:
 - a. Carnes;
 - b. Krueger;
 - c. Nailor Industries of Texas Inc.;
 - d. Price Industries;
 - e. Titus; Tuttle & Bailey;
 2. Material: Aluminum.

3. Finish: Baked enamel, color selected by Architect.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core Egg crate.
5. Frame: 1-1/4 inches wide.
6. Mounting Frame: Filter.
7. Mounting: Countersunk screw.
8. Damper Type: Adjustable opposed-blade assembly.
9. Mounting: Concealed bracket] Spring clip.
10. Damper Type: Adjustable opposed-blade assembly.

2.3 CEILING DIFFUSER OUTLETS

A. Round Ceiling Diffuser

1. Available Manufacturers:
 - a. Carnes;
 - b. METALAIRE, Inc., Metal Industries Inc.;
 - c. Nailor Industries of Texas Inc.;
 - d. Price Industries;
 - e. Titus;
 - f. Tuttle & Bailey;
2. Material: Aluminum.
3. Finish: Baked enamel, color selected by Architect.
4. Face Style: Three cone.
5. Pattern: Fully adjustable.
6. Dampers: Radial opposed blade.
7. Accessories: Refer to equipment schedule drawings.
 - a. Equaling grid.
 - b. Plaster ring.
 - c. Safety chain.
 - d. Wire guard.
 - e. Sectorizing baffles.
 - f. Operating rod extension.

B. Rectangular and Square Ceiling Diffusers:

1. Available Manufacturers:
 - a. Carnes.
 - b. Krueger.
 - c. METALAIRE, Inc.; Metal Industries Inc.
 - d. Nailor Industries of Texas Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
2. Material: Aluminum.
3. Finish: Baked enamel, color selected by Architect.
4. Face Size: 24 by 24 inches, 12 by 12 inches

5. Face Style: Three cone.
6. Mounting: T-bar.
7. Pattern: Adjustable.
8. Dampers: Radial opposed blade.
9. Accessories: Refer to equipment schedule drawings

- a. Equaling grid.
- b. Plaster ring.
- c. Safety chain.
- d. Wire guard.
- e. Sectorizing baffles.
- f. Operating rod extension.

C. Perforated Diffuser If applicable

1. Available Manufacturers:

- a. Carnes.
- b. Krueger.
- c. METALAIRE, Inc.; Metal Industries Inc.
- d. Nailor Industries of Texas Inc.
- e. Price Industries.
- f. Titus.
- g. Tuttle & Bailey.
- h. Warren Technology.

2. Material: Steel backpan and pattern controllers, with aluminum face.
3. Finish: Baked enamel, color selected by Architect.
4. Face Size: 12 by 12 inches or 24 by 12 inches.
5. Duct Inlet: Round.
6. Face Style: Flush.
7. Pattern Controller: Fixed with curved blades at inlet.
8. Mounting: Surface.
9. Dampers: Radial opposed blade.
10. Accessories: Refer to equipment schedule drawings
- 11.

- a. Equaling grid.
- b. Plaster ring.
- c. Safety chain.
- d. Wire guard.
- e. Sectorizing baffles.
- f. Operating rod extension.

D. Louver Face Diffuser If applicable.

1. Available Manufacturers:

- a. Carnes.
- b. METALAIRE, Inc.; Metal Industries Inc.
- c. Nailor Industries of Texas Inc.

- d. Price Industries.
 - e. Titus.
 - f. Tuttle & Bailey.
- 2. Material: Aluminum.
 - 3. Finish: Baked enamel, color selected by Architect.
 - 4. Face Size: See equipment schedule drawings
 - 5. Mounting: Surface.
 - 6. Pattern: See mechanical floor plan.
 - 7. Dampers: Radial opposed blade.
 - 8. Accessories: Refer to mechanical floor and schedules.
- a. Square to round neck adaptor.
 - b. Adjustable pattern vanes.
 - c. Throw reducing vanes.
 - d. Equaling grid.
 - e. Plaster ring.
 - f. Safety chain.
 - g. Wire guard.
 - h. Sectorizing baffles.
 - i. Operating rod extension.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 15872**VIBRATION CONTROLS FOR HVAC EQUIPMENT****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Housed spring mounts.
 - 5. Elastomeric hangers.
 - 6. Spring hangers.
 - 7. Spring hangers with vertical-limit stops.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Amber/Booth Company, Inc.
 - 2. Kinetics Noise Control.
 - 3. Mason Industries.
 - 4. Vibration Eliminator Co., Inc.
 - 5. Vibration Mountings & Controls, Inc.
- B. Pads : Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- D. Restrained Mounts: All-directional mountings with seismic restraint.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- E. Spring Isolators : Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
 2. Base: Factory drilled for bolting to structure.
 3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.
- H. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- I. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.2 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 1. Powder coating on springs and housings.
 2. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
 3. Baked enamel or powder coat for metal components on isolators for interior use.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by OSHPD.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND DEVICE INSTALLATION

- A. Comply with requirements in Division 7 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Equipment Restraints:
- C. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- D. Install cables so they do not bend across edges of adjacent equipment or building structure.
- E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- H. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
 6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.
 9. Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 10. Air-Mounting System Operational Test: Test the compressed-air leveling system.
 11. Test and adjust air-mounting system controls and safeties.
 12. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust air-spring leveling mechanism.

- D. Adjust active height of spring isolators.
- E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

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SECTION 15876**IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS**2.1 EQUIPMENT LABELS**

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

2. Letter Color: White.
 3. Background Color: Black Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch
 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 6. Fasteners: Stainless-steel rivets or self-tapping screws.
 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

END OF SECTION

SECTION 15881
HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes semi-rigid and flexible duct, plenum, and breeching insulation; insulating cements; accessories and attachments; and sealing compounds.
- B. Related Sections include the following:
 - 1. Division 15 Section "Pipe Insulation" for insulation for piping systems.
 - 2. Division 15 Section "Metal Ducts" for duct liner.

1.3 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate clearance requirements with duct Installer for insulation application.

1.7 SCHEDULING

- A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
 - 1. Mineral-Fiber Insulation:
 - a. CertainTeed Manson.
 - b. Knauf FiberGlass GmbH.
 - c. Owens-Corning Fiberglas Corp.
 - d. Schuller International, Inc.

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.
- B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

2.3 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd. (270 g/sq. m).
 - 1. Tape Width: 4 inches (100 mm).
- B. Bands: 3/4 inch (19 mm) wide, in one of the following materials compatible with jacket:
 - 1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch (0.5 mm) thick.
 - 2. Galvanized Steel: 0.005 inch (0.13 mm) thick.
 - 3. Aluminum: 0.007 inch (0.18 mm) thick.
 - 4. Brass: 0.010 inch (0.25 mm) thick.
 - 5. Nickel-Copper Alloy: 0.005 inch (0.13 mm) thick.
- C. Wire: 0.080-inch (2.0-mm), nickel-copper alloy; 0.062-inch (1.6-mm), soft-annealed, stainless steel; or 0.062-inch (1.6-mm), soft-annealed, galvanized steel.

- D. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
 - 1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb (45 kg) for direct pull perpendicular to the adhered surface.

2.4 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- E. Keep insulation materials dry during application and finishing.
- F. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- G. Apply insulation with the least number of joints practical.

- H. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- I. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
- J. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- K. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
 - 3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.
- M. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.
 - 1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
- N. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - 1. Seal penetrations with vapor-retarder mastic.
 - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 - 3. Seal insulation to roof flashing with vapor-retarder mastic.
- O. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- P. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.
- Q. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.
 - 1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

3.4 MINERAL-FIBER INSULATION APPLICATION

- A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches (450 mm) and smaller, along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - b. On duct sides with dimensions larger than 18 inches (450 mm). Space 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
 - c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over-compress insulation during installation.
 4. Impale insulation over anchors and attach speed washers.
 5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch (13-mm) staples, 1 inch (25 mm) o.c., and cover with pressure-sensitive tape having same facing as insulation.
 7. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches (450 mm) o.c.
 8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- (150-mm-) wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches (150 mm) o.c.
 10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.
- B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Space anchor pins as follows:
 - a. On duct sides with dimensions 18 inches (450 mm) and smaller, along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - b. On duct sides with dimensions larger than 18 inches (450 mm). Space 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.

- c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
- d. Do not over-compress insulation during installation.
- 4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- 5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch (13-mm) staples, 1 inch (25 mm) o.c., and cover with pressure-sensitive tape having same facing as insulation.
- 6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- (150-mm-) wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches (150 mm) o.c.
- 8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.5 DUCT SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.
- C. Insulate the following plenums and duct systems:
 - 1. Indoor concealed supply-, return-, and outside-air ductwork.
 - 2. Indoor exposed supply-, return-, and outside-air ductwork.
 - 3. Outdoor exposed supply and return ductwork.
 - 4. Indoor concealed range-hood exhaust ductwork.
 - 5. Indoor concealed oven and dishwasher ductwork.
- D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Testing agency labels and stamps.
 - 8. Nameplates and data plates.
 - 9. Access panels and doors in air-distribution systems.

3.6 INDOOR DUCT APPLICATION SCHEDULE

- A. Indoor applications shall be insulated with a minimum R-5, or in accordance with the most currently accepted version of the IECC.

- B. Service: Round, supply-air ducts, concealed.
 - 1. Material: Mineral-fiber blanket.
 - 2. Thickness: 2 inches (50 mm).
 - 3. Number of Layers: One.
 - 4. Vapor Retarder Required: Yes.

- C. Service: Round, outside-air ducts, concealed.
 - 1. Material: Mineral-fiber blanket.
 - 2. Thickness: 2 inches (50 mm).
 - 3. Number of Layers: One.
 - 4. Vapor Retarder Required: Yes.

- D. Service: Rectangular, supply-air ducts, concealed.
 - 1. Material: Mineral-fiber blanket.
 - 2. Thickness: 2 inches (50 mm).
 - 3. Number of Layers: One.
 - 4. Vapor Retarder Required: Yes.

- E. Service: Rectangular, outside-air ducts, concealed.
 - 1. Material: Mineral-fiber blanket.
 - 2. Thickness: 2 inches (50 mm).
 - 3. Number of Layers: One.
 - 4. Vapor Retarder Required: Yes.

- F. Service: Round, supply-air ducts, exposed.
 - 1. Material: Mineral-fiber board.
 - 2. Thickness: 2 inches (50 mm).
 - 3. Number of Layers: One.
 - 4. Jacket: Foil and paper.
 - 5. Vapor Retarder Required: Yes.

- G. Service: Round, outside-air ducts, exposed.
 - 1. Material: Mineral-fiber board.
 - 2. Thickness: 2 inches (50 mm).
 - 3. Number of Layers: One.
 - 4. Vapor Retarder Required: Yes.

- H. Service: Rectangular, supply-air ducts, exposed.
 - 1. Material: Mineral-fiber board.
 - 2. Thickness: 2 inches (50 mm).
 - 3. Number of Layers: One.
 - 4. Vapor Retarder Required: Yes.

- I. Service: Rectangular, outside-air ducts, exposed.

1. Material: Mineral-fiber board.
2. Thickness: 2 inches (50 mm).
3. Number of Layers: One.
4. Vapor Retarder Required: Yes.

J. Service: Rectangular, range-hood exhaust ducts, concealed.

1. Material: Mineral-fiber board.
2. Thickness: 1 inch (25 mm).
3. Number of Layers: One.
4. Vapor Retarder Required: Yes

END OF SECTION

SECTION 15950**TESTING, ADJUSTING, AND BALANCING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.
 - 2. HVAC equipment quantitative-performance settings.
 - 3. Space pressurization testing and adjusting.
 - 4. Verifying that automatic control devices are functioning properly.
 - 5. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. NC: Noise criteria.
- F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- G. RC: Room criteria.
- H. Report Forms: Test data sheets for recording test data in logical order.

- I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- M. TAB: Testing, adjusting, and balancing.
- N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- O. Test: A procedure to determine quantitative performance of systems or equipment.
- P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

- A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit [4] copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- E. Sample Report Forms: Submit two sets of sample TAB report forms.
- F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
- B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service

representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
- C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems."
- E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
- B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
 - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
 - 1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
 - 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201,

"Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- K. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- L. Examine strainers for clean screens and proper perforations.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine equipment for installation and for properly operating safety interlocks and controls.
- O. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 5. Sensors are located to sense only the intended conditions.
 - 6. Sequence of operation for control modes is according to the Contract Documents.
 - 7. Controller set points are set at indicated values.
 - 8. Interlocked systems are operating.
 - 9. Changeover from heating to cooling mode occurs according to indicated values.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Balance, smoke, and fire dampers are open.
 - 5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 6. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.

- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling unit components.
- K. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
 - 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 - 5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 - 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

- a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer, model, and serial numbers.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.

3.7 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Refrigerant Coils: Measure the following data for each coil:
 1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.
 3. Airflow.
 4. Air pressure drop.

5. Refrigerant suction pressure and temperature.

3.9 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.10 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Check free travel and proper operation of control devices such as damper and valve operators.
- F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.
- I. Check main control supply-air pressure and observe compressor and dryer operations.
- J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.11 TOLERANCES

- A. Set HVAC system airflow rates within the following tolerances:
 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
 2. Air Outlets and Inlets: 0 to minus 10 percent.

3.12 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.13 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 - 1. Fan curves.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of TAB firm.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB firm who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.

- c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer, type size, and fittings.
 14. Notes to explain why certain final data in the body of reports varies from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
 1. Quantities of outside, supply, return, and exhaust airflows.
 2. Duct, outlet, and inlet sizes.
 3. Pipe and valve sizes and locations.
 4. Balancing stations.
 5. Position of balancing devices.
- F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
 1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Sheave dimensions, center-to-center, and amount of adjustments in inches .
 - j. Number of belts, make, and size.
 - k. Number of filters, type, and size.
 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Cooling coil static-pressure differential in inches wg.
 - g. Heating coil static-pressure differential in inches wg.
 - h. Outside airflow in cfm.
 - i. Return airflow in cfm.
 - j. Outside-air damper position.
 - k. Return-air damper position.
 - l. Vortex damper position.

G. Apparatus-Coil Test Reports:

1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft. .
 - h. Tube size in NPS .
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outside-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Refrigerant expansion valve and refrigerant types.
 - i. Refrigerant suction pressure in psig (kPa).
 - j. Refrigerant suction temperature in deg F (deg C).
 - k. Inlet steam pressure in psig (kPa).

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:
 - a. System identification.
 - b. Location.

- c. Coil identification.
 - d. Capacity in Btuh.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft.
 - j. Minimum face velocity in fpm.
2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btuh.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - g. Number of belts, make, and size.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.

- J. Round, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
 - a. System and air-handling unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- K. Air-Terminal-Device Reports:
1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Test apparatus used.
 - d. Area served.
 - e. Air-terminal-device make.
 - f. Air-terminal-device number from system diagram.
 - g. Air-terminal-device type and model number.
 - h. Air-terminal-device size.
 - i. Air-terminal-device effective area in sq. ft.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
 - h.
- L. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Unit make and model number.

- d. Compressor make.
 - e. Compressor model and serial numbers.
 - f. Refrigerant weight in lb.
 - g. Low ambient temperature cutoff in deg F.
2. Test Data (Indicated and Actual Values):
- a. Inlet-duct static pressure in inches wg.
 - b. Outlet-duct static pressure in inches wg.
 - c. Entering-air, dry-bulb temperature in deg F.
 - d. Leaving-air, dry-bulb temperature in deg F.
 - e. Condenser entering-water temperature in deg F.
 - f. Condenser leaving-water temperature in deg F.
 - g. Condenser-water temperature differential in deg F.
 - h. Condenser entering-water pressure in feet of head or psig.
 - i. Condenser leaving-water pressure in feet of head or psig.
 - j. Condenser-water pressure differential in feet of head or psig.
 - k. Control settings.
 - l. Unloader set points.
 - m. Low-pressure-cutout set point in psig.
 - n. High-pressure-cutout set point in psig.
 - o. Suction pressure in psig.
 - p. Suction temperature in deg F.
 - q. Condenser refrigerant pressure in psig.
 - r. Condenser refrigerant temperature in deg F.
 - s. Oil pressure in psig.
 - t. Oil temperature in deg F.
 - u. Voltage at each connection.
 - v. Amperage for each phase.
 - w. Kilowatt input.
 - x. Crankcase heater kilowatt.
 - y. Number of fans.
 - z. Condenser fan rpm.
 - aa. Condenser fan airflow rate in cfm.
 - bb. Condenser fan motor make, frame size, rpm, and horsepower.
 - cc. Condenser fan motor voltage at each connection.
 - dd. Condenser fan motor amperage for each phase.

3.14 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.

- c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
- d. Measure sound levels at two locations.
- e. Measure space pressure of at least 10 percent of locations.
- f. Verify that balancing devices are marked with final balance position.
- g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
3. Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.15 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION



DIVISION 16

ELECTRICAL

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SECTION 16010**BASIC ELECTRICAL REQUIREMENTS****PART 1 GENERAL****1.01 RELATED SECTIONS**

- A. Requirements specified within this section apply to all sections in Division 16, ELECTRICAL. Work specified herein shall be performed as if specified in the individual sections. The CONTRACTOR shall review installation procedure under other sections and coordinate the installation with all other trades.

1.02 STANDARDS

- A. All electrical equipment and controls furnished under the provisions of this Section of the specifications shall conform to the current standards, rules, regulations and specifications of the following authorities:

American National Standards Institute (ANSI)

American Society of Testing and Materials (ASTM)

American Waterworks Association (AWWA)

City of San Antonio (CoSA)

CPS Energy (CPS)

Factory Mutual (FM)

Institution of Electrical and Electronics Engineers (IEEE)

Insulation Cable Engineers Association (ICEA)

International Building Code (IBC)

International Energy Conservation Code (IECC)

International Fire Code (IFC)

National Association of Corrosion Engineers (NACE)

National Electrical Contractors Association (NECA)

National Electrical Manufacturers Association (NEMA)

National Fire Protection Association (NFPA)

Underwriters' Laboratories, Inc. (UL)

- B. Reference to standards of any technical society, organization, or both shall be construed to mean the latest standard, code, specifications, or tentative specification adopted and published at the date of advertisement.

1.03 DESCRIPTION OF ELECTRICAL WORK

A. General Description:

1. The electrical work to be performed under the provisions of these Contract Documents consists of furnishing all materials, equipment, supplies, and appurtenances; providing all construction plans, equipment and tools; performing all necessary labor and supervision, and the construction, complete including all work appurtenant thereto, at the San Antonio Water System's locations as indicated below:

- a. La Rosa Pump Station
3019 La Rosa Street
San Antonio, TX 78211
- b. Pitluk Wellfield
3040 Pitluk Ave.
San Antonio, TX 78211

B. Electrical Work Provided within this Contract:

1. Provide demolition of equipment as shown on the Contract Drawings. SAWS shall have first right of refusal for all equipment.
2. Remove all cable in ductbanks being removed and/or relocated.
3. Remove all ductbanks as noted on the Contract Drawings.
4. Coordinate with CPS Energy for their service and transformer modifications. Contractor shall pay for installation with Contract allowance.
5. Furnish and install Motor Control Centers (MCC-A), (MCC-B) and Switchboard as per plans in the new Electrical Building for La Rosa. Reference Sections 16431, Low Voltage Motor Control Center and 16428, Low Voltage Switchboard.
6. Furnish and install modifications to existing Motor Control Center as per plans at Pitluk.
7. Furnish and install dry-type padmount transformers per Section 16461, Indoor/Outdoor Dry-type Distribution Transformers – General Purpose 3-Phase 500kVA and below.
8. Furnish and install power panelboards per Section 16050, Basic Electrical Materials and Methods.
9. Furnish and install Supervisory Control and Data Acquisition (SCADA) Equipment per project plans and Division 17.
10. Furnish and install electric feeders, control, instrumentation, and appurtenances for the upgrades for the High Service Pump modifications at La Rosa.

11. Furnish and install electric feeders, control, and appurtenances for existing chlorine booster pump at Pitluk.
12. Furnish and install electric feeders, control, and appurtenances for the control valves at Pitluk.
13. Furnish and install electric feeders, lighting, control, instrumentation, and appurtenances for the fluoride facility at Pitluk.
14. Furnish and install electric feeders, control, and appurtenances for the existing Ground Storage Tank at La Rosa.
15. Furnish and install electric feeders, control, and appurtenances for the altitude valve at La Rosa.
16. Furnish and install electrical distribution, lighting and other equipment in the new Electrical/SCADA Building for La Rosa as shown on the contract drawings.
17. Install new yard lighting and lighting contactor panel for La Rosa as shown on the Contract Drawings.
18. Furnish and install heat trace panels at La Rosa as shown on the Contract Drawings and Section 16940
19. Furnish and install a Standby Generator at La Rosa, Section 16600 and an Automatic Transfer Switch, Section 16501.
20. Furnish and install grounding systems as shown on the Contract Drawings and specified in Section 16451, Grounding.
21. Furnish and install Lightning Protection Systems as shown on the Contract Drawings and specified in Section 16770, Lightning Protection Systems.
22. Furnish and install required instrumentation per Contract Drawings and Section 17310, Field Instruments.
23. Furnish and install all interconnect wiring for controls and power. Wiring shall be in accordance with the Contract Drawings.
24. Furnish and install a security system at La Rosa as per the Contract Drawings and Section 17550, Security System.
25. The work shall include all ductbanks, conduit, cable, wiring, controls, instrumentation, grounding and lighting, as specified herein, as indicated on the Contract Drawings, and as necessary to provide a complete, functional, operating electrical system.
26. The CONTRACTOR is to provide the conduit layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete and concrete-encased conduits. Drawings shall show locations of pull and junction boxes and all penetrations on walls and floor slabs. Conduit shall not be installed until approved by Owner and Engineer. Conduit layout for the all proposed buildings shall be included.
27. Furnish Operations and Maintenance Manuals for the following items of electrical equipment: Reference Section, 01730 Operation and Maintenance Data.
 - a. Low Voltage Motor Control Center
 - b. Low Voltage Switchboard

- c. Dry-Type Transformers.
- d. Motor Operated Valve Actuators.
- e. Instrumentation.
- f. SCADA System Equipment.
- g. Security System Equipment.
- h. Panelboards.
- i. Standby Generator and Automatic Transfer Switch

1.04 SUBMITTALS

- A. Shop Drawing Submittals: The submittal of Shop Drawings in accordance with Section 01300, SUBMITTALS and the General Conditions of the Contract, Section 5.13, shall include the following:
 - 1. Outline and control drawings for Low Voltage Motor Control Centers and Switchboard including all relays, meters, instrument transformers, and control devices.
 - 2. Duct materials including conduit, fittings, and spacers.
 - 3. 600Vac cable specifications.
 - 4. Transformers and panelboards.
 - 5. Enclosures, light fixtures, and receptacles.
 - 6. Instrumentation.
 - 7. SCADA System equipment.
 - 8. Security System equipment.
 - 9. Standby Generator
 - 10. Automatic Transfer Switch
- B. Operation and Maintenance Manuals.
- C. Quality Control Submittals:
 - 1. Field Test Results.
 - 2. Factory test certification and reports for all major electrical equipment.

1.05 FINAL DRAWINGS

- A. Final drawings shall be submitted in accordance with Division 1 and shall include:
 - 1. Overall Interconnect Wiring Diagram:
 - a. The CONTRACTOR shall, prior to final acceptance, furnish the OWNER with interconnect wiring diagrams of the entire station installation.
 - b. The diagrams shall be documentation of all field wiring (interconnects) made between all equipment, motors, controllers, panels, instrumentation, etc. by the CONTRACTOR.

- c. The diagrams shall identify each terminal point, each cable as it was actually labeled and the size and number of cables actually installed by the CONTRACTOR.
2. Final "As-Built" Drawings:
 - a. The CONTRACTOR shall, prior to final acceptance, provide the OWNER with one copy of the Contract Drawings indicating all deviations made, and additional information provided, during construction and installation. Process and Instrumentation (P&ID) drawing revisions shall be included. The drawings shall be documentation of the entire station "as-built" by the CONTRACTOR and shall also indicate the following:
 - (i) All fuse sizes.
 - (ii) All current transformer ratios (overall & as-set).
 - (iii) All transformer sizes (kVA) and impedance values (%).
 - (iv) Numbers for all terminal points indicated on the Contract Drawings.
 - (v) Include the actual routing of exposed and concealed conduit runs on Record Drawings.
 - (vi) Items not furnished under this contract are not applicable.
- B. Contractor will not receive final project payment until the interconnect diagrams and "As-Built" Redlined Electrical and Control System Drawings are delivered to the Owner.

PART 2 PRODUCTS

2.01 GENERAL

- A. All electrical materials used shall conform to the National Electric Code, International Fire Code, International Building Code, International Energy Conservation Code and City of San Antonio Codes and shall be approved by the National Board of Fire Underwriters for the class of service for which they are intended and shall bear the label or approval of the Underwriters Laboratories insofar as such services are available.
- B. Permits: Obtain all permits required to commence work and, upon completion of the work obtain and deliver to the Engineer a Certificate of Inspection and Approval from the City of San Antonio or other authority having jurisdiction.
- C. CONTRACTOR shall be held responsible to have examined the site and existing facilities prior to bidding in order to compare them with the drawings and specifications with respect to the conditions of the premises, location of and/or connection to existing facilities and any obstructions, which may be encountered. Note that the site is an existing facility and the plans are based on as-built drawings that may contain some discrepancies.
- D. The design ambient temperature to be utilized for the electrical facilities is 40° C. Locations will be classified as identified in Section 100-A of the National Electrical Code. All plant areas, with the exception of the Chemical Facilities (sodium hypochlorite and fluoride) are classified as "Non-Hazardous".

PART 3 EXECUTION**3.01 GENERAL**

- A. Electrical Drawings show general locations of equipment, devices and raceways, unless specifically dimensioned.
 - 1. Dimensions shown on the Drawings related to equipment are based on one typical manufacturer's equipment. Coordinate the dimensions of the equipment furnished with the space available.
 - 2. Intent:
 - a. The drawings show the principal elements of the electrical system. They are not intended as detailed working drawings for the electrical work but as a complement to the specifications to clarify the principal features of the electrical systems.
 - b. It is the intent of this Section that all equipment and devices, furnished and installed under this and other Sections, be properly connected and interconnected with other equipment so as to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the specifications or shown on the drawings. Any work that may reasonably be inferred from the specifications or drawings as being required to provide the completed electrical systems shall be supplied whether or not it is specifically called for.
 - c. Dielectric couplings shall be installed between dissimilar metals in all cases.
- B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.
- C. Installation and Operation:
 - 1. Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary for proper results. When so specified, or when employees of CONTRACTOR or his SUBCONTRACTORS are not qualified, such personnel shall be field representatives of the manufacturer of the equipment or materials being installed.

3.02 LOAD BALANCE - NOT REQUIRED**3.03 CHECKOUT AND STARTUP**

- A. All equipment installed under this Contract shall be placed into successful operation according to the written instructions of the manufacturer or the instructions of the manufacturer's field representative. All required adjustments, tests, operation checks, and other startup activity shall be provided.
- B. Manufacturer's Start-Up Services:
 - 1. Manufacturers' representatives shall be present when the motor control centers, switchboard and generator are placed into operation. The manufacturers' representatives shall revisit the job site as often as necessary until all trouble is

corrected and the equipment installation and operation are satisfactory in the opinion of the OWNER.

2. Manufacturers' representatives shall furnish to OWNER a written report certifying that the equipment has been properly installed; is in accurate alignment, and has been operated under full load conditions and has operated satisfactorily.
3. All costs for these services by the manufacturers shall be included in the contract amount.

C. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
3. Unbalance Corrections:
 - a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
 - b. Obtain a written certification from a responsible power company official that the voltage variations and unbalance are within their normal standards if corrections are not made.

END OF SECTION

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SECTION 16050**BASIC ELECTRICAL MATERIALS AND METHODS****PART 1 GENERAL****1.01 SUBMITTALS**

- A. Shop Drawings and Data Sheets:
 - 1. Junction and pull boxes used at, or below, grade
 - 2. Device box relocation
 - 3. Terminal junction boxes
 - 4. Panelboards and circuit breaker data
 - 5. Fuses
 - 6. Contactors
 - 7. Transformers
 - 8. Lighting fixtures and poles
 - 9. Control cabinet enclosures
 - 10. Control cabinet wiring and terminal blocks
 - 11. Control cabinet devices and nameplates

1.02 QUALITY ASSURANCE

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

1.03 SPARE PARTS

- A. Furnish, tag, and box for shipment and storage and deliver prior to 75 percent Project completion the following spare parts:
 - 1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed as part of this project unless otherwise specified.
 - 2. Lamps for panel lighting: Twelve of each type installed as part of this project. Spare LED lamps are not required.

PART 2 PRODUCTS**2.01 METERING FACILITIES**

- A. Furnish materials as required by electric utility for utility's installation of metering equipment, service conductors, and mounting of utility company equipment.
- B. Coordinate all metering facility equipment installations with the utility company.

2.02 OUTLET AND DEVICE BOXES

- A. Sheet Steel: One-piece drawn type, galvanized, zinc- or cadmium-plated.
 - 1. Use for indoor locations.
 - 2. UL Standard 514
 - 3. Manufacturer:
 - a. Hubbell-Raco
 - b. Thomas & Betts-Steel City
- B. Cast Metal:
 - 1. Use for outdoor locations.
 - 2. UL Standard 514
 - 3. Box: Malleable iron
 - 4. Cover: Gasketed, weatherproof, malleable iron, with stainless steel screws.
 - 5. Hubs: Threaded
 - 6. Lugs: Cast Mounting
 - 7. Finish: Corrosion resistant zinc electroplate coated
 - 8. Manufacturers and Products:
 - a. Crouse-Hinds; Type FS or FD
 - b. Appleton; Type FS and FD
- C. PVC:
 - 1. Use wherever PVC conduit is required due to corrosive conditions.
 - 2. Box: PVC
 - 3. Cover: Gasketed
 - 4. Manufacturer:
 - a. Carlon
 - b. Crouse-Hinds
 - c. Cantex

2.03 JUNCTION AND PULL BOXES

- A. Outlet Boxes Used as Junction or Pull Box: As specified under Article OUTLET AND DEVICE BOXES.
- B. All junction and pull boxes shall be oversized to the next standard size.
- C. Sheet Steel Box: NEMA 250, Type 1
 - 1. Box: Code-gauge, galvanized steel
 - 2. Cover: Full access, screw type
 - 3. Machine Screws: Corrosion-resistant

4. For indoor installations where corrosive chemicals such as sodium hypochlorite and fluoride are not present.
 5. Manufacturers:
 - a. Hoffman
 - b. Hammond Manufacturing
 - c. Rittal
 - d. Saginaw Control & Engineering
- D. Stainless Steel Box: NEMA 250, Type 4X.
1. Box: 16-gauge, Type 316 stainless steel, with white enamel painted interior mounting panel, and 10 gauge stainless steel flanges.
 2. Cover: Hinged with clamps.
 3. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
 4. For outdoor installations where corrosive chemicals such as sodium hypochlorite and fluoride are not present.
 5. Manufacturers:
 - a. Hoffman Enclosures Co.
 - b. Hammond Manufacturing
 - c. Rittal
 - d. Saginaw Control & Engineering
- E. Use PVC junction and pull boxes wherever PVC conduit is required due to corrosive conditions.
1. Manufacturers:
 - a. Carlon
 - b. Cantex

2.04 WIRING DEVICES

- A. Switches:
1. Meets the requirements of NEMA WD1 and Federal Spec WS-896E.
 2. Specification grade, totally enclosed, ac type, with quiet tumbler switches and screw terminals
 3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
 4. Rating: 20 amps, 120/277 volts
 5. Color: Ivory
 6. Manufacturers:
 - a. Bryant
 - b. Leviton

- c. Hubbell
 - d. Pass and Seymour
 - e. Arrow Hart
- B. Receptacle, Single and Duplex:
- 1. Meets the requirements of NEMA WD 1 and Federal Spec W-C-596.
 - 2. Required to be tamper-resistant type if installed in a dwelling unit as per NEC Article 406.12.
 - 3. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
 - 4. High strength, thermoplastic base color.
 - 5. Color: Ivory.
 - 6. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
 - 7. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
 - 8. Manufacturers:
 - a. Bryant
 - b. Leviton
 - c. Hubbell
 - d. Pass and Seymour
 - e. Sierra
 - f. Arrow Hart
- C. Receptacle, Ground Fault Circuit Interrupter: Duplex, specification grade, tripping at 5 mA.
- 1. Color: Ivory.
 - 2. Meets the requirements of NEMA WD 1 and Federal Spec W C 596.
 - 3. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, capable of interrupting 5,000 amps without damage.
 - 4. Required at all outdoor locations, restrooms, kitchens, basements and other areas as per NEC Article 210.8.
 - 5. Required to be tamper-resistant type if installed in a dwelling unit as per NEC Article 406.12.
 - 6. Required to be weather resistant type with weather-proof cover when installed in outdoor locations.
 - 7. Size: For 2-inch by 4-inch outlet boxes.
 - 8. Feed-Through Model: NEMA WD 1, with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.
 - 9. Manufacturers:
 - a. Pass and Seymour
 - b. Bryant
 - c. Leviton

- d. Hubbell
- e. Arrow Hart

2.05 DEVICE PLATES

- A. General: Sectional type plates not permitted.
- B. Metal:
 - 1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
 - 2. Finish: ASTM A167, Type 302/304, satin
 - 3. Mounting Screw: Oval-head, finish matched to plate
 - 4. For indoor installations where sodium hypochlorite and fluoride are not present.
- C. Cast Metal:
 - 1. Material: Malleable ferrous metal, with gaskets
 - 2. Screw: Oval-head stainless steel
 - 3. For indoor installations where sodium hypochlorite and fluoride are not present.
- D. Weatherproof:
 - 1. For Receptacles: Gasketed, cast metal or stainless steel, with individual cap over each receptacle opening.
 - a. Shall be extra-duty, “in-use” type suitable for wet locations as per NEC Article 406.9.
 - b. Shall be weatherproof whether or not the attachment plug cap/cover is inserted/closed.
 - c. Mounting Screw: Stainless steel.
 - d. Cap Spring: Stainless steel.
 - e. Manufacturers:
 - (i) General Electric
 - (ii) Bryant
 - (iii) Hubbell
 - (iv) Sierra
 - (v) Pass and Seymour
 - (vi) Crouse-Hinds;
 - (vii) Bell
 - (viii) Arrow Hart
 - (ix) Appleton
 - 2. For Switches: Gasketed, cast metal incorporating external operator for internal switch.
 - a. Mounting Screw: Stainless steel
 - b. Manufacturers:
 - (i) Crouse-Hinds; DS-181 or DS-185
 - (ii) Appleton; FSK-1VTS or FSK-1VS
 - 3. For outdoor installations where sodium hypochlorite and fluoride are not present.
- E. Use PVC device plates wherever PVC conduit is required due to corrosive conditions.

2.06 LIGHTING AND POWER DISTRIBUTION PANELBOARD

- A. NEMA PB 1, NFPA 70, and UL 67
- B. Panelboards, Circuit Breakers and Terminals: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- C. Short-Circuit Current Equipment Rating: Fully rated 10kA.
- D. Voltage Rating: As shown on plans.
- E. The lighting and power distribution panelboards shall be provided with an integrally mounted Surge Protective Device: Refer to section 16450.
- F. Short Circuit Rating:
 - 1. Minimum short-circuit current of 10,000 amperes rms symmetrical for 240 Vac or less.
 - 2. Minimum short-circuit current of 14,000 amperes rms for 480Vac.
- G. Ground Fault Interrupter: 5-mA trip, 10,000 amps interrupting capacity circuit breakers.
- H. Cabinet: Meet the requirements of NEMA 250. Use NEMA Type 1 if inside a building without chemicals (sodium hypochlorite and fluoride); NEMA Type 4X-316 Stainless Steel if located outdoors. NEMA Type 4X -316 stainless steel if placed inside (or attached to) buildings where chlorine is present. Do not install power panels in areas containing fluoride.
 - 1. Material: Code-gauge, hot-dip galvanized sheet steel, with reinforced steel frame unless specified to be stainless steel.
 - 2. Front: Fastened with adjustable clamps.
 - a. Trim Size:
 - (i) Surface Mounted: Same as box.
 - (ii) Flush Mounted: $\frac{3}{4}$ inch larger than box on all sides.
 - 3. Exterior:
 - a. Finish: Rust inhibitor prime, with manufacturer's standard baked enamel or lacquer. All mounting hardware shall be corrosion resistant stainless steel.
 - 4. Interior:
 - a. Factory assembled, complete with circuit breakers.
 - b. Capable of circuit breaker replacement without disturbing adjacent circuit breakers or without removing main bus.
 - c. Spaces: Cover openings with easily removable metal cover.
 - 5. Door Hinges: Concealed
 - 6. Locking Device:
 - a. Pad lockable, Vandal-Resistant

b. Doors Over 30 Inches in Height: Multipoint

7. Circuit Directory: Metal frame with transparent plastic face and enclosed laminated card on interior of door. Hand-written directories are not acceptable.
8. Nameplates: Provide for each cabinet. On outdoor equipment the description nameplate shall be on the outer door.

I. Bus Bar:

1. Material: Tin-plated copper full sized throughout length.
2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
3. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
4. Ground: Copper, installed on panelboard frame, bonded to box, with at least one terminal screw for each circuit.
5. Lugs and Connection Points:
 - a. Suitable for either copper conductors.
 - b. Solderless main lugs for main, neutral, and ground bus bars.
 - c. Subfeed or through-feed lugs as shown.
6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

J. Circuit Breakers:

1. NEMA AB 1 and UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of the indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Noninterchangeable, in accordance with NFPA 70.
4. Type: Bolt-on circuit breakers in all panelboards.
5. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
6. Do not substitute single-pole circuit breakers with handle ties for multipole breakers.
7. Do not use tandem or dual circuit breakers in normal single-pole spaces.
8. Ground Fault Interrupter:
 - a. Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-milliampere ground fault (UL 943, Class A sensitivity).
 - b. Sensor with same rating as circuit breaker and a push-to-test button.
9. Means for lock open of the circuit breaker shall be permanently installed.

K. Manufacturers:

1. Eaton
2. General Electric
3. Siemens
4. Square D
5. ABB

2.07 TERMINAL JUNCTION BOX

- A. Cover: Hinged, unless otherwise shown.
- B. Terminal Blocks: Provide separate connection point for each conductor entering or leaving box.
1. Spare Terminal Points: 25 percent.
- C. Interior Finish: Paint with white enamel or lacquer.

2.08 TERMINAL BLOCK (0 TO 600 VOLTS)

- A. UL 486E and UL 1059.
- B. Screw-type for accepting ring-tongue compression lugs.
- C. Manufacturers:
1. Buchanan
 2. General Electric

2.09 SUPPORT AND FRAMING CHANNELS

- A. Material: Type 316 stainless steel. Fasteners and all related hardware to also be Type 316 stainless steel, 12-gauge, ASTM A1011 Grade 33.
- B. Inserts: Continuous
- C. Beam Clamps: Stainless steel
- D. Manufacturers:
1. Cooper B-Line
 2. Unistrut

2.10 CONTROL CABINETS

- A. Outdoor control cabinets shall be non-ventilated NEMA Type 4X (316 stainless steel). Use NEMA Type 4X (polycarbonate or fiberglass) if placed inside (or attached to) buildings where chlorine and/or fluoride is present. Electrical room and SCADA room

indoor enclosures shall be NEMA Type 12 unless noted otherwise. Refer to section 17550 for Security Cabinet and section 17325 for SCADA Cabinet requirements.

- B. All cabinets must be UL508A rated.
- C. Outdoor panels containing microprocessor equipment shall be provided with top, side, and door sunshield.
- D. All outdoor panels shall be equipped with a thermostat controlled heater.
- E. Enclosures shall be constructed of 16-gauge steel with powder coat over phosphatized surfaces for corrosion 2.10 n resistance.
- F. Enclosures shall have a single swing panel front with continuous hinge, and shall have provision for padlocking. Door handle type locks are not acceptable. Hinge pin and panel clamps shall be stainless steel. Hinged door shall be 16-gauge galvanized steel (unless otherwise specified to be stainless steel or polycarbonate). Door shall be vandal-resistant.
- G. Enclosures shall have an interior back panel. No screws shall penetrate the enclosure. The interior surfaces shall be white baked enamel finish. All control panels and devices shall be on a plane surface providing accessibility for maintenance without removing components.
- H. The control panel shall be provided with a Surge Protective Device: Refer to section 16450.
- I. Provide an internal, steel, hinged swing-out panel with white baked enamel finish for mounting devices such as pushbuttons, selector switches, control switches, and indicating lights. All devices shall be mounted inside the control cabinets.
- J. Devices and nameplates shall be furnished and installed as indicated in the Contract Drawings and elsewhere in the specifications.
- K. Enclosure Manufacturers:
 - 1. Hoffman Enclosure Co.
 - 2. Attabox (Polycarbonate Only)
 - 3. Saginaw Control and Engineering
- L. Design and Assembly: Contractor to submit name and qualifications of design and assemble firm for Owner's approval.

2.11 NAMEPLATES

- A. Nameplates shall be provided for each enclosure, control and indicating device. On outdoor equipment, the unit description nameplate shall be on the outer door.
- B. Exterior nameplates shall be paint-filled, engraved, corrosion-resistant metals of suitable dimensions using 1/4" high lettering minimum. Exterior switchgear/MCC nameplates shall have 3/8" high minimum lettering.

- C. Interior nameplates shall be of the size required, made of phenolic material with white core and engraved 3/16" minimum lettering.
- D. Permanent nameplates or stenciled painting shall identify each control device and each control wire terminal block connection inside the units to match identifications on the manufacturer's internal wiring diagrams and on the SUBCONTRACTOR's interconnection wiring diagram. Paper labels shall not be acceptable.
- E. Nameplates shall be mechanically fastened with rivets or screws.
- F. Engraving:
 - 1. Pushbuttons/Selector Switches: Name of equipment controlled on one, two, or three lines, as required.
 - 2. Panelboards: Panelboard designation, service voltage and phases.

2.12 LIGHTING

- A. Provide lighting fixtures and poles as shown on the Contract Drawings.
- B. For LED lighting ensure surge protection is included integral within the driver and shall protect the fixture from damage for transient voltages and currents as defined in ANSI/IEEE C64.41 2002 for Location A.

2.13 PUSHBUTTONS, INDICATING LIGHTS, AND SELECTOR SWITCHES

- A. Refer to sections 16428, 16431 and 16482 for requirements for MCC and Switchgear.
- B. All pushbuttons, indicating lights and selector switches shall be LED type, 30mm NEMA rated. IEC-only rated equipment is not acceptable.
- C. Contact Rating: NEMA ICS 2, Type A600.
- D. Selector Switch Operating Lever: Standard.
- E. Indicating Lights: Heavy-duty, oiltight, 120V, push-to-test:
 - 1. Motor On – Red
 - 2. Motor Off – Green
 - 3. Alarm - Amber
- F. Pushbutton Color:
 - 1. Emergency Stop: Red mushroom head without spring return
- G. Manufacturers:
 - 1. Heavy-Duty, Oiltight Type:
 - a. General Electric Type CR 104P.
 - b. Square D Type K Class 9001.
 - c. Eaton Type 10250T.
 - d. Allen-Bradley Type 800T.

2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
 - a. Square D Type SK.
 - b. General Electric Type CR104P.
 - c. Eaton Type E34.

2.14 MOLDED CASE CIRCUIT BREAKERS

- A. NEMA AB 1 and UL 489.
- B. NEMA rated, Thermal-magnetic, quick-make, quick-break, molded case, of the indicating type showing ON/OFF and TRIPPED positions of operating handle.
- C. Inverse time and instantaneous tripping characteristics.
- D. Ground fault protection shall be provided where indicated.
- E. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
- F. Do not substitute single-pole circuit breakers with handle ties for multipole breakers.
- G. Means for lock open of the circuit breaker shall be permanently installed.
- H. Manufacturer:
 1. Square D
 2. Siemens
 3. Eaton
 4. General Electric
 5. ABB

2.15 CONTROL POWER TRANSFORMERS (CPT)

- A. Type: Insulated dry indoor.
- B. Rating:
 1. Voltage rating per equipment requirements.
 2. kVA rating for control power requirements.
- C. Primary Protection: Two current-limiting fuses.
- D. Secondary Protection: Fused.

PART 3 EXECUTION**3.01 GENERAL**

- A. Install equipment in accordance with NECA 5055.
- B. All outdoor enclosures and boxes shall be bottom or side entry only. Top penetrations are not allowed.

3.02 OUTLET AND DEVICE BOXES

- A. Install suitable for conditions encountered at each outlet or device in the wiring or raceway system, sized to meet NFPA 70 requirements.
- B. Install plumb and level.
- C. Support boxes independently of conduit by attachment to building structure or structural member.
- D. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
- E. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
- F. Box Type (Steel Raceway System):
 - 1. Exterior Locations:
 - a. Exposed Raceways: Cast metal
 - b. Concealed Raceways: Cast metal
 - c. Concrete Encased Raceways: Cast metal
 - 2. Interior Dry Locations:
 - a. Exposed Rigid Conduit or IMC: Cast metal
 - 3. Interior Wet Locations:
 - a. Exposed Raceways: PVC SCH 80
 - b. Concealed Raceways: Cast metal
 - c. Concrete Encased Raceways: Cast metal
- G. Box Type (Nonmetallic Raceway System):
 - 1. Exposed Raceways: PVC SCH 80
 - 2. Concealed Raceways: PVC SCH 80
- H. Box Type, Corrosive Locations (PVC Raceway System): Fiberglass reinforced polyester.

3.03 JUNCTION AND PULL BOXES

- A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
- B. Install pull boxes where necessary in raceway system to facilitate conductor installation.
- C. Install in conduit runs at least every 150 feet or after the equivalent of three right angle bends.

- D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
- E. Installed boxes shall be accessible.
- F. Install plumb and level.
- G. Support boxes independently of conduit by attachment to building structure or structural member.
- H. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
- I. Boxes embedded in concrete or masonry need not be additionally supported.
- J. At or Below Grade:
 - 1. Install boxes for below grade conduits flush with finished grade in locations outside of paved areas, roadways, or walkways.
 - 2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
 - 3. Boxes shall not be installed in paved areas, roadways or walkways.
 - 4. Use boxes and covers suitable to support anticipated weights.
- K. Flush Mounted:
 - 1. Install with concealed conduit.
 - 2. Holes in surrounding surface shall be no larger than required to receive box.
 - 3. Make edges of boxes flush with final surface.
- L. Mounting Hardware:
 - 1. Noncorrosive Areas: Galvanized.
 - 2. Corrosive Areas (where sodium hypochlorite and/or fluoride are present): Stainless steel.
- M. Location/Type:
 - 1. Finished, Indoor, Dry: NEMA 250, Type 1.
 - 2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
 - 3. Unfinished Indoor and Outdoor, Wet: NEMA 250, Type 4X.
 - 4. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
 - 5. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.
 - 6. Unfinished, Indoor and Outdoor, Hazardous: NEMA 250, Type 7.
 - 7. Underground Locations: Concrete.
 - 8. Corrosive Locations: PVC SCH 80.

3.04 WIRING DEVICES

- A. Switches:
 - 1. Install with switch operation in vertical position.
 - 2. Install single-pole switches such that toggle is in up position when switch is on.
- B. Receptacles:
 - 1. Install with grounding slot down in vertical mounting, and with neutral slot up in horizontal mounting.
 - 2. Weatherproof Receptacles:
 - a. Install in cast metal box.
 - b. Install such that hinge for protective cover is above receptacle opening.
 - c. Receptacle shall be Ground Fault Circuit Interrupter type.
 - 3. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.
 - 4. Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

3.05 DEVICE PLATES

- A. Securely fasten to wiring device; ensure a tight fit to the box.
- B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.
- C. Surface Mounted: Plate shall not extend beyond sides of box unless plates have no sharp corners or edges.
- D. Install with alignment tolerance to box of 1/16-inch.
- E. Types (Unless Otherwise Shown):
 - 1. Exterior: NEMA 4X Weatherproof.
 - 2. Interior:
 - a. Surface Mounted, Cast Metal Boxes: Metal
 - b. Surface Mounted, Sheet Steel Boxes: Metal
 - c. Corrosive Areas (where chlorine and/or fluoride are present): PVC.

3.06 TERMINAL JUNCTION BOX

- A. Label each block and terminal with permanently attached, non-destructible tag.
- B. Do not install on finished outdoor surfaces.
- C. Location:
 - 1. Unfinished, Indoor and Outdoor, Wet: NEMA 250, Type 4X.

3.07 LIGHTING AND POWER DISTRIBUTION PANELBOARD

- A. Install securely, plumb, in-line and square with walls.
- B. Install top of cabinet 6 feet above floor unless otherwise shown.
- C. Provide typewritten, laminated circuit directory for each panelboard.

3.08 SUPPORT AND FRAMING CHANNEL

- A. Install where required for mounting and supporting electrical equipment and raceway systems.

3.09 CONTROL CABINETS

- A. Install securely, plumb, in-line and square with walls or structure.
- B. Cabinets shall be mounted using manufacturer furnished mounting brackets so that no screws or bolts penetrate the cabinet.

END OF SECTION

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SECTION 16073
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
1. Hangers and supports for electrical equipment and systems.
 2. Construction requirements for concrete bases.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Hangers
 - b. Steel slotted support systems
 - c. Clamps
 - d. Sockets
 - e. Eye nuts
 - f. Brackets
 2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.
1. Steel slotted-channel systems.
 2. Equipment supports.

PART 2 PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.

1. Manufacturers:
 - a. B-Line
 - b. Unistrut
 2. Material: Stainless Steel, Type 316.
 3. Channel Width: 1-1/2 inches.
 4. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 5. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Stainless-steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Refer to structural drawings for components.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 EXECUTION

3.01 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems unless requirements in this Section are stricter.
- B. Comply with requirements for raceways and boxes specified in Sections 16050 and 16110.

3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

- B. Raceway Support Methods: In addition to methods described in NECA 1, RMCs may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code or by Structural plans:
 - 1. To New Concrete: Bolt to concrete inserts.
 - 2. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 3. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 or Spring-tension clamps.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.04 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 Cast-in-Place Concrete.
- C. Anchor equipment to concrete base as follows:
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 16110**RACEWAYS****PART 1 GENERAL****1.01 SUBMITTALS**

- A. Shop Drawings:
 - 1. Manufacturer's Literature:
 - a. Rigid galvanized steel conduit
 - b. PVC Schedule 40 conduit
 - c. PVC Schedule 80 conduit
 - d. Flexible metal, liquid-tight conduit
 - e. Flexible, nonmetallic, liquid-tight conduit
 - f. Conduit fittings
 - g. Wireways
 - 2. Precast Vaults:
 - a. Dimensional drawings and descriptive literature
 - b. Traffic loading calculations
 - c. Accessory information

1.02 UL COMPLIANCE

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

PART 2 PRODUCTS**2.01 CONDUIT AND TUBING**

- A. Rigid Galvanized Steel Conduit (RGS):
 - 1. Meet requirements of ANSI C80.1 and UL6.
 - 2. Material: Hot-dip galvanized, with chromated protective layer.
 - 3. Manufacturers:
 - a. Allied Tube & Conduit
 - b. Cantex
 - c. Calpipe Industries: Calconduit
- B. PVC Schedule 40 Conduit:
 - 1. Meet requirements of NEMA TC 2 and UL 651.
 - 2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.
 - 3. Manufacturers:
 - a. Allied Tube & Conduit
 - b. Cantex

- c. Carlon
- C. PVC Schedule 80 Conduit:
 - 1. Meet requirements of NEMA TC 2 and UL 651.
 - 2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.
 - 3. Manufacturers:
 - a. Allied Tube & Conduit
 - b. Cantex
 - c. Carlon
- D. Flexible Metal, Liquid-Tight Conduit:
 - 1. UL 360 listed.
 - 2. Material: Galvanized steel, with an extruded PVC jacket.
 - 3. Manufacturers:
 - a. Southwire: Titan
 - b. Anaconda: Sealtite
 - c. Electri-Flex: Liqueflex
- E. Flexible, Nonmetallic, Liquid-Tight Conduit:
 - 1. Material: PVC core with fused flexible PVC jacket.
 - 2. UL 1660 listed for:
 - a. Dry Conditions: 80 degrees C insulated conductors.
 - b. Wet Conditions: 60 degrees C insulated conductors.
 - 3. Manufacturers:
 - a. Carlon: Carflex or X-Flex
 - b. Thomas & Betts: Xtraflex LTC or EFC
 - c. Southwire: Ultratite

2.02 FITTINGS

- A. Rigid Galvanized Steel:
 - 1. General:
 - a. Meet requirements of UL 514B.
 - b. Type: Threaded, galvanized. Setscrew fittings not permitted.
 - 2. Bushing:
 - a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
 - b. Manufacturers:
 - (i) Thomas & Betts

- (ii) O.Z. Gedney
 - (iii) Crouse-Hinds
- 3. Grounding Bushing:
 - a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
 - b. Manufacturers:
 - (i) Appleton
 - (ii) O.Z. Gedney
 - (iii) Crouse-Hinds
- 4. Conduit Hub:
 - a. Material: Hot Dipped Galvanized Malleable Iron with insulated throat.
 - b. Manufacturers:
 - (i) O.Z. Gedney
 - (ii) Thomas & Betts
 - (iii) Crouse-Hinds
- 5. Conduit Bodies:
 - a. Material: Cast ferrous, sized as required by NFPA 70.
 - b. Manufacturers (For Normal Conditions):
 - (i) Appleton; Form 35 threaded Unilets
 - (ii) Crouse-Hinds; Form 7 or 8 threaded condulets
 - (iii) Killark; Series O Electrolets
- 6. Couplings: As supplied by conduit manufacturer.
- 7. Drain/Breather Fitting Manufacturers:
 - a. Appleton; Type ECDB
 - b. Crouse-Hinds; ECD
- 8. Expansion Fitting Manufacturers:
 - a. Deflection/Expansion Movement:
 - (i) Appleton; Type DX
 - (ii) Crouse-Hinds; Type XD
 - b. Expansion Movement Only:
 - (i) Appleton; Type XJ
 - (ii) Crouse-Hinds; Type XJG
- 9. Cable Sealing Fittings:
 - a. To form watertight nonslip cord or cable connection to conduit

- b. For Conductors with OD of 1/2-inch or less: Neoprene bushing at connector entry
 - c. Material: Malleable iron
 - d. Meet requirements of UL 886.
 - e. Manufacturers:
 - (i) Appleton; Type EYD or EYDM
 - (ii) Crouse-Hinds; Type EYD or EZD
- 10. Concrete Tank Mounted Conduit Support:
 - a. 1 ½" x 1 ½" stainless steel channel
 - b. Stainless steel conduit straps and hardware
 - c. Steel channels shall be fastened to concrete tank with angle clips
 - d. Angle clips shall be fastened to tank with Tapcon S.S. concrete screws
 - e. Manufacturer:
 - (i) Thomas and Betts: Kindorf
 - (ii) Unistrut
- B. PVC Conduit and Tubing:
 - 1. Meet requirements of NEMA TC-3
 - 2. Type: PVC, slip-on
- C. Flexible Metal, Liquid-Tight Conduit:
 - 1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
 - 2. Insulated throat and sealing O-rings.
 - 3. Long design type extending outside of box or other device at least 2 inches.
- D. Flexible, Nonmetallic, Liquid-Tight Conduit:
 - 1. Type: One-piece fitting body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.
 - 2. Meet requirements of UL 514B.
 - 3. Manufacturers:
 - a. Carlon
 - b. Kellems
 - c. Thomas & Betts
- E. Watertight Entrance Seal Device:
 - 1. New Construction:
 - a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
 - b. Manufacturer: O.Z. Gedney; Type FSK or WSK, as required.
 - 2. Cored-Hole Application:
 - a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
 - b. Manufacturer: O.Z. Gedney; Series CSM.

2.03 VAULTS AND HANDHOLES

- A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.
- B. Loading: AASHTO Division 1, H-20 in accordance with ASTM C857.
- C. Drainage:
 - 1. Slope floors toward drain points, leaving no pockets or other nondraining areas.
- D. Raceway Entrances:
 - 1. Provide on all four sides.
 - 2. For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.
 - 3. At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.
- E. Hardware: Steel, hot-dip galvanized, with porcelain cable support insulators.
- F. Furnish knockout for ground rod in each handhole and vault.
- G. For non-roadway installations:
 - 1. Top of vaults and handholes shall protrude a minimum of 6" above finished grade. All protruding areas shall be painted safety yellow.
- H. Manufacturers:
 - 1. Brooks Products, Inc.
 - 2. Oldcastle Precast

2.04 ACCESSORIES

- A. Duct Bank Spacers:
 - 1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
 - 2. Suitable for all types of conduit.
 - 3. Manufacturer:
 - a. Underground Devices, Inc.
 - b. Carlon: Snap-Loc
- B. Identification Devices:
 - 1. Raceway Tags:
 - a. Material: .024 Stainless Steel.
 - b. Shape: 2 inch Round.
 - c. Shall be tied to conduit with minimum 32-mil stainless steel wire.
 - d. Raceway Designation: Pressure stamped, embossed, or engraved.
 - e. Tags relying on adhesives or taped-on markers not permitted.
 - f. Manufacturers:
 - (i) Brady

2. Warning Tape:
 - a. Material: Polyethylene, 4-mil gauge
 - b. Color: Red
 - c. Width: Minimum 6-inch
 - d. Designation: Warning on tape that electric circuit is located below tape.
 - e. Manufacturers:
 - (i) Blackburn
 - (ii) Terra Tape
- C. Raceway Coating:
 1. Material: Bitumastic or plastic tape coating.
 2. Manufacturers:
 - a. Koppers bitumastic
 - b. Scotchwrap
 3. All rigid galvanized conduit shall be wrapped where in contact with concrete and/or soil. Wrap conduits 6" above contact point with soil and/or concrete.
- D. Wraparound Duct Band:
 1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
 2. Manufacturer: Raychem

PART 3 - EXECUTION

3.01 GENERAL

- A. Conduit and Tubing sizes shown are based on the use of copper conductors.
- B. All installed Work shall comply with NECA 5055.
- C. Crushed or deformed raceways not permitted.
- D. Maintain raceway entirely free of obstructions and moisture.
- E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
- F. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
- G. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
- H. Group raceways installed in same area.
- I. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

- J. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
- K. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes. Do not install raceways within walls.
- L. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.
- M. Install watertight fittings in outdoor, underground, or wet locations.
- N. Paint threads, before assembly of fittings, of galvanized conduit installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.
- O. All metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
- P. Do not install raceways in concrete equipment pads, foundations, or beams.
- Q. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
- R. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

3.02 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

- A. Minimum cover 3 inches.
- B. Conduit to be concrete encased horizontally and vertically.
- C. Provide support during placement of concrete to ensure raceways remain in position.
- D. Floor Slabs:
 - 1. Outside diameter of conduit not to exceed one-third of the slab thickness.
 - 2. Separate conduit by minimum six times conduit outside diameter, except at crossings.

3.03 CONDUIT APPLICATION

- A. Diameter: Minimum 3/4-inch.
- B. Exterior Exposed: Rigid galvanized steel.
- C. Interior Exposed: Rigid galvanized steel.
- D. Concrete-Encased Raceways: PVC Schedule 40. Refer to ductbank details on the Contract Drawings for transitions from steel to PVC.
- E. Corrosive Locations (where chlorine and/or fluoride are present): PVC Schedule 80.

3.04 CONNECTIONS

- A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, and other equipment where flexible connection is required to minimize vibration:
 - 1. Conduit Size 4 Inches or Less: Flexible liquid-tight conduit.
 - 2. Conduit Size Over 4 Inches: Nonflexible.
 - 3. Corrosive Areas: Flexible, nonmetallic, liquid-tight.
 - 4. Length: 18-inch minimum, 60-inch maximum, of sufficient length to allow movement or adjustment of equipment.
- B. Outdoor Areas, Process Areas Exposed to Moisture, and Areas required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.
- C. Transition From Underground Concrete Embedded to Exposed: Transition from PVC to rigid metal shall occur prior to the final 90° turn out of the ground.
 - 1. Wrap rigid steel conduit per section 2.04 C.
- D. Exterior Light Pole Foundations: PVC Schedule 80 conduit.

3.05 PENETRATIONS

- A. Make at right angles, unless otherwise shown.
- B. Notching or penetration of structural members, including footings and beams, not permitted.
- C. Fire-Rated Walls, Floors, or Ceilings: Fire-stop openings around penetrations to maintain fire-resistance rating. Provide fire-stops per local codes for all penetrations of the fire-rated sodium hypochlorite and fluoride area walls.
- D. Apply single layer of wraparound duct band to all metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.
- E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.
- F. Entering Structures:
 - 1. General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
 - 2. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.
 - 3. Non-waterproofed Wall or Floor (Underground, without Concrete Encasement):
 - a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
 - b. Sleeve shall be flush with finished surfaces.

- c. Fill space between raceway and sleeve with an expandable plastic compound, or oakum and lead joint, on each side.
4. Vaults:
 - a. Metallic Raceways: Provide insulated grounding bushings.
 - b. Nonmetallic Raceways: Provide bell ends flush with wall.
 - c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.06 SUPPORT

- A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.
- B. Multiple Adjacent Raceways: Provide ceiling trapeze.
- C. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
 1. Wood: Wood screws.
 2. Hollow Masonry Units: Toggle bolts.
 3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
 4. Steelwork: Machine screws.
- D. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.07 BENDS

- A. Install concealed raceways with a minimum of bends in the shortest practical distance.
- B. Make bends and offsets of longest practical radius.
- C. Install with symmetrical bends or cast metal fittings.
- D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.
- E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.
- F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.
- G. PVC Conduit:
 1. Bends 30-Degree and Larger: Provide factory-made elbows.
 2. 90-Degree Bends: Use PVC Schedule 80.

3. Use manufacturer's recommended method for forming smaller bends.
- H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.08 EXPANSION/DEFLECTION FITTINGS

- A. Provide on all raceways at all structural expansion joints, and in long tangential runs.
- B. Provide expansion/deflection joints for 50 degrees F maximum temperature variation.
- C. Install in accordance with manufacturer's instructions.

3.09 PVC CONDUIT

- A. Solvent Welding:
 1. Provide manufacturer recommended solvent; apply to all joints.
 2. Install such that joint is watertight.
- B. Adapters:
 1. PVC to Metallic Fittings: PVC terminal type.
 2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.
- C. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.

3.10 TERMINATION AT ENCLOSURES

- A. Cast Metal Enclosure: Provide manufacturer's pre-molded insulating sleeve inside metallic conduit terminating in threaded hubs.
- B. Sheet Metal Boxes, Cabinets, and Enclosures:
 1. Rigid Galvanized Conduit:
 - a. Provide one lock nut each on inside and outside of enclosure.
 - (i) Install grounding bushing.
 - (ii) Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
 - b. Install insulated bushing on ends of conduit where grounding is not required per NEC.
 - c. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
 2. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.
 3. PVC Schedule 40 and 80 Conduit: Provide PVC terminal adapter with lock nut.
- C. Motor Control Center, Switchboard, Switchgear, and Free-Standing Enclosures: Terminate conduit-entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

3.11 UNDERGROUND RACEWAYS

- A. All underground conduit shall be concrete encased with steel reinforcing with a minimum of 3 inches of concrete over steel reinforcing as indicated on drawings.
- B. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one vault, handhole, or pull box to the next, or from a high point between them, depending on surface contour.
- C. Cover: Maintain minimum 2-foot cover above concrete encasement, unless otherwise shown.
- D. Make routing changes as necessary to avoid obstructions or conflicts.
- E. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.
- F. Conduits shall have end bells where terminated at walls and adapters for steel conduit continuations.
- G. Union type fittings not permitted.
- H. Spacers:
 - 1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in concrete encasement.
 - 2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 5 feet.
- I. Support conduit so as to prevent bending or displacement during concrete placement.
- J. Installation with Other Piping Systems:
 - 1. Crossings: Maintain minimum 12-inch vertical separation.
 - 2. Parallel Runs: Maintain minimum 12-inch separation.
 - 3. Installation over valves or couplings not permitted.
- K. Metallic Raceway Coating: Along entire length, coat with raceway coating.
- L. Concrete Encasement: Class "A" (3000-PSI) concrete as specified in SAWS Standard Specification for Construction, Item No. 300.
- M. Backfill:
 - 1. Backfill with sand pneumatically compacted in 6" lifts.
 - 2. Do not backfill until inspected by OWNER.
- N. Cutting and Patching of Asphalt Surfaces:
 - 1. Refer to Civil Plans.

3.12 EMPTY RACEWAYS

- A. Provide permanent, removable cap over each end.
- B. Provide PVC plug with pull-tab for underground raceways with end bells.
- C. Provide nylon pull cord.
- D. Identify, as specified in Article IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.13 IDENTIFICATION DEVICES

- A. Raceway Tags:
 - 1. Identify origin and destination.
 - 2. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed Raceway, whether in ceiling space or surface mounted.
 - 3. Provide noncorrosive wire for attachment.
- B. Warning Tape: Install approximately 10 inches above underground concrete-encased raceways. Align parallel to, and above centerline of runs.
- C. Buried Raceway Markers:
 - 1. Install at grade to indicate direction of underground raceways.
 - 2. Install at all bends and at intervals not exceeding 100 feet in straight runs.
 - 3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.14 PROTECTION OF INSTALLED WORK

- A. Protect products from effects of moisture, corrosion, and physical damage during construction.
- B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.
- C. Touch up painted conduit threads after assembly to cover nicks or scars.

END OF SECTION

SECTION 16120**CONDUCTORS****PART 1 GENERAL****1.01 SUBMITTALS**

- A. Shop Drawings:
 - 1. Wire and cable descriptive product information.
 - 2. Wire and cable accessories descriptive product information.
- B. Quality Control Submittals:
 - 1. Factory Test Report for conductors 600 volts and below.
 - 2. Factory Test Report per AEIC, including AEIC qualification report for conductors above 600 volts
 - 3. Manufacturer's data sheets and catalog data.

1.02 UL COMPLIANCE

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

PART 2 PRODUCTS**2.03 CONDUCTORS 600 VOLTS AND BELOW**

- A. Conform to applicable requirements of:
 - 1. UL 83
 - 2. ASTM Standards
 - 3. Federal Specification A-A-59544
 - 4. NFPA 70, Article 725
- B. Conductor Type: Stranded Copper
- C. Insulation: Type THHN/THWN 90°C. Allowable conductor ampacity shall be as listed for 75°C Temperature rating even for conductor with 90°C rated insulation.
- D. No conductor smaller than #12 AWG shall be used.

2.04 600-VOLT RATED POWER AND INSTRUMENTATION CABLE

- A. General:
 - 1. NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable

2. Tray Rated Cable (Type TC) shall meet the requirements of UL 1277 and UL 1581. Shall also meet the Flame Test requirements of IEEE 383 or UL 1685. Tray rated cable shall be installed in all cable trays.
 3. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
 4. Suitable for installation in open air, in cable trays (when required), or conduit (both above and below ground).
 5. Minimum Temperature Rating: 90° C dry locations, 75° C wet locations.
 6. Overall Outer Jacket: PVC, flame-retardant, sunlight-and oil-resistant.
- B. Twisted, Shielded Pair Instrumentation Cable (TW/SH/PR):
1. No. 16 AWG, Single pair, designed for noise rejection for process control, computer, or data log applications.
 2. Outer Jacket: PVC.
 3. Individual Pair Shield: double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
 4. Conductors:
 - a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
 - b. 20 AWG, seven-strand tinned copper drain wire.
 - c. Insulation: 15-mil nominal PVC.
 - d. Jacket: 4-mil nominal PVC.
 - e. Color Code: Pair conductors black (positive) and white (negative).
 5. Standards:
 - a. UL 1685
 - b. When installed in cable trays shall be cable tray rated (Type TC).
 - c. NEMA WC 55
 6. Manufacturers:
 - a. Okonite
 - b. AlphaWire
 - c. Belden
- C. Twisted, Shielded Pair Instrumentation Cable for RS485 Applications (RS485 TW/SH):
1. No. 24 AWG, Single pair, designed for noise rejection for Modbus RS485 applications.
 2. Outer Jacket: PVC.

3. Individual Pair Shield: double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage. Tinned copper braid shield with 90% coverage.
 4. Conductors:
 - a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
 - b. 24 AWG, seven-strand tinned copper drain wire.
 - c. Insulation: 23-mil nominal polyethylene.
 - d. Jacket: 35-mil nominal PVC.
 - e. Color Code: Pair conductors blue and white.
 5. Standards:
 - a. UL 1685
 - b. When installed in cable trays shall be cable tray rated (Type TC).
 - c. NEMA WC 55
 6. Manufacturers:
 - a. Belden type 9841 or equal from below manufacturers:
 - (i) AlphaWire
 - (ii) Okonite
- D. Twisted, Shielded Triad Instrumentation Cable (TW/SH/TRIAD): No. 16 AWG, Single triad, designed for noise rejection for process control, computer, or data log applications.
1. Outer Jacket:PVC.
 2. Individual Pair Shield: double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
 3. Conductors:
 - a. Bare soft annealed copper, Class B, seven-strand concentric, ASTM B8.
 - b. 20 AWG, seven-strand tinned copper drain wire.
 - c. Insulation: 15-mil PVC.
 - d. Color Code: Triad conductors black, red, and white.
 4. Standards:
 - a. UL 1685
 - b. When installed in cable trays shall be cable tray rated (Type TC).
 - c. NEMA WC 55
 5. Manufacturers:
 - a. Okonite
 - b. AlphaWire
 - c. Belden

2.05 GROUNDING CONDUCTORS

- A. Equipment:
 - 1. No. 8 AWG and Larger:
 - a. Stranded Bare Copper, Class B stranding, soft drawn.
 - b. A continuous white outer finish shall be used on all systems with a voltage of less than 150V between grounded and ungrounded conductors.
 - c. A continuous gray outer finish shall be used on all systems with a voltage of 150V or higher between grounded and ungrounded conductors.
 - 2. No. 10 AWG and smaller:
 - a. Solid Bare Copper or Stranded copper with Type THHN/THWN, insulation.
 - b. A continuous white outer finish shall be used on all systems with a voltage of less than 150V between grounded and ungrounded conductors.
 - c. A continuous gray outer finish shall be used on all systems with a voltage of 150V or higher between grounded and ungrounded conductors.
 - 3. Do not install bare grounding conductors in the same conduit as insulated power conductors.
- B. Direct Buried: Stranded bare copper, class B stranding soft drawn.

2.06 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

- A. Tape:
 - 1. General Purpose, Flame-Retardant:
 - a. 7-mil, vinyl plastic, Scotch Brand 33, rated for 105° C, meeting requirements of UL 510.
 - 2. Flame Retardant, Cold and Weather Resistant:
 - a. 8.5-mil, vinyl plastic, Scotch Brand 88, rated for 105° C meeting requirements of UL 510.
 - 3. Arc and Fireproofing:
 - a. 30-mil, elastomer, Scotch; Brand 77, with Scotch Brand 69-glass cloth tape binder.
- B. Identification Devices:
 - 1. Sleeve: Permanent, PVC, yellow or white, 2-inch minimum, with legible machine-printed black markings.
 - 2. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
 - 3. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.
 - 4. Manufacturers:
 - a. Brady
 - b. Thomas & Betts

- c. 3M
 - d. Panduit
- C. Connectors and Terminations:
- 1. Nylon, Self-Insulated Crimp Connectors:
 - a. Manufacturers and Products:
 - (i) Thomas & Betts; Sta-Kon
 - (ii) Burndy; Insulink
 - (iii) ILSCO
 - 2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
 - a. Manufacturers and Products:
 - (i) Thomas & Betts; Sta-Kon
 - (ii) Burndy; Insulink
 - (iii) ILSCO
 - 3. Self-Insulated, Free spring Wire Connector (Wire Nuts):
 - a. Plated steel, square wire springs.
 - b. UL Standard 486C.
 - c. Manufacturers and Product:
 - (i) Thomas & Betts
 - (ii) Ideal; Twister
- D. Cable Lugs:
- 1. In accordance with NEMA CC 1.
 - 2. Rated 600 volts of same material as conductor metal.
 - 3. Insulated, Locking-Fork, Compression Lugs:
 - a. Suitable for use with 75°C wire at full NFPA 70, 75°C ampacity.
 - b. Manufacturers and Products:
 - (i) Thomas & Betts; Sta-Kon
 - (ii) ILSCO; ILSCONS
 - 4. Uninsulated Crimp Connectors and Terminators:
 - a. Suitable for use with 75°C wire at full NFPA 70, 75°C ampacity.
Manufacturers and Products:
 - (i) Square D; Versitide
 - (ii) Thomas & Betts; Color-Keyed
 - (iii) ILSCO
 - 5. Uninsulated, Bolted, Two-Way Connectors and Terminators:

- a. Manufacturers and Products:
 - (i) Thomas & Betts; Locktite
 - (ii) Burndy; Quiklug
 - (iii) ILSCO
- E. Cable Ties: Nylon, adjustable, self-locking, and reusable.
 - 1. Manufacturer and Product: Thomas & Betts; TY-RAP.
- F. Heat Shrinkable Insulation: Thermally stabilized, cross-linked polyolefin.
 - 1. Manufacturer and Product: Thomas & Betts; SHRINK-KON.

2.07 PULLING COMPOUND

- A. Nontoxic, noncorrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.
- B. Suitable for raceway material and conductor jacket material.
- C. Manufacturers and Products:
 - 1. Ideal Co.; Yellow 77
 - 2. Polywater, Inc.
 - 3. Cable Grip Co.

2.08 SOURCE QUALITY CONTROL

- A. Conductors 600-Volts and below: Test in accordance with UL 44 and 854 Standards.

PART 3 EXECUTION

3.09 GENERAL

- A. Conductor installation to be in accordance with NECA 5055.
- B. Conductor and cable sizing shown on Contract Drawings is based on copper conductors, unless noted otherwise.
- C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radius.
- D. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.
- E. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.
- F. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.
- G. Ream; remove burrs, and clear interior of installed conduit before pulling wires or cables.
- H. Concrete encased raceway installation prior to installation of conductors: pull through each raceway a mandrel approximately ¼ inch smaller than raceway inside diameter.

3.10 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. No. 4 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 2 inches wide.
2. No. 6 AWG and Smaller: Provide colored conductors.
3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White or Gray Purple Brown Yellow
NOTE: Phase A, B, C implies direction of positive phase rotation.		

4. Tracer: Outer covering of white with an identifiable colored strip other than green in accordance with NFPA 70.

3.11 CIRCUIT IDENTIFICATION

- A. Circuits Appearing in Circuit Schedules: Identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.
- B. Labels shall be permanently legible, typed or preprinted. Label shall be Brady Type DAT-292 self-laminating vinyl film or as manufactured by Thomas & Betts, 3M or Panduit.
- C. Circuits Not Appearing in Circuit Schedules:
 1. Assign circuit name based on device or equipment at load end of circuit.
 2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

- D. Method:
1. Conductors No. 3 AWG and Smaller: Identify with sleeves.
 2. Cables, and Conductors No. 2 AWG and Larger:
 - a. Identify with marker plates.
 - b. Attach marker plates with nylon tie cord.
 3. Taped-on markers or tags relying on adhesives not permitted.

3.12 CONDUCTORS 600 VOLTS AND BELOW

- A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.
- B. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by OWNER.
- C. Connections and Terminations:
1. Install wire nuts only on solid conductors.
 2. Install nylon self-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 6 AWG and smaller.
 3. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
 4. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.
 5. Install uninsulated bolted, two-way connectors for motor circuit conductors No. 12 and larger.
 6. Tape insulate all uninsulated connections.
 7. Place no more than one conductor in any single-barrel pressure connection.
 8. Install crimp connectors with tools approved by connector manufacturer.
 9. Install terminals and connectors acceptable for type of material used.
 10. Compression Lugs:
 - a. Attach with a tool specifically designed for purpose.
 - b. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
 - c. Do not use plier type crimpers.
- D. Do not use soldered mechanical joints.
- E. Splices and Terminations:
1. Indoors: Use general purpose, flame retardant tape.
 2. Outdoors: Use flame retardant, cold- and weather-resistant tape.

- F. Cap spare conductors and conductors with UL listed end caps.
- G. Cabinets, Panels, and Motor Control Centers:
 - 1. Remove surplus wire, bridle and secure.
 - 2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.
- H. Control and Instrumentation Wiring:
 - 1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
 - 2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
 - 3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
 - 4. Cable Protection:
 - a. Under Infinite Access Floors: May be installed without bundling.
 - b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least 1/2-inch in diameter.
 - c. Maintain integrity of shielding of instrumentation cables.
 - d. Ensure grounds do not occur because of damage to jacket over the shield.
 - 5. Instrument shields shall be grounded at only one end.
- I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.13 CONDUCTOR ARC AND FIREPROOFING

- A. Wrap conductors of same circuit entering from separate conduit together as a single cable.
- B. Follow tape manufacturer's installation instructions.
- C. Secure tape at intervals of 5 feet with bands of tape binder. Each band to consist of a minimum of two wraps directly over each other.

3.14 FIELD QUALITY CONTROL

- A. In accordance with Section 16950, Electrical Testing.

END OF SECTION

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SECTION 16406**AC INDUCTION MOTORS – 100 HP TO 1000 HP****PART 1 - GENERAL**

1.01 SCOPE:

- A. This specification covers the requirements for squirrel cage induction motors with ratings between 100 HP and 1000 HP.
- B. Motors shall be vertical type and installed on vertical turbine pumps.
- C. The CONTRACTOR shall install the motors under the supervision and guidance of the motor manufacturer's representative. The CONTRACTOR shall supply the coupling and align the new motors with the existing pumps.
- D. If a motor horsepower rating larger than indicated is offered as a substitute and accepted, the CONTRACTOR shall provide required changes in conductors, motor controllers, overload relays, fuses, breakers, switches, and other related items with no change in the contract price.
- E. Submersible motors are not included in this specification.

1.02 RELATED SECTIONS (NOT USED)

1.03 REFERENCES:

- A. The following documents of the exact issue indicated, or of the issue in effect on the date of invitation for bids where no issue is indicated, shall apply to this procurement to the extent specified herein. In the event of any conflict between the requirements of this Specification and the requirements of the following documents, the requirements of the Specification shall govern.
 - 1. Anti-Friction Bearing Manufacturer's Association (AFBMA):
 - a. 9, Load Ratings and Fatigue Life for Ball Bearings.
 - b. 11, Load Rating and Fatigue Life for Roller Bearings.
 - 2. American National Standards Institute (ANSI): C50.41, Polyphase Induction Motors for Power Generating Stations.
 - 3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 85, Test Procedure for Airborne Sound Measurements on Rotating Machines.
 - b. 112, Standard Test Procedures for Polyphase Induction Motors and Generators.
 - c. 620, Guide for Construction and Interpretation of Thermal Limit Curves for Squirrel-Cage Motors Over 500 Horsepower.
 - 4. National Electrical Manufacturers Association (NEMA):
 - a. MG 1, Motors and Generators.
 - b. MG 2, Safety Standard and Guide for Selection, Installation, and Use of Electric Motors and Generators.

- c. MG 13, Frame Assignments for Alternating Current Integral Horsepower Induction Motors.

5. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)

1.04 WARRANTY:

- A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 2 years from the date of final acceptance. Warranty shall comply with Division 1.

1.05 SUBMITTALS:

A. Shop Drawings:

1. Descriptive information, including materials and features.
2. Nameplate data in accordance with NEMA MG 1.
3. Additional Rating Information:
 - a. Service factor.
 - b. Locked rotor current.
 - c. No load current.
 - d. NEMA insulation system classification.
 - e. Temperature rise at full load by resistance temperature detector (RTD) and resistance.
4. Maximum ambient temperature for which motor is designed.
5. Enclosure type and mounting.
6. Dimensions and total weight.
7. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
8. Bearing type.
9. Bearing lubrication.
10. Bearing life.
11. Space heater voltage and watts.
12. Motor sound power level in accordance with NEMA MG 1.
13. Maximum brake horsepower required by the equipment driven by the motor.
14. RTD type and mounting.
15. RTD alarm and trip set points.
16. Motor power factor at full load.
17. Date and place of manufacture.

18. Description of any modifications contemplated to mount motor on the existing pump.
19. Stator and rotor thermal damage curves for motor located in a 40° C ambient.
20. Maximum kVAR allowed for power factor correction. Maximum kVAR shall be included on motor nameplate as well.
21. Allowable time periods between starts.
22. Efficiency at ¼, ½, ¾ and full load.

Note: All documentation listed above shall be supplied with the motor's initial submittal. Incomplete submittals will be returned "NOT APPROVED, REVISE AND RESUBMIT".

1.06 QUALITY ASSURANCE:

A. Service of manufacturer's representative:

1. The motor manufacturer shall furnish the services of a competent factory trained technician, who shall have had a minimum of five (5) years' experience in the installation, adjustment, and operation of the equipment which is being furnished under this contract. This service is to ensure proper installation and adjustment of the motor, instruct personnel in proper operation, maintenance, and care of the equipment, for performing operation tests of equipment, and recommendations for obtaining the most efficient use thereof. The motor technician shall be an employee of the motor manufacturer unless otherwise approved by the Engineer in which case the CONTRACTOR shall submit qualifications of the employee a minimum of 7 calendar days before the bid date.
2. The service representative shall verify the proper installation, alignment, wiring, lubrication, and connection of all appurtenances prior to start-up. Representative shall be present during start-up and shall certify to the OWNER in writing that the motor has been properly installed and operates satisfactorily.

B. Certified Test Reports:

1. Submit the following Certified Test Reports (CTR) for motor:
 - a. Provide CTR for motor factory performance tests.
 - b. Provide CTR (with EIR) for field tests after motors are installed.
 - c. Provide CTS (with EIR) for motor field tests.

C. Equipment Installation Report:

1. Submit Equipment Installation Reports (EIR) from the motor manufacturer field service representative indicating the equipment was installed in accordance with the manufacturer's instructions and that the equipment was adjusted and aligned to be in the best operating condition. The report shall also indicate that the equipment is operating satisfactorily in accordance with the project specifications.

1.07 OPERATION AND MAINTENANCE MANUAL:

- ##### A. Organization:
- The following information shall be provided by the Motor Manufacturer and incorporated in the Motor Operation and Maintenance Manual:

1. Project record drawings clearly indicating operating features and including as-built shop drawings, outline drawings, and schematic and wiring diagrams.
2. Instructions for erection, alignment (including tolerances), and preparation for use.
3. Normal maintenance, inspection, and lubrication procedures.
4. Recommended spare parts list.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. U.S. Electrical Motors (Nidec)
- B. TECO-Westinghouse Motor Co.
- C. Toshiba
- D. Reliance (Baldor)
- E. Siemens

2.02 GENERAL:

- A. The motors shall be designed to fit in the space shown on the drawings.
- B. Replacement parts must be readily available through USA distributors.
- C. The brake horsepower required at any point along the drive curve including tolerance allowed by Hydraulic Institute standards and during shop and field testing of driving units shall not exceed the rated motor horsepower.
- D. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.
- E. Meet requirements of NEMA MG 1.
- F. Frame assignments in accordance with NEMA MG 13.
- G. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.
- H. Lifting lugs on all motors.
- I. Operating Conditions:
 1. Outdoor, high humidity, dusty.
 2. Maximum ambient temperature not greater than 40 degrees C.
 3. Standard altitude (Below 3300 feet).
 4. Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise.

5. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING AND FULL LOAD RPM:

- A. Refer to electrical plan sheets for pump motors HP and RPM.
- B. The motor nameplate horsepower shall be equal to or greater than the maximum load which will be imposed on it by the pump when operating at any point in the operating head range.

2.04 SERVICE FACTOR:

- A. 1.15 minimum at 40 degrees C temperature, unless otherwise indicated.

2.05 VOLTAGE AND FREQUENCY RATING:

- A. Motor shall be 3-phase, 60Hz.
- B. Motor voltage shall be as indicated on the Contract Drawings.
- C. Suitable for full voltage direct-on-line starting.
- D. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.06 EFFICIENCY AND POWER FACTOR:

- A. Efficiency:
 - 1. The motor shall be rated NEMA Premium in accordance with NEMA MG1.
 - 2. Tested in accordance with NEMA MG 1.
 - 3. Guaranteed minimum at full load.
- B. Power Factor:
 - 1. Power factor for each motor shall have the capability to be corrected to 95% or better without overexciting the motor.

2.07 LOCKED ROTOR RATINGS:

- A. Safe stall time 15 seconds or greater.
- B. Locked Rotor Code shall be "G".

2.08 INSULATION SYSTEMS:

- A. Sealed windings in accordance with NEMA MG 1 - 1.27.2.
- B. Class H insulation system.
- C. Two cycles of vacuum impregnation of 100% solid epoxy resins.
- D. Insulation system materials shall be moisture and mildew resistant, and shall include a resilient outer covering, which will not erode when the motor is operated in sand laden air.

2.09 TEMPERATURE RISE:

- A. Motors shall have a maximum temperature rise, by resistance, of 80°C (Class B) for continuous operation at rated load.

2.10 ENCLOSURE:

- A. Enclosure to conform to NEMA MG 1.
- B. Totally Enclosed Fan Cooled (TEFC)
- C. Bolts shall be stainless steel.
- D. Drain shall be provided to prevent accumulation of liquids.
- E. There shall be a metal arrow on each end of the motor to indicate direction of rotation.

2.11 ROTOR:

- A. Rotor cage shall be constructed of copper or copper alloy bars. Aluminum bar rotors are not acceptable.

2.12 LEADS:

- A. Shall be made of ASTM B 173, class G stranded copper.
- B. Provide permanent identification numbers on leads as per NEMA MG 1.
- C. Motor leads shall have same class of insulation as the motor stator windings.

2.13 TERMINAL (CONDUIT) BOXES:

- A. Oversize main terminal box.
- B. Diagonally split, rotatable to each of four 90-degree position. Threaded hubs for conduit attachment.
- C. Furnish gaskets between box halves and between box and motor frame.
- D. Minimum usable volume in percentage of that specified in NEMA MG1 and NFPA 70, Article 430, shall be 200 percent.
- E. The cables associated with both the motor and the power factor correction capacitors (PFCC's) will terminate in the main motor terminal box.

2.14 BEARINGS AND LUBRICATION:

- A. Thrust Bearings:
 - 1. Antifriction self cooled bearing.
 - 2. Minimum 50,000 hours L-10 bearing life.
 - 3. Thrust bearing to be insulated from magnetic currents.
 - 4. Bearings shall be designed for the necessary upthrust and RPM as specified by the pump manufacturer.
- B. Guide Bearings:
 - 1. Manufacturer's standard bearing type.

2. Minimum 100,000 hours L-10 bearing life.
- C. Bearings shall be oil lubricated.
- 2.15 NOISE:
- A. Measured in accordance with IEEE 85 and NEMA MG 1.
 - B. The average sound pressure level shall not exceed the levels indicated in NEMA MG 1 at one meter at no load.
- 2.16 BALANCE AND VIBRATION CONTROL:
- A. In accordance with NEMA MG 1.
 - B. Rotors shall be dynamically balanced. Vibration displacement shall not exceed .001 inches peak-to-peak.
- 2.17 EQUIPMENT FINISH:
- A. Factory finish.
- 2.18 SPECIAL FEATURES AND ACCESSORIES:
- A. Anti-reverse Device:
 1. Motors shall be provided with an anti-reverse ratchet to prevent reversing due to phase reversal or backspin at shutdown.
 - B. Motor Shaft:
 1. Motor shall have solid shaft.
 - C. Space Heater:
 1. Motors shall be furnished with a space heater.
 2. Heater shall be rated at 240Vac and operated at 120Vac. Shall be low-density type for long life.
 3. Heater leads shall be wired to a terminal box separate from motor terminal box.
 4. Controlled by remote motor starter contact. See Pump Control diagrams in the Contract Drawings.
 5. Manufacturers standard construction, designed for long life.
 - D. Winding Thermal Protection:
 1. Resistance Temperature Detectors:
 - a. All motors shall be provided with 120-ohm nickel stator RTD's.
 - b. Six (two each phase) positioned to detect highest winding temperature and located between coil sides in stator slots.
 - c. Shall be physically embedded in the windings and not installed on the end turns.

- d. RTD leads brought to conduit box separate from motor terminal box, together with bearing RTD leads.
- E. Bearing Temperature Protection:
1. Replaceable 120 ohm nickel RTD on each bearing of motor.
 - a. All motors shall be provided with a 120-ohm nickel RTD on each bearing of the motor.
 - b. RTD leads brought to conduit box separate from motor terminal box, together with winding RTD leads.
- F. Motor Couplings:
1. Flexible limited slip couplings shall be the heavy duty type, designed so that the pump shaft may be removed without disturbing the position or adjustment of the driving unit. Coupling shall be all carbon steel. Minimum factor of safety of 1.5 times shaft strength shall be used. Horizontal surface of the coupling shall be machined parallel to the axis of the shaft, and faces shall be machined perpendicular to the axis of the shaft. CONTRACTOR/motor supplier shall field verify the type of coupling required and coordinate with the OWNER for exact requirements.
- G. Surge Protection:
1. Lightning arrester (4.5 Kv) to limit the magnitude of the transient voltage spike.
 2. Surge capacitor (0.5 microfarad) to limit the rate of rise of voltage.
 3. Both shall be located in an oversized conduit box mounted on the motor.
 4. The surge capacitor shall be connected between the motor and lightning arrester and the capacitor lead length shall be less than 3 feet.
- H. Nameplates:
1. Raised or stamped letters on stainless steel. Attached with stainless steel fasteners.
 2. Display all motor data required by NEMA MG 1 in addition to bearing numbers for both bearings.
 3. Provide temperature nameplate with alarm and trip temperature set points for winding and bearing temperatures.
 4. Bearings nameplate: Display bearing manufacturer's name and identifications and recommended lubricant.
- 2.19 FACTORY TESTING:
- A. Tests:
1. Test each motor in accordance with IEEE 112 for polyphase motors.
 2. Routine (production) tests on all motors in accordance with NEMA MG 1, plus no load power at rated voltage and measurement of locked rotor current.

- a. Power factor.
- b. Speed.
- c. Current at rated horsepower.
- d. KW input at rated horsepower.

B. Test Report Forms:

- 1. Routine Tests: IEEE 112, Form A-1.
- 2. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1.

C. Manufacturer shall provide certified test report.

2.20 ADDITIONAL REQUIREMENTS:

- A. CONTRACTOR to perform final motor and pump alignment with a laser and report of alignment must be submitted to OWNER.
- B. CONTRACTOR to perform a vibration test on motors and submit test report to OWNER. CONTRACTOR shall make adjustments as necessary until vibration levels are acceptable to OWNER.
 - 1. CONTRACTOR shall retain a testing laboratory service to record the vibration of existing pump and motor prior to removal of the motor. Submit test data to Engineers for review. Testing laboratory shall also test the pumping units after installation of new motors. The RMS value of vibration shall not exceed the value recorded for the existing pump and motor. Vibration reading shall be taken as per Hydraulic Institute Standards.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. In accordance with manufacturer's instructions and recommendations.
- B. Align motor carefully and properly with driven equipment.
- C. Secure equipment to mounting surface with anchor bolts. Provide anchor bolts meeting manufacturer's recommendations and of sufficient size and number for the specified load conditions.

3.02 FIELD QUALITY CONTROL:

- A. Motors shall be field tested. Refer to Section 16950, Electrical Testing.

3.03 MANUFACTURER'S FIELD SERVICES:

- A. Furnish manufacturer's representative at site in accordance with Section 01650, Manufacturers' Field Services, for installation assistance, inspection, equipment testing, and startup assistance.
- B. Manufacturer's Certificate of Proper Installation.

3.04 WARRANTY

- A. Equipment manufacturer shall warrant that all goods supplied are free of non-conformities in workmanship and materials for two (2) years from date of initial operation.

END OF SECTION

SECTION 16411**POWER SYSTEM STUDY****PART 1 GENERAL****1.01 DESCRIPTION****A. General:**

1. This section specifies that the CONTRACTOR provide short circuit and coordination studies including arc flash hazard study. Each electrical power system shall be deemed to include the utility company's transformers and the OWNER's power distribution system for this project. The short circuit, protective device coordination, and arc flash study reports shall provide an evaluation of the electrical power systems and the model numbers and settings of the protective devices for setting by the CONTRACTOR.

B. Scope:

1. Provide complete short circuit study, equipment interrupting or withstand evaluation, and a protective device coordination study for the power distribution systems. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly addressed in the study. The study shall assume all motors operating at rated voltage. Electrical equipment bus impedance shall be assumed zero. Short circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at the motor control centers.
2. A protective device coordination study shall be performed to determine appropriate relay settings. The study shall include all motor control centers, and panelboard main circuit breakers. Panelboard branch circuit devices need not be considered. The phase overcurrent and ground-fault protection shall be included as well as settings for all other adjustable protective devices.
3. An arc flash hazard study shall be performed based on the worst-case short circuit scenario. The study shall be performed in accordance with the latest version of IEEE Std 1584. Labels shall be provided for each covered piece of equipment for installation on the equipment. These labels will provide all necessary information for personnel to select the proper Personnel Protective Equipment (PPE). A one-line diagram shall be provided showing incident energy, flash protection boundary, and pertinent ratings.
4. An equipment evaluation study shall be performed to determine the adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the available fault currents.

5. All panelboards, MCC Sections and Switchgear sections should be provided with Arc Flash Hazard labels even if they are exempt from NFPA 70E requirements.
6. Infinite bus calculation is not acceptable. Use data provided by the electric utility.
7. Any problem areas or inadequacies in the equipment shall be promptly brought to the ENGINEER's attention.

1.02 REFERENCES

- A. This Section contains references to the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
IEEE 141-86	Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 242-86	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
IEEE 1584-02	IEEE Guide For Performing Arc Flash Hazard Calculations

1.03 SCHEDULE

- A. The approved reports shall be completed and a copy sent to the electrical distribution equipment manufacturer 45 days before the equipment is shipped to the Work site. The report shall be provided to the OWNER and ENGINEER 90 days before the equipment is shipped to the Work site.

PART 2 PRODUCTS

2.01 REPORTS

- A. The product shall be a certified report summarizing the short circuit coordination study and conclusions or recommendations that may affect the integrity of the electric power distribution system. As a minimum, the report shall include the following:
1. The equipment manufacturer's information used to prepare the study.
 2. Assumptions made during the study.
 3. Short circuit calculations listing short circuit levels at each bus.

4. Coordination study time-current curves including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker.
5. Comparison of short circuit duties of each bus to the interrupting capacity of the equipment protecting that bus.
6. All data that was used as input to the report. This data shall include cable impedances, source impedances, equipment ratings, etc.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide short circuit, coordination, and arc flash hazard studies on the electrical power distribution system, as specified. Each study shall be performed in accordance with IEEE Standards 141, 242, and 1584 and shall utilize the ANSI method of short circuit analysis in accordance with ANSI C37.010. Each study shall be performed using actual equipment data for all equipment. Each coordination study shall use the data from the manufacturer of protective devices.

3.02 QUALIFICATIONS

- A. Each report shall be performed by an electrical engineering or testing service that is regularly engaged in power system studies. A Professional Engineer, with proficiency in electrical engineering power studies, shall sign and seal the studies. The Professional Engineer shall be licensed to practice engineering in the State of Texas, with a minimum 5 years experience in system studies.

3.03 SHORT CIRCUIT STUDIES

- A. The CONTRACTOR shall be responsible to obtain and verify all data needed to perform the studies.
- B. As a minimum, each short circuit study shall include the following:
 1. One-Line Diagram:
 - a. Location and function of each protective device in the system, such as relays, direct acting trips, fuses, etc.
 - b. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.
 - c. Power, voltage ratings, impedance, primary and secondary connections of all transformers.
 - d. Type, manufacturer, and ratio of all instrument transformers energizing each relay.
 - e. Nameplate ratings of all motors and generators with their subtransient reactances. Transient reactances of synchronous motors and generators and synchronous reactances of all generators.

- f. Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors.
 - g. All significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc.
 - h. Emergency as well as normal switch conditions.
 - i. The time-current setting of existing adjustable relays and direct acting trips, if applicable.
2. Impedance Diagram:
 - a. Available MVA or impedance from the utility company
 - b. Local generated capacity impedance
 - c. Bus impedance
 - d. Transformer and/or reactor impedances
 - e. Cable impedances
 - f. Equipment impedances
 - g. System voltages
 - h. Ground scheme (resistance grounding, solid grounding, or no grounding)
 3. Calculations:
 - a. Determine the paths and situations where short circuit currents are the greatest. Assume bolted faults and calculate the 3-phase and line-to-ground short circuits of each case.
 - b. Calculate the maximum and minimum fault currents.

3.04 COORDINATION STUDY

- A. As a minimum, the coordination study for the power distribution system shall include the following on 5-cycle, log-log graph paper.
 1. Time-current curves for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the tap and time dial settings shall be specified.
 2. Time-current curves for each device shall be positioned to provide for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the ENGINEER shall be notified as to the cause.
 3. Time-current curves and points for cable and equipment damage.
 4. Circuit interrupting device operating and interrupting times.
 5. Indicated maximum fault values on the graph.
 6. Sketch of bus and breaker arrangement.

3.05 ARC FLASH HAZARD STUDY

- A. Colored labels shall be provided that meet the requirements of NFPA 70E (2018 Edition) and shall therefore contain at a minimum:
1. Arc Flash Boundary
 2. (Available Incident Energy and the Corresponding Working Distance) Or (Arc Flash PPE Category for the equipment)
 3. Site Specific Level of PPE
 4. Minimum Arc Rating of Clothing
 5. Nominal System Voltage
- B. All panelboards, MCC Sections and Switchgear sections should be provided with Arc Flash Hazard labels even if they are exempt from NFPA 70E requirements.

END OF SECTION

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SECTION 16412**SAFETY SWITCHES – HEAVY DUTY****PART 1 GENERAL****1.01 SCOPE**

- A. The Contractor shall furnish and install the low-voltage fused switches as specified herein and as shown on the contract drawings.

1.02 SUBMITTALS

- A. Shop Drawings:
 - 1. Dimensioned outline drawing
 - 2. Conduit entry/exit locations
 - 3. Switch ratings including:
 - a. Short-circuit rating
 - b. Voltage
 - c. Continuous current
 - 4. Fuse ratings and type
 - 5. Cable terminal sizes
- B. Product Information:
 - 1. Descriptive bulletins.
 - 2. Product sheets.

1.03 QUALITY ASSURANCE

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

1.04 SPARE PARTS

- A. Furnish, tag, and box for storage three (3) spare fuses of each type and current rating installed.

PART 2 PRODUCTS**2.01 HEAVY-DUTY SAFETY SWITCHES**

- A. Construction:
 - 1. Switchblades and jaws shall be plated copper.
 - 2. Switches shall have copper current carrying parts.
 - 3. Switches shall have a handle that is easily padlockable in the OFF position.

4. Switches shall have defeatable door interlocks that prevent the door from opening when the handle is in the ON position.
 5. Switch assembly and operating handle shall be an integral part of the enclosure base.
 6. Switches rated 100A to 600A shall have reinforced fuse clips.
 7. Switchblades shall be readily visible in the OFF position.
 8. Switch operating mechanism shall be non-teasible, positive quick-make/quick break type (except 30A plug fuse-type).
 9. Fusible switches shall be suitable for service entrance equipment.
 10. Switches shall have line terminal shields.
 11. Switch shall be supplied with an isolated grounded neutral bar.
 12. Switch shall be supplied with a grounding bar.
- B. Manufacturers:
1. Square D
 2. General Electric
 3. Eaton
 4. Siemens
 5. ABB
- C. Enclosures:
1. The enclosure shall be NEMA 4X – 316 stainless steel if located outdoors or where chlorine and/or fluoride are stored/used, or NEMA 12 if located in the Electrical Building.
 2. The enclosure shall have ON and OFF markings stamped into the cover.
 3. The operating handle shall be provided with a dual colored, red/black position indication.
- D. Surge Protection Device:
1. Provide with surge protection device per section 16450.
- E. Switch Ratings:
1. The UL Listed short circuit current rating of the switch shall be 10,000 rms, symmetrical amperes when used with or protected by Class H or K fuses (30-600 amperes) and 200,000 rms, symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 amperes switches employing appropriate fuse rejection schemes).

2.02 NAMEPLATES

- A. Nameplates shall be front cover mounted, contain a permanent record of switch type, ampere rating, and maximum voltage rating.

PART 3 EXECUTION

3.01 FACTORY TESTING

- A. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.

3.02 INSTALLATION

- A. The equipment shall be installed per the manufacturer's recommendations and the contract drawings.
- B. Contractor is responsible for providing all mounting brackets and structure to provide proper support and working clearances.

END OF SECTION

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SECTION 16421**SOFT START MOTOR CONTROLLER****PART 1 GENERAL****1.01 SCOPE OF WORK**

- A. This section provides specification requirements for solid-state soft start devices packaged as a complete motor control unit or herein identified as soft start controller units for use with NEMA B design AC motors.
- B. The solid state soft start controller unit manufacturer shall furnish, field test, adjust and certify all installed soft start controller units for satisfactory operation.
- C. Any exceptions/deviations to this specification shall be indicated in writing and submitted with the quotation.

1.02 SUBMITTALS

- A. Submit with the delivery of the Motor Controller an Installation and Maintenance Manual and one (1) copy of the manufacturer's drawings for each unit furnished.

1.03 REGULATORY REQUIREMENTS

- A. ANSI/NFPA 70 - National Electrical Code
- B. NEMA ISC 1, Industrial Control Systems: General Requirements
- C. NEMA ISC 2, Industrial Control Systems: Contactors and Overload Relays, rated not more than 2000 Volts AC or 750 Volts DC
- D. NEMA ICS 6, Industrial Control Systems: Enclosures
- E. UL 508 – UL Standard for Safety Industrial Control Equipment
- F. UL 845 – UL Standard for Safety for Motor Control Centers

1.04 WARRANTY

- A. The soft start controller unit shall be warranted to be free from defects in materials and workmanship for a period of two (2) years from the acceptance of the facility by the OWNER.

1.05 QUALITY ASSURANCE

- A. The soft start controller unit and all selected catalog options shall be UL listed according to Motor Control Center Equipment Specification UL 845. A UL label shall be attached inside each soft start controller unit as verification.

- B. The soft start controller unit shall be designed, constructed and tested in accordance with NEMA & NEC standards.
- C. All soft start controllers and factory-supplied options shall be completely tested for successful operation before shipment. Documentation shall be furnished with all submittals.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Square D
- B. Siemens
- C. General Electric
- D. Eaton
- E. ABB

2.02 GENERAL DESCRIPTION

- A. Starter shall include the following components:
 - 1. Control panel:
 - a. Digital alphanumeric door mounted display panel
 - b. Digital control keypad to program controller and select parameters to view
 - 2. Display functions and codes:
 - a. Display basic functions to include starter status functions, motor status functions, and fault status functions.
 - b. Display running codes
 - c. Display error codes
 - 3. Terminal strips:
 - a. Terminal strip for control power input
 - b. Terminal output strip for auxiliary relays
 - c. Terminal input strip: e.g. Start; Stop (Reset)
 - 4. Molded case circuit breaker for disconnecting means and emergency shunt trip.
 - 5. Output Relays:
 - a. 3 form A programmable output relays, minimum
 - b. NEMA B300 rated

- B. The soft starter shall utilize an SCR bridge consisting of at least two SCR's per phase.
- C. The soft starter shall be controlled by a microprocessor that continuously monitors the current and controls the phasing of the SCR's.
- D. A shorting contactor shall be standard, and all protective features and control options shall be available even when the shorting contactor is engaged.

2.03 CONSTRUCTION

- A. Units shall be of modular construction so that it is possible to readily interchange units of the same size without modifications to the motor control structure.
- B. All conducting parts on the line side of the unit disconnect shall be isolated to prevent accidental contact with those parts.
- C. Provisions shall be provided for locking the enclosure with owner's padlock.
- D. A shorting contactor shall be supplied in each soft start controller unit to reduce temperature rise within the unit and enclosure. The shorting contactor shall be rated to carry the motor full load current during steady state after full voltage has been applied to the motor by the soft start.

2.04 MOTOR DATA

- A. The soft start controller unit shall be sized to operate the following AC induction motor:
 - 1. Motor horsepower: As indicated on the contract drawings.
 - 2. Motor full load ampere: As indicated on the contract drawings.
 - 3. Motor rpm: As indicated in Division 11 specifications.
 - 4. Motor voltage: As indicated on the contract drawings.
 - 5. Motor service factor: 1.15

2.05 ENVIRONMENTAL RATINGS

- A. The soft start controller unit shall be housed in a NEMA Type 1 gasketed indoor motor control center type enclosure. Also reference specifications 16431 and 16482.
- B. The soft start controller unit shall be designed to operate while mounted in an enclosure with an ambient temperature from 15°F to 110°F.
- C. The storage temperature range shall be -13°F to 158°F.
- D. The maximum relative humidity shall be 95%, non-condensing.
- E. The soft start controller unit shall be rated to operate at altitudes less than or equal to 3,300 ft.

2.06 ELECTRICAL RATINGS

- A. The soft start controller unit shall be designed to operate from an input voltage between -10% and +10% of nominal voltage rating.
- B. The soft start controller unit shall operate at 60Hz with a tolerance of + / - 5%.
- C. The soft start controller shall be capable of supplying starting current of 300% of rated full load current, for minimum of 20 seconds.
- D. The SCR's shall have a minimum repetitive peak inverse voltage (P.I.V) rating of 1800 Vac. Lower rated SCR's with MOV protection are not acceptable.

2.07 PROTECTION

- A. A microprocessor-based thermal protection system shall be included which calculates the temperature-rise of the motor and soft starter and provides:
 - 1. A motor overload pre-alarm that indicates by relay contact or logic output that the motor windings have exceeded 130% of its rated temperature rise. This function shall be for alarm only.
 - 2. A motor overload fault will stop the motor if the windings have exceeded 140% of temperature-rise.
 - 3. An electronic circuit with a time-constant adjustable to the motor's thermal cooling time-constant ensuring the memorization of the thermal state even if power is removed from the soft starter.
- B. The soft starter shall provide line and motor phase loss, phase reversal, underload, stall, and jam protection.
- C. The integral protective features shall be active even when the shorting contactor is used to bypass the SCRs during steady state operation. Shunt trip coil to trip disconnect in the event of a soft starter fault condition including a shorted SCR.
- D. The integral protective features shall monitor, alarm and trip, the motor based on the motor winding and bearing temperature reading.

2.08 ADJUSTMENTS & CONFIGURATIONS

- A. Digital indication shall provide, as a minimum, the following conditions:
 - 1. Soft starter status – ready, starting/stopping, run
 - 2. Motor status – current, torque, power factor, elapsed time, power in kW
 - 3. Fault status – Motor thermal overload, soft starter thermal fault, loss of line or motor phase, line frequency fault, low line voltage fault, locked rotor fault, motor

underload, maximum start time exceeded, external fault, serial communication fault, line phase reversal fault, motor overcurrent fault.

- B. Output relays shall be programmed to provide the following status indications:
 - 1. One Form A (N.O.) minimum for indication of fault
 - 2. One Form A (N.O.) for indication that acceleration ramp is complete and current is below 130% motor FLA (ramp complete or motor at speed)
 - 3. One Form A (N.O.) assignable to one of the following functions: motor thermal alarm, motor current level alarm, and motor underload alarm
- C. Additional inputs and outputs shall be available to provide the following status indications:
 - 1. Two assignable control inputs for the following functions: soft stop, pump control, kick start, linear ramp, dual motor or remote control
- D. Relay and I/O functions listed above must be isolated with respect to common.
- E. All programming/configuration devices, display units, and field control wiring terminals shall be accessible on the front of the control module. Circuit boards or electrical power devices shall not be exposed during routine adjustments.

2.09 CONTROL OPTIONS

- A. All control circuitry shall be operated at 120 Vac, 60 Hz.

2.10 CONTROL CHARACTERISTICS

- A. Starting:
 - 1. (Full load) Motor current: 40 to 100 % rated starter current
 - 2. Current limit: 300% motor full load current
 - 3. Linear (torque-controlled) acceleration ramp time: adjustable 0 to 60 seconds, preset to 15 seconds
- B. Stopping:
 - 1. Coasting: Power removed from motor with no soft stop
 - 2. Brake time by ramp: Soft stop, 1 to 60 seconds, adjustable, independent of starting ramp

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that the location is ready to receive work and the dimensions are as indicated.
- B. Do not install the soft start controller unit until the enclosure environment can be maintained within the service conditions required by the manufacturer.

3.02 PROTECTION

- A. Before and during the installation, the soft start controller unit shall be protected from site contaminants.

3.03 INSTALLATION

- A. Installation shall be in compliance with manufacturer's instructions, drawings and recommendations.
- B. The soft start controller unit manufacturer shall provide a factory certified technical representative to supervise the contractor's installation, programming, testing and start-up of the soft start controller unit(s) furnished under this specification.
- C. A standard wiring diagram shall be included in the Installation and Maintenance Manual for making the appropriate electrical connections.

3.04 TRAINING

- A. A one-half day, on-site training course shall be provided by a representative of the soft start controller unit manufacturer for plant and/or maintenance personnel.

END OF SECTION

SECTION 16428
LOW VOLTAGE SWITCHBOARD

PART 1 GENERAL

1.01 SCOPE

- A. The Contractor shall furnish and install, where indicated, a free-standing, dead-front type low voltage distribution switchboard, utilizing group mounted circuit protective devices as specified herein, and as shown on the contract drawings.

1.02 SUBMITTALS

- A. For Review/Approval:
1. Itemized Bill of Material
 2. Descriptive information
 3. Dimensional drawings
 - a. Front elevation
 - b. Floor plan
 4. Nameplate Schedule
 5. Assembly ratings including:
 - a. Short-circuit rating
 - b. Voltage
 - c. Continuous current
 6. Major component ratings including:
 - a. Voltage
 - b. Continuous current
 - c. Interrupting ratings
 7. Component List
 8. Conduit entrance locations
 9. Bus data
 10. Protective Devices: Copies of instruction books and software.
 11. Operational description
 12. Anchoring instructions and details.
 13. One-Line diagrams
 14. Schematic (elementary) diagrams.
 15. Outline diagrams
 16. Interconnection diagrams
 17. Product Data Sheets
 18. Cable terminal sizes
 19. Key interlock scheme drawing and sequence of operations
- B. For Construction/Record Purposes:
1. Final as-built drawings and information and incorporating all changes made during the manufacturing process
 2. Manufacturer's installation instructions
 3. Operation and maintenance manual (Shall include all items in Part A above at a minimum.)
 4. Certified factory test reports
 5. Wiring Diagrams

1.03 REFERENCES

- A. The low voltage distribution switchboards and all components shall be designed, manufactured and tested in accordance with the latest applicable following standards:
 - 1. UL Standard 891 with UL labels
 - 2. NEMA PB-2.

1.04 PACKING AND SHIPPING

- A. Shipping Splits: Established by CONTRACTOR to facilitate ingress of equipment to final installation location within the building.
- B. Sills and anchor bolts shall be shipped ahead of the scheduled equipment delivery to permit installation of anchor bolts with the construction of the concrete slab.

1.05 SPARE PARTS

- A. 1 set each – Spare fuses, both power and control, of every size and type used.
- B. 10 each – Indicating lamps.
- C. 2 each – Indicating lamp pullers.
- D. 2 each – Lamp sockets for indicating lamps.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. The listing of specific manufacturers below does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed below are not relieved from meeting these specifications in their entirety.
 - 1. Eaton
 - 2. Siemens
 - 3. Square D
 - 4. ABB
 - 5. General Electric

2.02 GENERAL

- A. The completed switchboard assembly shall have, or exceed if applicable, the following electric ratings:
 - 1. Maximum Design voltage: 600V
 - 2. BIL: 60 kV
 - 3. Power Frequency Dielectric Withstand – 1 min.: 2.2 kV
 - 4. Frequency: 60 Hz
 - 5. Continuous Current: Refer to drawings
 - 6. Interrupting Amperes – Symmetrical: 65 kA
 - 7. Fault Closing – Symmetrical: 65 kA
 - 8. Momentary Current – 10 cycle Asymmetrical: 65 kA
- B. Equipment suitable for 480 volts, three-phase, four-wire with ground, solid grounded-wye electrical system.

- C. Equipment arrangement to be as shown on contract drawings.
- D. Designed, tested, and assembled in accordance with ANSI/IEEE C37.21.
- E. Like items of equipment shall be end products of one manufacturer in order to achieve standardization for appearance, operation and maintenance, spare parts and replacement, and manufacturer's services.
- F. Removable lifting lugs on all equipment and devices weighing over 100 pounds.
- G. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer.
- H. Operating Conditions:
 - 1. Ambient Temperature: Maximum 40 degrees C.
 - 2. Equipment to be fully rated without any de-rating for operating conditions.
- I. Equipment Finish: Electrocoating process applied over a rust-inhibiting phosphated base coating.
 - 1. Color:
 - a. ANSI 61 light gray in color.
 - b. Interior surfaces: White.

2.03 ENCLOSURE

- A. In accordance with NEMA 250 and ICS-6 Standards.
- B. Type: NEMA 1
- C. Construction:
 - 1. Front and rear aligned
 - 2. 11-gauge sheet steel, reinforced with welded channel or angle iron
 - 3. Butt sections flush, end-to-end with similar sections
 - 4. Freestanding
 - 5. Steel bottom cover plates
 - 6. 1.5 inch height bolt-on base sill for level installation on concrete pad
 - 7. Front accessible only
 - 8. Low voltage control compartment with separate door
 - 9. Shall fit in the space allotted as shown on the plans
 - 10. Ventilating openings shall be provided complete with replaceable fiberglass air filters.

2.04 INCOMING CABLE SECTIONS

- A. General:
 - 1. Incoming mains to be bottom-entrance insulated power cable.
 - 2. Cable entrance sections to have provision for termination of main cables.
 - 3. Cable: As specified in Section 16120, CONDUCTORS.
 - 4. Conductor size and cable arrangement: As shown on the Contract Drawings.
 - 5. Main Cable Terminations: As specified in Section 16120, CONDUCTORS.
 - 6. Provision for termination on the switchboard ground bus of neutral/ground cable from the utility transformer and ground connection to local grounding.

- B. Surge Protective Devices (SPD):
 - 1. Type 1, UL 1449 4th Edition
 - 2. MOV technology
 - 3. Dual-color Protection status indicators for each phase and neutral-ground protection modes
 - 4. Integrated unit
 - 5. Peak kA rating per phase: 400 kA
 - 6. 20 kA nominal discharge current (I_n) rating
 - 7. 10 year warranty
 - 8. Manufacturer:
 - a. Eaton: SPD Series or equal

2.05 BUS

- A. Incoming main, tie, and load buses to be insulated, silver-plated copper, rated 1600 amperes minimum throughout.
 - 1. Provide bus transition sections as necessary for connection of main cables, and transition to tie interrupter section.
 - 2. Bus support insulators to be either non-tracking moisture-resistant epoxy or porcelain.
 - 3. Bus bar insulation to be non-tracking flame retardant 600V class.
- B. Load Bus Termination:
 - 1. Provision for cable connection to motor control center (MCC "A" & "B") horizontal bus.
- C. Ground Bus: Copper, 300 ampere, ground bus to extend continuous throughout all sections of lineup without cable connections between sections. Ground bus to be provided with two NEMA 2-hole terminal pads at each exit and incoming position for connection of ground wire to motor control centers and incoming circuits. Each incoming section shall also have 2-hole terminal pad for connection to local ground electrode.
- D. Bus Bracing: 65,000 amperes rms asymmetrical.
- E. Connections and Joints: Bolted with Belleville washers.

2.06 POWER METER

- A. Provide one power meter on each of the main buses.
- B. Manufacturers:
 - 1. Eaton Power Xpert 2250 or equal.

2.07 INSTRUMENT TRANSFORMERS

- A. Current Transformer (CT):
 - 1. Types: Current Transformer (CT):
 - a. Insulated dry indoor.
 - b. Window type for relaying and ground sensing.
 - c. Wound type for metering.

2. Transformer Accuracy in Accordance with ANSI C57.13:
 - a. Class C20 or greater for relaying.
 - b. Class 1.2 maximum for imposed burden for metering.
 3. One CT per phase.
 4. Rating: 480V.
 5. Mechanical Rating: Equal to short-time current-carrying capability of motor starter.
 6. Thermal Rating: Maximum 55° rise above 30°C ambient.
 7. Thermal Rating Factor: RF 1.5, to operate continuously at 1.5 rated CT secondary current without exceeding temperature rise.
 8. Identify polarity with standard mark or symbol.
 9. Secondary Wiring:
 - a. Installed in conduit and wiring trough.
 - b. Terminate on short-circuiting type terminal block.
 - c. CT's to be wye connected with the neutral grounded directly at the CT X2 terminal common.
 - d. Single point ground.
 10. Isolate from adjacent components and circuit by removable insulating or metal barriers.
- B. Potential Transformer (PT):
1. Type: Insulated dry, indoor.
 2. Rating: 480/120-volt, single-phase.
 3. Electrical arrangement as shown on contract drawings.
 4. Thermal Capacity: Minimum 55° rise above 30°C ambient.
 5. Mechanical Rating; Equal to short-time current-carrying capability of circuit breaker.
 6. Accuracy classification in accordance with ANSI C57.13 for connected burden.
 7. Primary Protection: Integral mounted current-limiting fuses.
 8. Secondary Protection: Single separately mounted, current-limiting fuse.
 9. Identify polarity with standard marking or symbols.
 10. Grounding to be single point.
 11. Mount on drawout carriage installed in separate steel compartment. Primary and secondary terminals to be disconnected and the primary fuses grounded when drawout carriage is in OPEN position.

2.08 SPACE HEATERS

- A. Space heater rated 120 Vac, shall be low-density type for long life, sized for prevention of condensation in each vertical section.
- B. Adjustable thermostat with temperature range of 50° to 70° F.
- C. Power supply from control power transformer within the switchgear.
- D. Heaters shall be located and connected in a manner that prevents heat damage to adjacent wire or devices.

2.09 AUTOMATIC TRANSFER SWITCH COMPARTMENT

- A. Provide automatic transfer switch as per section 16500.

2.10 EQUIPMENT IDENTIFICATION

- A. Master Nameplate:
 - 1. Deep etched aluminum or stainless steel with manufacturer's name and model number.
 - 2. Attached to main vertical section with stainless steel panhead screws.
- B. Section Identification:
 - 1. Engraved stainless steel, attached to outside door of each vertical section with stainless steel panhead screws.
 - 2. Serial number, bus rating, and section reference number.
 - 3. Size: As required with 3/8" high minimum lettering.
- C. Interior Nameplates:
 - 1. Engraved, phenolic for each section, and each door mounted device.
 - 2. Black with white block type characters.
 - 3. Character Height: ¼ inch.
 - 4. Size: As required for 3 lines, with 15 characters each line.
 - 5. Inscriptions: As shown on one-line diagram.
 - 6. Blank plates for future spaces.
 - 7. Attachment Screws: Stainless steel panhead.
- D. Cubicle Labels:
 - 1. Non-metallic, applied inside each cubicle compartment.
 - 2. Device serial number, rating, and description.
- E. Control Switches: Deep etched, aluminum escutcheon plate.
- F. Signs:
 - 1. Sign on front of switchboard.
 - a. Size: As required.
 - b. Engraved, phenolic.
 - c. Color: Orange with black.
 - d. Inscription: DANGER/HIGH VOLTAGE/KEEPOUT.
 - e. Character: Gothic type, 2-inch high.
 - f. Attachment: Four stainless steel panhead screws for each sign.
- G. Provide a laminated, reduced-size approved control schematic permanently attached to the interior of each cubicle.

2.11 FACTORY TESTS

- A. Standard factory tests shall be performed in accordance with the latest version of ANSI and NEMA standards.
- B. The switchboard shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to ensure the accuracy of the wiring and the functioning of all equipment.
- C. The manufacturer shall provide three (3) certified copies of factory test reports.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. General:
1. Install in accordance with manufacturer's instructions and recommendations.
 2. Secure equipment sills to concrete with anchor bolts of sufficient size and number for load conditions.
 3. Proper coordination with equipment manufacturer conduit opening and stub up will be necessary for proper positioning of each switchboard and conduit stub up.
 4. Tighten current-carrying bus bolted connections and power cable bolted connections to manufacturer's recommendations.

3.02 FIELD QUALITY CONTROL

- A. In accordance with Section 16950, ELECTRICAL TESTING.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Furnish manufacturer's representative for the following services at site for minimum person-days listed below, travel time excluded.
1. 2 person-days for installation assistance and inspection, and certification of installation.

END OF SECTION

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SECTION 16431
LOW VOLTAGE MOTOR CONTROL CENTER

PART 1 GENERAL

1.01 SUBMITTALS

- A. Shop Drawings:
1. Itemized Bill of Material.
 2. Descriptive information.
 3. Dimensional Drawings.
 4. Conduit entrance locations.
 5. Bus data.
 6. Protective Devices: Copies of time-current characteristics, instruction books, and software.
 7. Operational description.
 8. Anchoring instructions and details.
 9. Typed tabulation:
 - a. Motor horsepower.
 - b. Nameplate full load current.
 - c. Main fuse.
 - d. CT ratio.
 - e. OL protection.
 10. Control Diagrams:
 - a. NEMA ICS 2, Section 322.08, Class IS or IIS custom drawings.
 - b. Wiring, Type B or C.
 - c. Remote control devices.
 - d. Remote indication and pilot lights.
 - e. Interconnections and interlocking circuits between starter and remote equipment.
 - f. Tag numbers associated with all control devices and equipment.
 11. One-line diagrams.
 12. Schematic (elementary) diagrams.
 13. Outline diagrams.
 14. Interconnection diagrams.
 15. Cubicle nameplate tabulation.
- B. Quality Control Submittals:
1. Manufacturer's installation instructions.
 2. Operation and maintenance manual (Shall include all information as in Part A above at a minimum)
 3. Factory test reports.

1.02 UL COMPLIANCE

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

1.03 PACKING AND SHIPPING

- A. Shipping Splits: Established by CONTRACTOR to facilitate shipping and installation.

1.04 SPARE PARTS

- A. 1 set each – Spare fuses, both power and control, of every size and type used.
- B. 10 each – Indicating lamps.
- C. 2 each – Indicating lamp pullers.
- D. 2 each – Lamp sockets for indicating lamps.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Eaton
- B. Siemens
- C. Square D
- D. General Electric
- E. ABB

2.02 GENERAL

- A. Products specified herein are based on motors for High Service Pumps (HSP).
- B. Equipment suitable for 480 volts, three-phase, three-wire with ground, solid grounded-wye electrical system having an available short-circuit current at line terminals of 65,000 amperes rms symmetrical.
- C. Equipment arrangement to be as shown on contract drawings.
- D. Designed, tested, and assembled in accordance with NEMA ICS 3 and UL 347.
- E. Like items of equipment shall be end products of one manufacturer in order to achieve standardization for appearance, operation and maintenance, spare parts and replacement, and manufacturer's services.
- F. Removable lifting lugs on all equipment and devices weighing over 100 pounds.
- G. Anchor Bolts: type 316 stainless steel, sized by equipment manufacturer and supplied by contractor.
- H. Operating Conditions:
 - 1. Ambient Temperature: Maximum 40°C.
 - 2. Equipment to be fully rated without any derating for operating conditions.
- I. Equipment Finish: Electrocoating process applied over a rust-inhibiting phosphated base coating.
 - 1. Color:
 - a. Exterior Color: ANSI 61 light gray color

- b. Interior surfaces: White

2.03 ENCLOSURE

- A. In accordance with NEMA 250 and ICS-6 Standards.
- B. Type: 12
- C. Construction:
 - 1. 11-gauge sheet steel, reinforced with welded channel or angle iron with ANSI 61 gray polyester powder coating.
 - 2. Butt sections flush, with similar sections.
 - 3. Controllers to be arranged in one-high configuration, except as specifically indicated on Contract Drawings.
 - 4. Steel bottom cover plates.
 - 5. 1.5-inch height base sill for installation on concrete floor.
 - 6. Completely front accessible.
 - 7. Horizontal bus compartment with protective barriers.
 - 8. Equipment with defeater to allow intentional access only to qualified personnel.
 - 9. Must meet maximum dimensions as shown on plans.

2.04 INCOMING SERVICE SECTION

- A. General:
 - 1. Incoming service to be provided by cable connection from the 480V Switchboard.
 - 2. MCC to have provision for termination of the incoming service switchboard cable to the MCC main horizontal bus.
- B. Surge Protective Devices (SPD):
 - 1. Type 1, UL 1449 4th Edition
 - 2. MOV technology
 - 3. Dual-color Protection status indicators for each phase and neutral-ground protection modes
 - 4. Integrated unit
 - 5. Peak kA rating per phase: 400 kA
 - 6. 20 kA nominal discharge current (I_n) rating
 - 7. 10 year warranty
 - 8. Manufacturer:
 - a. Eaton: SPD Series or equal

2.05 BUS

- A. MCC lineup to be provided with a horizontal 480-volt power bus located in bus compartment above controller sections.
 - 1. Isolated, 1200 ampere, three-phase, extending entire length of MCC lineup.
 - 2. Silver-plated copper throughout entire length.
 - 3. Bus shall be insulated with rigid PVC and shall have insulating boots over joints.
 - 4. Bus support isolators to be non-tracking moisture-resistant epoxy, or porcelain.
 - 5. The motor controller center shall consist of two (2) multiple section lineups (MCC "A" & MCC "B") connected by cable to the switchboard (refer to Section

16428). Provide provisions for extension to future controller sections as designated on Contract Drawings.

- B. Vertical Bus: Insulated, three-phase with rating as required by connected motor load. Load cables will be bottom entrance.
- C. Ground Bus: Tin-plated copper, 300 ampere, ground bus extending continuous throughout all sections of MCC lineup without cable connections between sections. Each motor starter section to be provided with two NEMA 2-hole terminal pads for connecting to motor ground cable.
- D. Bus Bracing: 100,000 amperes rms symmetrical.
- E. Connections and Joints: Bolted with Belleville washers.
- F. Buses shall be sized for present and anticipated future loads as indicated on one-line diagram.

2.06 MOTOR STARTER

- A. Shall be reduced-voltage soft starters. Refer to specification 16421. (For La Rosa)
- B. Provide for all manual, automatic, and supervisory control and indication in accordance with Contract Drawings.
- C. Provisions for motor space heater control as indicated on Contract Drawings.
- D. MAGNETIC MOTOR CONTROLLERS - NON-REVERSING, FULL VOLTAGE(For Chlorine Booster Pump No. 2 at Pitluck)

Square D Class 8536 or equal.

- 1. Description: Magnetic Controller for submersible pump applications.
- 2. Coil operating voltage: 120 volts, 60 Hz.
- 3. Coil: Shall be encapsulated type.
- 4. Poles: Three
- 5. NEMA Size: Refer to Contract Drawings.
- 6. Contacts: Totally enclosed, double-break, silver-cadmium-oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring.
- 7. Wiring: Straight-through wiring with all terminals clearly marked.
- 8. Overload Relay: NEMA ICS
 - a. Square D Motor Logic SSOLR or equal.
 - b. Solid State: Trip current rating will be established by selection of overload relay and shall be adjustable (3 to 1 current range). The overload shall be self-powered, provide phase loss and phase unbalance protection, have a permanent tamper guard, and be ambient insensitive. It will also be available in Trip Class 10 or 20 and have a mechanical test function.
 - c. Protective features shall include current unbalance and loss-of-phase protection.
 - d. Outputs: Unit shall be provided with normally open or normally closed auxiliary contact and be field convertible.

- e. Reset: Manual reset

2.07 MOTOR PROTECTION, CONTROL, AND METERING

- A. Motor Protection Relay (MPR) – Multifunction:
 - 1. General:
 - a. Multifunction, microprocessor based, self-diagnostic, programmable digital device.
 - b. Single, self-contained, door mounted unit with data input and programming pushbuttons/keypad on face of relay. Metering features may be provided with add-on device.
 - c. Motor protection against overload, over-temperature, phase reversal, phase current unbalance and phase loss, locked rotor, jam, and bearing over-temperature. Relay will not be used for tripping of electrical faults that exceed capability of motor controller contactor.
 - d. Standard thermal curves self generated within module based on motor data.
 - e. Motor current integrated with winding temperatures to establish trip times.
 - f. Monitor 120 Ohm nickel RTD inputs for winding and bearing temperatures.
 - g. Trip relay to have fail-safe mode: Trip relay energizes on power up and de-energizes on trip or loss of power.
 - h. Visual display to indicate relay status and operation.
 - i. Read out to include real-time motor data using pushbuttons.
 - j. System data and trip limit points accessible from same display.
 - k. Non-changeable trip limit points except with program jumper.
 - l. Separate alarm, auxiliary, and trip output contacts rated 10 amperes, 250 Vac continuous.
 - m. Alarm contacts suitable for connection to remote SCADA input.
 - n. Interconnecting wires terminated on terminal boards.
 - 2. Protective Features:
 - a. Time overcurrent-overload (51) trip and alarm.
 - b. Time overcurrent-ground (50G) trip and alarm.
 - c. Locked rotor current (51) trip and alarm.
 - d. Locked Rotor/Multiple Start (48) trip and alarm.
 - e. Winding temperature (49) and motor bearing temperature (38) protection, with capability of individually adjustable RTD trip and alarm levels.
 - f. Mechanical jam trip and alarm.
 - g. Unbalanced current (46) trip and alarm.
 - h. Phase reversal and phase loss-current (46) trip and alarm.
 - i. Phase reversal (47).
 - j. Starts per Hour (66) trip and alarm.
 - k. Acceleration timer, maximum allowable stall time, trip and alarm.
 - l. All trip and alarm independently adjustable.
 - m. Loss of protection alarm.
 - 3. Measurement and Display:
 - a. Three-phase line and percent full load currents.
 - b. L-L voltage, kW, kvar, mWhr, Pf, Hz. (relay to be connected to open-delta PT's located in the incoming service switchboard).

- c. RTD temperature readings.
 - d. Current unbalance at trip condition only.
 - e. Normal operating conditions and trip annunciation.
 - f. Operation counter (number of times motor has been started).
 - g. Run time (elapsed time meter).
 - 4. Features:
 - a. Programmable trip, alarm, and auxiliary relays.
 - b. Relay status.
 - c. Settable CT ratio.
 - d. Hold system values at trip.
 - e. Ethernet Communication
 - 5. Manufacturers and Products:
 - a. General Electric – Multilin, Model 869
 - 6. Programming:
 - a. Contractor shall integrate, configure and program the MPR. Graphics at the top end shall also be included.
 - b. Event enabling (trending) function shall be enabled.
 - c. Contractor must have OWNER approval of programming before final project acceptance.
- B. Three-Phase Overload Relay (OL):
- 1. Block type, ambient compensated, thermal overload relay with manual reset and appropriate heaters to match pump motor characteristics.
- C. Space Heater Current Relay (SHCR):
- 1. High Service Pump space heater indication to be provided as indicated on contract drawings.
 - 2. Manufacturer: ABB Type SSAC – ECS Series AC Current Sensor and Control.
- D. Time Delay Relay (TR), Incomplete Sequence Relay (IS):
- 1. Adjustable time-delay relay, heavy-duty, solid state, NEMA B600 rated convertible contacts.
 - 2. Manufacturer: Square D 9050 JCK or equal.
- E. Pushbuttons, Indicating Lights, and Selector Switches:
- 1. Contact Rating: NEMA ICS 2, Type A600, 30mm.
 - 2. All pushbuttons, lights and switches shall be NEMA rated. IEC-only rated equipment is not acceptable.
 - 3. Selector Switch Operating Lever: Standard.
 - 4. Indicating Lights: Heavy-duty, oiltight, 120V, push-to-test:
 - a. Pump Motor On -- Red
 - b. Pump Motor Off -- Green
 - c. Valve Open -- Red
 - d. Valve Closed -- Green
 - e. Lockout Relay Trip -- Amber
 - f. Motor Space Heater On -- Red
 - 5. Pushbutton Color:
 - a. On – Red
 - b. Off – Green
 - c. Emergency Off – Red mushroom head without spring return.
 - 6. Legend Plate:

- a. Material: Aluminum.
 - b. Engraving: 11 character/spaces on one line, 14 character/spaces on each of two lines, as required, indicating specific function.
 - c. Letter Height: 7/64-inch.
7. Manufacturers:
- a. Heavy-Duty, Oiltight Type:
 - (i) General Electric Type CR 104P.
 - (ii) Square D Type K.
 - (iii) Eaton Type 10250T.
 - (iv) Allen-Bradley Type 800T.
- F. Latching Relays:
1. Time Delay Relay Attachment:
 - a. Pneumatic type, timer adjustable from 5 to 200 seconds (minimum).
 - b. Field convertible from ON delay to OFF delay and vice versa.
 - c. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.
 2. Manufacturers:
 - a. Eaton; Type M-600.
 - b. General Electric; Type CR120B.
- G. Lockout Relays:
1. Heavy-duty switchboard type, manual reset, pistol grip handle, 120 Vac trip coil, mechanical target, nameplate, and rear cover.
 2. Contact Arrangement: Minimum four normally open, four normally closed.
 3. Manufacturers:
 - a. General Electric Type HEA.
 - b. Electroswitch Type WL or LOR Series 24.
- H. Control Relays:
1. Heavy-duty, multiple pole, NEMA rated control relays as indicated on contract drawings.
 2. Electrically held, 120 Vac operation, contacts rated 10 amperes continuous at 300 volts.
 3. Stackable, convertible contacts arranged as indicated on drawings. All spare contacts to be wired to terminal blocks.
 4. Manufacturers:
 - a. Allen-Bradley Type N
- I. Control Switches:
1. Heavy-duty switchboard type, 3-position spring return to center, pistol grip handle, mechanical target, nameplate, and rear cover.
 2. Contact Arrangement: Momentary contacts as scheduled on contract drawings.
 3. Manufacturers:
 - a. General Electric Type SB-1.
 - b. Electroswitch Type W2.
- J. Current and Potential Test Switches (TS)
1. 12 pole: 8 shorting current, 1 non-shorting current, 3 potential.
 2. Back connected, with front cover.
 3. Manufacturer: ABB type FT-1.

- K. Ammeters, Triplex, Digital
1. Three Phase, Triplex, Digital Ammeter.
 2. Current Input: 0-5 A ac.
 3. Power: 115 Vac.
 4. Faceplate Legend: AMPERES ABC.
 5. Manufacturer: Bitronics – Model ATAIE1
 6. Analog I/O shall be 4-20mA.
- L. Control Transformers:
1. Type: Insulated dry indoor.
 2. Rating:
 - a. 480/120-volt, single-phase, three-wire.
 - b. kVA rating for control power requirements.
 3. Drawout with motor starter.
 4. Primary Protection: Two current-limiting fuses mounted on drawout carriage.
 5. Secondary Protection: Fused.
 6. Provisions for test control power.
 - a. Control power plug connection or knife switch selector for operation of controls from either normal control power source or test power source. Visible disconnect from normal control power when test power is connected to prevent the possibility of backfeed to the control power transformer from external power source.
 - b. Open operation of starter isolation switch to open normal control power source circuit.
 - c. Test power may be used for operation of control in the event the control power transformer is out-of-service.
- M. Terminal Blocks:
1. Rating: 600 volts, 30-ampere minimum.
 2. Type:
 - a. One-piece barrier with strap screws.
 - b. Shorting type for current transformer leads.
 3. Provide terminal blocks for:
 - a. Control conductors connecting to circuits external to motor control.
 - b. Internal circuits crossing shipping splits with plug connectors.
 - c. Equipment parts requiring replacement and maintenance.
 4. Spares: Minimum 20 percent spare unused terminals.
 5. Grouped together terminal blocks for external circuit wiring leads.
 6. 6-inch minimum space between columns of terminal blocks.
 7. Permanently identify each terminal and columns of terminal blocks.
 8. Manufacturer and Product:
 - a. G.E. Type EB-25, EB-27.
- N. Control Wiring
1. Internal wiring to be flame retardant NFPA70, Type SIS, single conductor, Class B, stranded copper, rated 600 volts for control, instrumentation, and low voltage power circuits. Minimum wire size to be #14 AWG.
 2. Individual seven-strand, copper conductors, twisted and covered with 100 percent aluminum, polyester shield with tinned copper drain wire and overall jacket, rated 600 volts, 90 degrees C minimum for transducer output and analog circuits.

3. Conductor Lugs: Pre-insulated, self-locking, spade type with reinforced sleeves.
4. Wire Markers: Each wire individually identified with permanent markers at each end.
5. Splices: Not permitted.

2.08 INSTRUMENT TRANSFORMERS

- A. Current Transformer (CT):
 1. Types: Current Transformer (CT):
 - a. Insulated dry indoor.
 - b. Window type for relaying and ground sensing.
 - c. Wound type for metering.
 2. Transformer Accuracy in Accordance with ANSI C57.13:
 - a. Class C20 or greater for relaying.
 - b. Class 1.2 maximum for imposed burden for metering.
 3. One CT per phase.
 4. Rating: 480V.
 5. Mechanical Rating: Equal to short-time current-carrying capability of motor starter.
 6. Thermal Rating: Maximum 55° rise above 30°C ambient.
 7. Thermal Rating Factor: RF 1.5, to operate continuously at 1.5 rated CT secondary current without exceeding temperature rise.
 8. Identify polarity with standard mark or symbol.
 9. Secondary Wiring:
 - a. Installed in conduit and wiring trough.
 - b. Terminate on short-circuiting type terminal block.
 - c. CT's to be wye connected with the neutral grounded directly at the CT X2 terminal common.
 - d. Single point ground.
 10. Isolate from adjacent components and circuit by removable insulating or metal barriers.
 11. Accessible for replacement without removing high voltage contactor.

2.09 CIRCUIT BREAKER COMPARTMENT

- A. Three-pole circuit breaker compartments to be provided for 480 volt source equipment as indicated on the Contract Documents.
 1. Auxiliary transformer rating: As indicated on the Contract Documents.
 2. Circuit breaker to be an integral part of the MCC, arranged in accordance with the Contract Drawings.
- B. Ratings:
 1. Voltage Rating: 480V.
 2. BIL: 60kV.
 3. Continuous Current: As shown on drawings.
 4. Interrupting: Continuous current at 0.8 P.F.
 5. Momentary-10 cycles asymmetrical: 65kA.
 6. Fault closing-asymmetrical: 65kA.

2.10 ACCESSORIES

- A. Furnish with a portable lifting dolly for handling the roll-out contactor.

2.11 CUBICLE SPACE HEATERS

- A. Space heater rated 120 Vac, shall be low density type for long life, sized for prevention of condensation in each vertical section.
- B. Adjustable thermostat with temperature range of 50° to 70°F.
- C. Power supply from station service panelboard external to MCC. Heaters shall be interconnected for supply from a single source.
- D. Heaters shall be located and connected in a manner that prevents heat damage to adjacent or connected wire or devices.

2.12 EQUIPMENT IDENTIFICATION

- A. Master Nameplate:
 - 1. Deep etched aluminum or stainless steel with manufacturer's name and model number.
 - 2. Attached to main vertical section with stainless steel panhead screws.
- B. Section Identification:
 - 1. Engraved stainless steel, attached to outside door of each vertical section with stainless steel panhead screws.
 - 2. Serial number, bus rating, and section reference number.
 - 3. Size: As required, with 3/8" high minimum lettering.
- C. Interior Nameplates:
 - 1. Engraved, phenolic for each incoming service section, motor starter unit, fused switch section, and each door mounted device.
 - 2. Black with white block type characters.
 - 3. Character Height: 1/4-inch.
 - 4. Size: 2 inch x 2-1/2 inch minimum.
 - 5. Inscriptions: As shown on one-line diagram.
 - 6. Attachment Screws: Stainless steel panhead.
- D. Cubicle Labels:
 - 1. Non-metallic, applied inside each cubicle compartment.
 - 2. Device serial number, rating, and description.
- E. Control Switches: Deep etched, aluminum escutcheon plate.
- F. Signs:
 - 1. Sign on front of motor control center:
 - a. Size: As required.
 - b. Engraved, phenolic.
 - c. Color: Orange with black.
 - d. Inscription: DANGER/HIGH VOLTAGE/KEEPOUT.
 - e. Characters: Gothic type, 2-inch high.
 - f. Attachment: Four stainless steel panhead screws for each sign.

2.13 FACTORY TESTS

- A. Test in accordance with latest version of UL 347 and applicable ANSI and NEMA standards.
- B. Manufacturer to provide three copies of certified test reports.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. Install in accordance with manufacturer's instructions and recommendations.
 - 2. Secure equipment sills to concrete with anchor bolts of sufficient size and number for load conditions.
 - 3. Equipment is to be installed on top surface of a building floor.
 - 4. Proper coordination with equipment manufacturer conduit opening and stub up will be necessary for proper positioning of each switchboard and conduit stub up.
 - 5. Tighten current-carrying bus bolted connections and power cable bolted connections to manufacturer's recommendations.
 - 6. Contractor shall be responsible for the installation of all relay settings for the motor protection relay. Settings shall conform to SAWS standard motor settings. Relay settings shall be complete with all function programming and logic.
- B. Multilin Relays: Ethernet terminals on all Multilin relays shall be connected to interface with a port on the SCADA panel's Ethernet switch.

3.02 FIELD QUALITY CONTROL

- A. In accordance with Section 16950, Electrical Testing.

3.03 EQUIPMENT REFERENCES

- A. Motor Data:
 - 1. Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:
 - a. Motor served by tag (number and equipment name).
 - b. Nameplate horsepower.
 - c. Motor code letter.
 - d. Full load amperes.
 - e. Service factor.
 - f. Installed overload relay heater catalog number.
- B. Control Schematic:
 - 1. Provide a laminated, reduced-size, approved control schematic permanently attached to the interior door of each motor cubicle.

3.04 MANUFACTURER'S FIELD SERVICES

- A. Furnish manufacturer's representative for the following services at site for minimum person-days listed below, travel time excluded:

1. 2 person-days for installation assistance and inspection, and certification of installation.

END OF SECTION

SECTION 16450**SURGE PROTECTIVE DEVICES****PART 1 GENERAL**

1.01 SCOPE

- A. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment for panelboards, safety switches and control panels for 600V and below. The equipment shall have the characteristics and ratings as specified herein and as shown on the contract drawings.

1.02 SUBMITTALS

- A. Shop Drawings:
Submit drawings indicating front and side views of enclosures, unit dimensions, weights, installation instruction details, and wiring configuration.
- B. Product Data:
Indicate capacities, operating characteristics, accessories and bill of materials for each component. Include indication of listing in accordance with UL 1449 and UL 1283.
- C. Manufacturers Certificate:
Submit manufacturer's certificate attesting that products meet or exceed specified requirements. Equipment to meet UL 1449 Edition and UL 1283 standards.
- D. Instruction Manuals:
Submit for record instruction manuals for the units to be installed

1.03 RELATED SECTIONS

- A. 16050 - BASIC ELECTRICAL MATERIALS AND METHODS
- B. 16451 - GROUNDING

1.04 REFERENCES

- A. SPD units and all components shall be designed, manufactured and tested in accordance with the latest applicable standards.
 - 1. ANSI/UL 1449 4th Edition or later
 - 2. ANSI/UL 1283 5th Edition or later
 - 3. IEEE C62.45 -2002 IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits (1000V and less).
 - 4. IEEE C62 41.1
 - 5. IEEE C62 41.2
 - 6. UL96A
 - 7. NFPA 780

1.05 QUALIFICATIONS

- A. Manufacturer: The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

- B. The manufacturer of this equipment shall have produced similar equipment for a minimum period of 10 years. When requested by the Owner, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- C. Manufacturer shall be ISO 14001 and ISO 9001 or 9002 certified.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Transport, handle and store equipment in accordance with manufacturer's instructions.
- B. Store in a clean, dry space. Maintain factory wrapping to protect units from dirt, water, construction debris and traffic.

PART 2 PRODUCTS

2.01 PANELBOARDS

- A. The SPD covered under this section includes lighting and distribution panelboards. Provide the SPD with the following:
 1. SPD shall be installed immediately following the load side of the main breaker. SPD's installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
 2. The panelboard shall be capable of re-energizing upon removal of the SPD.
 3. The SPD shall be the same manufacturer as the panelboard.
 4. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
 5. The SPD shall be integral to the panelboard and be connected to a circuit breaker for disconnecting purposes.
 6. SPD shall connect using internal bolted lugs.
 7. LED indicator lights for power and protection status.
 8. Surge event operations counter.
 9. Redundant suppression circuits and redundant replacement modules.
 10. Audible alarm with silencing switch to indicate when protection has failed.
- B. Voltage Protection Rating (VPR) for the device shall not exceed the following:

Modes	208Y/120	480Y/277
L-N; L-G; N-G	700	1200
L-L	1000	1800

- C. Protection modes: Line to neutral, line to line, line to ground and neutral to ground.
- D. Minimum Surge Capacity shall be 200 kA per phase.
- E. Nominal Discharge Current: 20 kA
- F. Short Circuit Current Rating shall be 200 kA minimum.

- G. Maximum Continuous Operating Voltage shall not be less than 115 percent of nominal system operating voltage.
- H. Warranty: 10 years
- I. Dual-colored protection status indicators for each phase.
- J. Dual-colored protection status indicators for the neutral-ground protection mode.
- K. Manufacturer:
 - 1. Eaton: Model SPD (integrated version) with Standard Features and surge counter.
 - 2. Or equal.

2.02 SAFETY SWITCHES

- A. The SPD covered under this section includes safety switches. Provide the SPD with the following:
 - 1. SPD shall be installed external to the switch.
 - 2. The switch shall be capable of re-energizing upon removal of the SPD.
 - 3. The SPD shall be the same manufacturer as the switch.
 - 4. The SPD shall be connected to a circuit breaker for disconnecting purposes.
 - 5. LED indicator lights for power and protection status.
 - 6. Surge event operations counter.
 - 7. Redundant suppression circuits and redundant replacement modules.
 - 8. Audible alarm with silencing switch to indicate when protection has failed.
- B. Voltage Protection Rating (VPR) for the device shall not exceed the following:

Modes	208Y/120	480Y/277
L-N; L-G; N-G	900	1200
L-L	1500	1800

- C. Protection modes: Line to neutral, line to line, line to ground and neutral to ground.
- D. Minimum Surge Capacity shall be 200 kA per phase.
- E. Nominal Discharge Current: 20 kA
- F. Short Circuit Current Rating shall be 200 kA minimum.
- G. Maximum Continuous Operating Voltage shall not be less than 115 percent of nominal system operating voltage.
- H. Warranty: 10 years
- I. Dual-colored protection status indicators for each phase.
- J. Dual-colored protection status indicators for the neutral-ground protection mode.

- K. Enclosure: Same NEMA type rating as switch.
- L. Manufacturer:
 1. Eaton: Model SPD (sidemount version) with Standard Features and surge counter.
 2. Or equal.

2.03 OUTDOOR CONTROL PANELS

- A. The SPD covered under this section includes outdoor control panels. Provide the SPD with the following:
 1. SPD shall be installed external to the panel.
 2. The SPD shall be connected to a circuit breaker for disconnecting purposes.
 3. LED indicator lights for power and protection status.
- B. Voltage Protection Rating (VPR) for the device shall not exceed the following:

Modes	120	208Y/120	480Y/277
L-N; L-G; N-G	700 L-N	700	1200
L-L	N/A	1200	2500

- C. Protection modes: Line to neutral, line to line, line to ground and neutral to ground.
- D. Minimum Surge Capacity shall be 45 kA per phase.
- E. Nominal Discharge Current: 10 kA
- F. Short Circuit Current Rating shall be 200 kA minimum.
- G. Maximum Continuous Operating Voltage shall not be less than 115 percent of nominal system operating voltage.
- H. Warranty: 2 years
- I. Dual-colored protection status indicator.
- J. Enclosure: NEMA 4X.
- K. Manufacturer:
 1. Eaton: Model SP2
 2. Or equal.

2.04 INDOOR CONTROL PANELS

- A. The SPD covered under this section includes 120V indoor control panels. Provide the SPD with the following:
 1. SPD shall be installed inside the panel.

2. The SPD shall be connected to a circuit breaker for disconnecting purposes.
3. LED indicator light for protection status.

B. Voltage Protection Rating (VPR) for the device shall not exceed the following:

Modes	120
L-N; L-G; N-G	400 L-N 330 L-G/N-G

- C. Protection modes: Line to neutral, line to ground and neutral to ground.
- D. Minimum Surge Capacity shall be 30 kA per mode.
- E. Nominal Discharge Current: 5 kA
- F. Short Circuit Current Rating shall be 5 kA minimum.
- G. Maximum Continuous Operating Voltage shall not be less than 115 percent of nominal system operating voltage.
- H. Warranty: 15 years
- I. Manufacturer:
 1. Eaton: Model AG PH 120 20
 2. Or equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Check mechanical and electrical connections assure they are properly torqued to the manufacturer's recommendations.
- B. Check all installed equipment for proper grounding and fastening.

3.02 INSTALLATION

- A. The installation of the SPD shall be factory installed on panelboards and safety switches integral to the distribution equipment. The Contractor shall install all distribution equipment per the manufacturer's recommendations and electrical codes.

3.03 FIELD TESTING

- A. Engage a factory authorized service representative to train Owners maintenance personnel to adjust, operate and maintain the SPDs.

END OF SECTION

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SECTION 16451**GROUNDING****PART 1 GENERAL****1.01 SUBMITTALS**

- A. Shop Drawings:
 - 1. Product Data:
 - a. Exothermic weld connectors
 - b. Mechanical connectors
 - c. Compression connectors
 - d. Ground Rods
 - e. Surge Arresters
 - f. Conductors

1.02 UL COMPLIANCE

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

1.03 GROUNDING SYSTEM

- A. The grounding system is a solidly grounded neutral system that is multigrounded. The grounding electrode is the grounding rings formed by the conductors encircling the equipment and/or structures.

PART 2 PRODUCTS**2.01 GROUND RODS**

- A. Located as shown on the plans.
- B. Material: Copper Bonded.
- C. Size: 3/4" x 10'
- D. Use Ground Enhancement Material (GEM) backfill.
- E. Manufacturers: Erico, Inc.; ground rods and GEM backfill.

2.02 GROUND CONDUCTORS

- A. Conductor size as shown on the plans.
- B. As specified in Section 16120, CONDUCTORS.

2.03 CONNECTORS

- A. Exothermic Weld Type:
 - 1. Outdoor Weld: Suitable for exposure to elements or direct burial.
 - 2. Indoor Weld: Utilize low-smoke, low-emission process.
 - 3. Manufacturers:
 - a. Erico Products, Inc.; Cadweld and Cadweld Exolon
 - b. Thermoweld

- B. Above Grade Compression Type for Equipment Ground Connection:
 - 1. Single indentation for conductors 6 AWG and smaller.
 - 2. Double indentation with extended barrel for conductors 4 AWG and larger.
 - 3. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.
 - 4. Specifically listed four ground connections
 - 5. All mechanical hardware, nuts, bolts and washers shall be high strength copper alloy.
 - 6. Manufacturers:
 - a. Burndy Corp

2.04 SURGE PROTECTIVE DEVICES

- A. Refer to Section 16450

PART 3 EXECUTION

3.01 GENERAL

- A. Grounding shall be in compliance with NEC Article 250, NFPA 70 and ANSI C2.
- B. Ground each separately derived system neutral in accordance with NEC 250-30. All connections will be connected to the grounding grid.
- C. Ground elements of the reservoir tank if shown on Contract Drawings for dissipation of lightning energy into the earth.
- D. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.
- E. Arresters shall be installed in locations as shown on the Contract Drawings.
- F. Shielded Instrumentation Cables:
 - 1. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.

2. Do not ground instrumentation cable shield at more than one point.
- G. Ground grid conductors to be installed not less than 30 inches deep.

3.02 WIRE CONNECTIONS

- A. Ground Conductors: Install in conduit containing low voltage power conductors and control circuits above 50 volts.
- B. Nonmetallic Raceways and Flexible Tubing: Install an equipment-grounding conductor connected at both ends to noncurrent carrying grounding bus.
- C. Connect ground conductors to raceway grounding bushings.
- D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.
- E. Connect enclosure of equipment containing ground bus to that bus.
- F. Bolt connections to equipment ground bus.
- G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.
- H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.03 MOTOR GROUNDING

- A. Motor frame shall be connected to the ground grid.
- B. Nonmetallic Raceways and Flexible Tubing: Install an equipment-grounding conductor connected at both ends to noncurrent carrying grounding bus.
- C. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.
- D. Circuits 20 Amps or above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 GROUND RODS

- A. Install ground rod full length with conductor connection at upper end. The ground rod shall be driven into undisturbed earth.
- B. If soil conditions prevent driving the ground rod to full length, installation shall be accomplished by augering a 3" diameter or larger hole and backfilling with compacted ground enhancement material.
- C. Install top of rod 6 inches below finished grade, unless otherwise shown.

3.05 CONNECTIONS

- A. General:
 - 1. Above Grade Connections: Use either exothermic weld, mechanical, or compression-type connectors.
 - 2. Below Grade Connections: Install exothermic weld connections.
 - a. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
 - b. Notify OWNER prior to backfilling ground connections.
- B. Exothermic Weld Type:
 - 1. Wire brush or file contact point to bare metal surface.
 - 2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
 - 3. Do not use badly worn molds.
 - 4. Mold to be completely filled with metal when making welds.
 - 5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.
- C. Compression Type:
 - 1. Install in accordance with connector manufacturer's recommendations.
 - 2. Install connectors of proper size for grounding conductors and ground rods specified.
 - 3. Install using connector manufacturer's compression tool having proper sized dies.
- D. Mechanical Type:
 - 1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
 - 2. Install in accordance with connector manufacturer's recommendations.
 - 3. Do not conceal mechanical connections.

3.06 METAL STRUCTURE GROUNDING

- A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.
- B. Bond electrical equipment supported by metal platforms to the platforms.
- C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.07 HANDHOLE AND VAULT GROUNDING

- A. Install one ground electrode inside each where shown on drawing.
- B. Ground Electrode Floor Protrusion: 4 to 6 inches above floor.
- C. Make connections of grounding conductors fully visible and accessible.
- D. Connect all noncurrent-carrying metal parts, and any metallic raceway grounding bushings to ground electrode conductor with No. 6 AWG copper conductor.

3.08 TRANSFORMER GROUNDING

- A. Bond neutrals of transformers to grounding grid.

3.07 SURGE PROTECTIVE DEVICE GROUNDING

- A. Connect surge protective device ground terminals to equipment ground bus.

END OF SECTION

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SECTION 16461**TRANSFORMERS – GENERAL PURPOSE 3-PHASE****PART 1 GENERAL****1.01 SCOPE**

- A. The CONTRACTOR shall furnish and install three-phase 60 Hz general purpose individually floor mounted dry-type transformers of the two-winding type, self-cooled, as specified herein, and as shown on the contract drawings.

1.02 REFERENCES

- A. The transformers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of ANSI and NEMA.

1.03 SUBMITTALS

- A. The following information shall be included:
 - 1. Dimension drawing and weight.
 - 2. Technical certification sheet.
 - 3. Conduit entry/exit locations.
 - 4. Transformer ratings including:
 - a. Primary and secondary kVA
 - b. Voltage
 - c. Taps
 - d. Primary and secondary continuous current
 - e. Basic impulse rating
 - f. Impedance
 - g. Insulation class and temperature rise
 - h. Sound level

1.04 UL COMPLIANCE

- A. All transformers shall be UL listed and bear the UL label.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.06 FIELD MEASUREMENTS

- A. Measure primary and secondary voltages and make appropriate tap adjustments.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Eaton

- B. Square D
- C. FPT (Federal Pacific)
- D. General Electric
- E. Siemens

2.02 RATINGS

- A. kVA and voltage ratings, and the 3-phase winding configuration, shall be as shown on the drawings.
- B. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96
- C. Transformer sound levels shall not exceed NEMA ST-20 levels for self-cooled ratings.

2.03 CONSTRUCTION

- A. Insulation Systems:
 - 1. Transformers shall be insulated as follows:
 - a. 2 kVA and below: 150°C insulation system based upon 80°C rise.
 - b. 3 to 15 kVA: 185°C insulation system based upon 115°C rise.
 - c. 15 kVA and above: 220°C insulation system based upon 150°C rise.
 - 2. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40°C maximum ambient.
 - 3. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.
- B. Core and Coil Assemblies.
 - 1. Transformer core shall be constructed with high-grade, non-aging, grain-oriented silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the nominal tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade copper with continuous wound construction.
 - 2. The core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The assembly shall be installed on vibration-absorbing pads. Taps shall be two (2) steps above and two (2) steps below nominal voltage in 2.5% increments.
 - 3. Ventilated transformers with wye-connected secondary shall have the neutral brought out to an XO terminal grounded to the transformer enclosure with a flexible copper ground strap.

2.04 ENCLOSURE

- A. Transformers enclosure shall be NEMA 1. The maximum temperature of the enclosure shall not exceed 90°C. The core of the transformer shall be grounded to the enclosure with flexible ground strap.

2.05 NAMEPLATE

- A. Diagrammatic nameplate to include all rating data and wiring diagram with connection point identification.

2.06 FINISH

- A. Enclosures shall be furnished with manufacturer's standard finish, ANSI 61 light gray color.

PART 3 EXECUTION**3.01 FACTORY TESTING**

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
 1. Ratio tests at the rated voltage connection and at all tap connections.
 2. Polarity and phase relation tests on the rated voltage connection.
 3. Applied potential tests.
 4. Induced potential test.
 5. No-load and excitation current at rated voltage on the rated voltage connection.

3.02 INSTALLATION

- A. The CONTRACTOR shall install all equipment per the manufacturer's recommendations and the contract drawings.
- B. Provide flexible conduit for external connections to the transformer enclosure.

3.03 FIELD QUALITY CONTROL

- A. In accordance with Section 16950, Electrical Testing.

3.04 FIELD ADJUSTMENTS

- A. Adjust taps to deliver appropriate secondary voltage.

END OF SECTION

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SECTION 16501**AUTOMATIC TRANSFER SWITCH****PART 1 GENERAL****1.01 SCOPE**

- A. Furnish and install an automatic transfer switch (ATS) with three (3) poles, 1200A, 480V, and withstand current ratings of 65,000A. Each automatic transfer shall consist of an inherently double throw power transfer switch unit and a microprocessor controller, interconnected to provide complete automatic operation. All transfer switches and control panels shall be the product of the same manufacturer.

1.02 MANUFACTURERS

- A. Asco
- B. Russelectric
- C. Generac
- D. Cummins
- E. Caterpillar
- F. MTU Onsite Energy

1.03 CODES AND STANDARDS

- A. UL 1008 - Standard for Automatic Transfer Switches
- B. NFPA 70 - National Electrical Code
- C. NFPA 110 - Emergency and Standby Power Systems
- D. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- E. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
- F. NEC Articles 700, 701, 702

PART 2 PRODUCTS**2.01 MECHANICALLY HELD TRANSFER SWITCH**

- A. The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include overcurrent disconnect devices will not be accepted. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.

- B. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.
- C. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand current capability and be protected by separate arcing contacts.
- D. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.
- E. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- F. Where neutral conductors must be switched, the ATS shall be provided with fully-rated neutral transfer contacts.
- G. Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.

2.02 MICROPROCESSOR CONTROLLER WITH MEMBRANE INTERFACE PANEL

- A. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, and inherent serial communications capability. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.
- B. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers.
- C. The panel shall be capable of operating over a temperature range of -20° to $+60^{\circ}\text{C}$.
- D. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
 - 1. ANSI C37.90A/IEEE 472 Voltage Surge Test
 - 2. NEMA ICS – 109.21 Impulse Withstand Test
 - 3. IEC801-2 Electrostatic discharge (ESD) immunity
 - 4. IEC 801 – 3 Radiated electromagnetic field immunity
 - 5. IEC 801 – 4 Electrical fast transient (EFT) immunity

2.03 ENCLOSURE

- A. The ATS shall be furnished as part of a NEMA Type 1 Switchboard lineup.
- B. Provide strip heater with thermostat for NEMA Type 1 enclosure requirements.
- C. Enclosures shall be constructed of 16-gauge steel with powder coat over phosphatized surfaces, unless otherwise specified to be stainless steel for corrosion resistance.
- D. Enclosures shall have a single swing panel front with continuous hinge, and shall have provision for padlocking. Hinge pin and panel clamps shall be stainless steel. Hinged door shall be 16-gauge galvanized steel, unless otherwise specified to be stainless steel. Door shall be vandal-resistant.
- E. Enclosures shall have an interior back panel. No screws shall penetrate the enclosure. The interior surfaces shall be white baked enamel finish. All control panels and devices shall be on a plane surface providing accessibility for maintenance without removing components.
- F. Provide an internal, steel, hinged swing-out panel with white baked enamel finish for mounting devices such as pushbuttons, selector switches, control switches, and indicating lights. All devices shall be mounted inside the control cabinets.
- G. Controller shall be flush-mounted display with LED indicators for switch position and source acceptability. It shall also include test and time delay bypass switches.

PART 3 OPERATION

3.01 VOLTAGE AND FREQUENCY SENSING

- A. The voltage of each phase of the normal source shall be monitored, with pickup adjustable to 95% of nominal and dropout adjustable from 70% to 90% of pickup setting.
- B. Single-phase voltage and frequency sensing of the emergency source shall be provided.

3.02 TIME DELAYS

- A. An adjustable time delay shall be provided to override momentary normal source outages and delay all transfer and engine starting signals.
- B. An adjustable time delay shall be provided on transfer to emergency, adjustable from 0 to 5 minutes for controlled timing of transfer of loads to emergency.
- C. A generator stabilization time delay shall be provided after transfer to emergency.
- D. An adjustable time delay shall be provided on retransfer to normal, adjustable to 30 minutes. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.

- E. A 5-minute cooldown time delay shall be provided on shutdown of engine generator.
- F. All adjustable time delays shall be field adjustable without the use of special tools.

3.03 ADDITIONAL FEATURES

- A. A set of contacts rated 5 amps, 32 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
- B. A push-button type test switch shall be provided to simulate a normal source failure.
- C. A push-button type switch to bypass the time delay on transfer to emergency, the engine exerciser period on the retransfer to normal time delay whichever delay is active at the time the push-button is activated.
- D. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal.
- E. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact, closed, when the ATS is connected to the emergency source.
- F. Indicating lights shall be provided, one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red). Also provide indicating lights for both normal and emergency source availability.
- G. Terminals shall be provided to indicate actual availability of the normal and emergency sources, as determined by the voltage sensing pickup and dropout settings for each source.
- H. Inphase Monitor - An Inphase monitor shall be inherently built into the controls. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer.
- I. Selective Load Disconnect - A double throw contact shall be provided to operate after a time delay, adjustable to 20 seconds prior to transfer and reset 0 to 20 seconds after transfer. This contact can be used to selectively disconnect specific load(s) when the transfer switch is transferred. Output contacts shall be rated 6 amps at 28 VDC or 120 VAC.
- J. Programmable Engine Exerciser - A seven or fourteen day programmable engine exerciser with digital readout display. Shall include one form C contact for availability of normal and emergency sources. Include "with or without" load control switch for exerciser period. The exerciser shall be backed up by a permanent battery.
- K. Enclosure Heater - A 125 watt enclosure heater with transformer and thermostat (adjustable from 30° to 140 ° F).

PART 4 ADDITIONAL REQUIREMENTS

4.01 WITHSTAND AND CLOSING RATINGS

- A. The ATS shall be rated to close on and withstand the available rms symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans. WCR ATS ratings as be as follows when used with specific circuit breakers:

ATS Size	Withstand & Closing
30	22,000A
70 - 200	22,000A
230	22,000A
260 – 400	42,000A
600 – 1200	65,000A
1600 – 2000	85,000A
2600 – 3000	100,000A

4.02 TESTS AND CERTIFICATION

- A. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
- B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- C. The ATS manufacturer shall be certified to ISO 9001: 2000 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001: 2000.

4.03 SERVICE REPRESENTATION

- A. The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
- B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.
- C. For ease of maintenance, the transfer switch nameplate shall include drawing numbers and serviceable part numbers.

END OF SECTION

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**SECTION 16600
STANDBY GENERATOR**

PART 1 GENERAL

OWNER has determined a requirement for a generator unit as part of its emergency plan. In the event of a natural, or man-made, disaster where electric service is lost to the OWNER's facility for an extended period of time, the OWNER will strive to maintain operation of the pump station. The task will be accomplished through the use of a standby generator. The generator shall be installed in an electrical configuration as shown on the electrical one-line diagram. The generator shall be sized to accommodate the loads as indicated on the plans.

1.01 SUBMITTALS

A. Shop Drawings:

Generator

1. Descriptive information, including materials and features.
2. Subtransient Reactance - Nameplate data
3. Additional rating information
4. Enclosure type and mounting
5. Dimension and total weight
6. Conduit box dimension and usable volume
7. Bearing type
8. Bearing life
9. Space heater voltage and watts
10. Generator sound power level
11. Generator sizing calculation data (To conform to test parameters outlined in Part 3)

1.02 CERTIFICATION

- A. Shall be generator set designed manufactured, tested and certified to relevant UL, NFPA and ISO standard.

1.03 SCOPE

A. This section covers requirement for Standby Generator:

1. One diesel fueled, engine generator rated 500 kW (estimated to be verified with supplier) for use on a 480/277 Vac three phase system.
2. Secondary breaker rated 1000 Amperes with protective devices and manual/electric control.
3. Sound attenuated weather-protected enclosure. Sound levels should not exceed 73 dB(A) @ 7 meters (23 ft.).
4. Engine Generator control and indication panel.
5. Critical grade exhaust silencer.
6. UL 142 Listed fuel storage system for minimum 24-hour operation at generator full load output in a dual wall sub-base fuel tank. Tank to be provided with leak alarm system.

1.04 SERVICE

- A. The vendor or manufacturer shall have local service personnel available to service and/or maintain the supplied equipment. Local shall be defined as having personnel located within four hours land travel of the OWNER Location.

1.05 CODES, PERMITS AND STANDARDS

- A. All work shall be accomplished in accordance with applicable Federal, State, and Municipal safety, transportation and construction codes. Permits and licenses, where required, shall be obtained by the vendor at his expense. All electrical equipment and controls shall conform to current applicable standards of the following:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society of Testing and Materials (ASTM)
 - 3. American Water Works Association (AWWA)
 - 4. Institute of Electrical and Electronic Engineers (IEEE)
 - 5. National Electrical Manufacturers Association (NEMA)
 - 6. National Fire Protection Association (NFPA)
 - 7. UL 2200

1.06 RECORD DRAWING AND OPERATIONS AND MAINTENANCE MANUALS

- A. The vendor shall furnish the OWNER Operations and Maintenance Manuals for the completed product. These manuals shall be received by the OWNER prior to, and shall be a condition of, final acceptance of the product. The manuals shall contain:
 - 1. All final manufacturers' "as-built" schematic drawings, internal wiring diagrams, interconnect wiring diagrams, and outline and assembly drawings.
 - 2. Instruction books covering installation, operation, and maintenance of all major equipment, fuel storage treatment, relays, control devices, etc.
 - 3. Test data and performance curves.
 - 4. Complete renewal parts list showing all components identified to original manufacturer and ordering designation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Cummins Power Generation
- B. Generac Power Systems
- C. Caterpillar
- D. MTU Onsite Energy
- E. Kohler

2.02 REQUIREMENTS FOR ENGINE GENERATOR

A. Site Conditions

1. Location..... San Antonio, Texas
2. Altitude.....650 feet above msl
3. Temperature (min).....15 F deg
4. Temperature (max).....110 F deg
5. Humidity.....50-100%

B. Generator

1. Voltage.....480/277 Vac
2. Phases.....3
3. Single Phase Connection.....3-Wire
4. Frequency.....60 Hertz
5. Power Rating @ .8 Power Factor.....500 kW
6. Volt-Ampere Rating625 kVA 125⁰C rise continuous
7. Type.....Static Regulated Brushless
8. RPM.....1800
9. Excitation.....Self Excited
10. Insulation.....Class H w/ Tropicalization and Antiabrasion
11. Voltage Regulation.....Less than $\pm 1.0\%$
12. Voltage Regulator.....3 \emptyset Sensing w/ Volts/Hertz
13. Voltage Gain.....Adjustable
14. Over Speed Capability.....150%
15. Total Harmonic Distortion.....Less than 5%

C. Engine

1. Fuel.....Diesel
2. RPM.....1800
3. Vibration.....Linear Isolation; Engine, Generator and Base
4. Exhaust Silencer.Critical Grade Type Silencer
5. Batteries.....HD, Lead Acid the ampere-hour capacity shall be sufficient for starting within the temperature range for the site.
6. Battery Charger: Current Limiting with Overload Protection, Provide with Voltmeter & Ammeter. It shall have an easily accessible terminal strip where external 120 Vac power may be connected to provide battery charging during engine generator storage.
7. Alternator Heater and Block Heater

D. Control Panel

1. Control Voltage.....24Vdc
2. Control Start/Stop.....Automatic Transfer Switch
3. Front.....Electrical Dead Front
4. Door.....Lockable hinged Door
5. Voltmeter.....2% Accuracy
6. Ammeter.....2% Accuracy
7. Frequency Meter.....45-65 Hz Range
8. Voltage Adjust.....Manual, Rheostat
9. Emergency Stop.....PB w/ Red Mushroom Head, No Spring Return

10. Cool Down.....Automatic w/ Timer
11. Run Time.....Elapsed Time Meter
12. Coolant.....Coolant Temperature Gauge
13. Lube Oil.....Oil Pressure Gauge
14. Shutdown Protection and Indication
 - a. High Coolant Temperature
 - b. Low Oil Pressure
 - c. Overcrank
 - d. Overspeed
 - e. Low Fuel Alarm (Pressure) output to SCADA System
 - f. Fuel Leak Alarm output to SCADA System
 - g. Generator Run output to SCADA System
 - h. Modbus RS-485 Port

E. Load Connection Provision

1. Circuit Breaker NEMA AB 1000Amp, Manual/Electric, w/ Thermal and Magnetic Trip (must override motor start). The generator circuit breaker must be supplied with a shunt trip.
2. Electrical Protection
 - a. Overvoltage
 - b. Overcurrent
 - c. Reverse Power
3. Terminal Box - NEMA 3R if located outside of weather protective enclosure, NEMA 1 otherwise

PART 3 FIELD PERFORMANCE TEST AND TRAINING

3.01 FIELD PERFORMANCE TESTING

- A. Field performance as described below will be the basis for final acceptance of the engine generator. The vendor shall supply all materials and labor to perform the testing in the presence of the Owner, or his authorized representative. Note that the engine generator is specified to be 500 kW output (estimated); however, the vendor must supply an engine generator capable of successfully passing the tests below. The contractor must provide, with the submittals, a sizing calculation report obtained from the manufacturer that indicates how the generator was sized.
- B. Demonstrate that the engine generator can start the following loads in this order:
 - a. Step 1
 - i. Power Panels 'A', 'B', 'C', '150 HP HSP-1'
 - b. Step 2
 - i. 150 HP HSP-2

The maximum instantaneous voltage dip shall not exceed 15% at any time. This test at full load shall continue for two hours with all parameters mentioned above monitored to determine compliance with vendor-stated performance. Generator can be load bank tested if full load testing at the facility is not feasible.

- C. Training of the Owner's personnel and contractors shall be included as an integral part of the test. Additional training on operation of the unit and the function of each of the different

control, metering and protection devices shall continue after the actual load test. The vendor should assume a full day of testing and training and include such in his bid.

3.02 WARRANTY

- A. Manufacturer shall include a minimum 2 year/400 run-time hour written warranty. 2 year warranty shall start after generator is installed and commissioned.

END OF SECTION

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SECTION 16770**LIGHTNING PROTECTION SYSTEMS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Air terminals and interconnecting conductors
- B. Grounding and bonding for lightning protection.

1.02 SYSTEM DESCRIPTION

- A. Lightning Protection System: System consisting of air terminals on roofs, roof mounted mechanical equipment, bonding of structure and other metal objects, grounding electrodes, and interconnecting conductors.
- B. System shall be installed on the Electrical and SCADA building at La Rosa.

1.03 SUBMITTALS

- A. Shop Drawings:
Provide minimum 1/8" = 1'-0" scale drawings indicating layout of air terminals, grounding electrodes and bonding connections to structure and other metal objects. Include terminal electrode, connections, conductor sizes and termination details.
- B. Product Data:
Provide dimensions and bill of materials for each component and include indication of listing in accordance with UL 96.
- C. Manufacturers Certificate:
Certify that products meet or exceed specified requirements.
- D. As-Built: Record actual locations of air terminals, grounding electrodes, bonding connections and routing of system conductors in project record documents. Dimension components to permanent structures or column lines. Submit certificate of compliance from LPI and UL's Master Label indicating approval of lightning protection systems.

1.04 REGULATORY COMPLIANCE

- A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark. Product shall be listed to UL 96 and LPI-176.

1.05 RELATED SECTIONS

- A. 16451 GROUNDING

1.06 REFERENCES

- A. LPI 175: Lightning Protection Installation Standard.
- B. LPI 176: Lightning Protection Systems Material and Components Standard.
- C. LPI 177: Inspection Guide for LPI Certified Systems.
- D. NFPA 78: Lightning Protection Code.
- E. UL 96: Lightning Protection Components.
- F. UL 96A: Installation Requirements for Lightning Protection Systems.

1.07 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 78.
- B. Perform Work in accordance with UL 96A and provide Master Label.
- C. Perform Work in accordance with LPI 175 and provide LPI Certification.

1.08 QUALIFICATIONS

- A. Manufacturer: Company specializing in lightning protection equipment with minimum five years documented experience and member of the Lightning Protection Institute.
- B. Installer: Authorized installer of manufacturer with minimum five years documented experience and certified by the Lightning Protection Institute.

1.09 COORDINATION

- A. Verify that field measurements are as indicated on shop drawings.
- B. Coordinate work with roofing and exterior/interior finish installations.

PART 2 PRODUCTS

2.01 COMPONENTS

- A. Air Terminals: Copper unless aluminum is required to match roofing materials.
- B. Grounding Rods: Copper clad steel.
- C. Roof Conductors: Copper, minimum 12 gauge, 28 strands weighing not less than 375 lbs per 1000 feet. Use aluminum conductors if required to match roofing materials.
- D. Down Conductors: Copper, minimum 12 gauge, 28 strands weighing not less than 375 lbs per 1000 feet. Use aluminum conductors if required to match roofing materials.
- E. Counterpoise conductor(if required by NFPA 780): Copper, 211 MCM, 28 strands.
- F. Connectors: Bronze. Use bimetallic fittings for lightning protection components of dissimilar metals. Use exothermic welds below grade.

2.02 MANUFACTURERS

- A. ERICO
- B. BURNDY
- C. THOMPSON
- D. HARGER

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that surfaces are ready to receive work.
- B. Verify that field measurements are as shown on Drawings.
- C. Beginning of installation means installer accepts existing conditions

3.02 PROTECTION OF SURROUNDING ELEMENTS

- A. Protect elements surrounding work of this section from damage or disfiguration.

3.03 INSTALLATION

- A. Install in accordance with NFPA 78, UL 96A, and LPI-175.
- B. Install air terminals not more than 20' apart.
- C. Securely bond all metallic objects located on the roof to the lightning protection system.
- D. Install all down conductors concealed unless approved otherwise by Architect.
- E. Include provisions for future extension of lightning protection system either vertically or horizontally.
- F. Locate all ground rods 3' from edge of building
- G. Interconnect all system ground rods to form a continuous ground loop.

3.04 FIELD QUALITY CONTROL

- A. Obtain the services of Underwriters Laboratories, Inc. to provide inspection and master label for the lightning protection system in accordance with UL 96A.
- B. Obtain the services of the Lightning Protection Institute to provide inspection and certification of lightning protection system in accordance with LPI-177.
- C. This specification recognizes that UL will not Master Label structures or additions that are attached to a structure which does not fully comply with current UL96A lightning protection standards. Therefore, all attached structure(s) shall be reviewed for compliance. The attached structure(s) not fully complying because of damaged systems,

missing systems or improperly installed systems shall be fully protected and/or repaired in order to obtain all required inspections and certifications for the owner.

END OF SECTION

SECTION 16940**INSTRUMENTATION HEAT TRACE SYSTEM****PART 1 GENERAL****1.01 DESCRIPTION OF WORK**

- A. Furnish and install thermostatically controlled heat trace system for freeze protection.
- B. The system shall include controls, control cabinet, cable, insulation and jacket as indicated on the Contract Drawings and as specified hereinafter.
- C. Furnish and install all weather-tight LB fittings, liquid-tight connectors, liquid-tight flexible metal conduit and wiring, etc, to provide power and controls for a complete operating system.
- D. Items to be protected by heat trace include:
 - 1. Instrument fluid housings and all associated piping, valves, fittings, etc. This includes pressure switches, pressure gauges, pressure transmitters, process piping associated with gauges/transmitters and process piping.

1.02 SUBMITTALS

- A. Heat Trace Cable
- B. Heat Trace Cable Insulation and Jacket
- C. Heat Trace Thermostat
- D. Heat Trace Panel Wiring and Data Sheets

PART 2 - PRODUCTS**2.01 HEAT TRACE CABLE**

- A. Heat cable shall be U.L. listed, self-regulating, with additional footage at all valves, instruments, and pipe supports, as recommended by the manufacturer. Maximum circuit lengths shall be in accordance with the manufacturer's recommendations.
- B. Manufacturer: Heat cable shall be Raychem "5BTV1", 6 watts/ft at 40°F for operation at 120 volts, or equal product as manufactured by Chromalox or Thermon.

2.02 HEAT TRACE CABLE INSULATION AND JACKET

- A. The insulation shall be preformed cellular glass insulation, 1" thick minimum, non-absorptive, impermeable to moisture and impervious to hydrochloric acid.
- B. A weather-resistant, watertight, protective finish or jacket shall be applied over all insulation as recommended and manufactured by the insulation manufacturer.

- C. Manufacturer: Heat trace insulation shall be Pittsburg Corning “Foamglas”, Armstrong Armaflex II pipe insulation, or approved equal.

2.03 HEAT TRACE THERMOSTAT (HTT) AND CONTACTOR (HTC)

- A. Heat trace circuits shall be switched through a thermostat, set at 40°F, and a multipole contactor (HTC) as indicated on the Contract Drawings. The contactor shall be NEMA rated, 20 ampere, 120 volts, multipole, with 120-volt control coil. The thermostat shall be weatherproof, line-type, 120 volts.
 - 1. Contactor Manufacturers:
 - a. Eaton
 - b. Square D
 - c. Siemens
 - d. ABB
 - 2. Heat Trace Thermostat Manufacturer:
 - a. Thermon model B4X.

PART 3 EXECUTION

3.01 HEAT TRACE CABLE

- A. Spiral the heat cable around the pipe, criss-cross around valves, and attach cable to pipe with GT-66 glass fiber adhesive tape or plastic tie wraps.
- B. All power connections to heat trace cable shall be made in watertight j-boxes or with power connection kits recommended by the cable manufacturer. Tees, splices, terminations, and cable shall be of the same manufacturer.

3.02 HEAT TRACE CABLE INSULATION

- A. Install insulation over the entire length of piping protected with heat cable. Insulation shall be mitered and nested to cover all tees, fittings, supports, valves, etc. Fitting covers may be preformed or field fabricated. The inner bore and joint surfaced shall be coated to fill the surface cells, and all joints shall be sealed as recommended by the manufacturer and secured in place with ½” wide stainless steel bands.

END OF SECTION

SECTION 16950**ELECTRICAL TESTING****PART 1 GENERAL****1.01 SCOPE**

- A. CONTRACTOR will provide, and pay the cost of, electrical testing by an independent testing firm. This cost shall be included in the Contract Bid.
- B. The CONTRACTOR shall immediately correct all deficiencies discovered during testing by the independent firm.

1.02 REFERENCES

- A. International Electrical Testing Association – Acceptance Testing Specifications (NETA-ATS), current version.
- B. Related equipment specifications in all sections of Division 16.

1.03 SUBMITTALS

- A. Administrative Submittals: Submit 30 days prior to performing inspections or tests:
 - 1. Schedule for performing inspection and tests.
 - 2. List references to be used for each test.
 - 3. Sample copy of equipment and materials inspection form(s).
 - 4. Sample copy of individual device test form.
 - 5. Sample copy of individual system test form.
 - 6. Company data, project experience, resumes, etc. validating the qualifications in part 1.04 below.
- B. Quality Control Submittals: Submit within 15 days after completion of test:
 - 1. Test or inspection reports and certificates for each electrical item tested.
- C. Contract Closeout Submittals:
 - 1. Operation and Maintenance Data:
 - a. In accordance with Section 01730, Operation and Maintenance Data.
 - b. After test or inspection reports and certificates have been reviewed by OWNER and returned, insert a copy of each in operation and maintenance manual.

1.04 QUALITY ASSURANCES

- A. Testing Firm Qualifications:
 - 1. Corporately and financially independent organization functioning as an unbiased authority, for a minimum of 5 years.

2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
 3. Employer of engineers and technicians regularly engaged in testing and inspecting electrical equipment, installations, and systems.
 4. Supervising technician having a minimum of 5 years testing experience on similar projects.
 5. Full-time employed Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
- B. Test equipment shall have an operating accuracy equal to, or greater than, requirements established at NETA-ATS.
- C. Test instrument calibration shall be in accordance with NETA-ATS.

1.05 SEQUENCE AND SCHEDULING

- A. Perform inspection and electrical tests after equipment has been installed.
- B. Perform tests with apparatus de-energized whenever feasible.
- C. Inspection and electrical tests on energized equipment are to be:
1. Scheduled with OWNER prior to de-energization.
 2. Minimized to avoid extended period of interruption to the operating plant equipment.
- D. Notify OWNER at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 GENERAL

- A. Tests specified in this section are to be performed in accordance with the requirements of Section 01751, STARTING OF SYSTEMS.
- B. Tests and inspection shall establish that:
1. Electrical equipment is operational within industry and manufacturer's tolerances.
 2. Installation operates properly.
 3. Equipment is suitable for energization.

4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.
- C. Perform inspection and testing in accordance with NETA-ATS, industry standards, and manufacturer's recommendations.
- D. Set, test, and calibrate protective relays, circuit breakers, and other applicable devices in accordance with standard values established by a short circuit and coordination study provided by OWNER.
- E. Adjust mechanisms and moving parts for free mechanical movement.
- F. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.
- G. Verify nameplate data for conformance to Contract Documents.
- H. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.
- I. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
- J. Provide proper lubrication of applicable moving parts.
- K. Inform OWNER of working clearances not in accordance with NFPA 70.

3.02 DRY TYPE TRANSFORMERS – LOW VOLTAGE

- A. Visual and Mechanical Inspection:
 1. Physical and insulator damage.
 2. Compare equipment nameplate data with drawings and specifications.
 3. Proper winding connections.
 4. Bolt torque level in accordance with NETA-ATS, Table 10.12, unless otherwise specified by manufacturer.
 5. Defective wiring.
 6. Proper operation of fans, indicators, and auxiliary devices.
 7. Removal of shipping brackets, fixtures, or bracing.
 8. Free and properly installed resilient mounts.
 9. Cleanliness and improper blockage of ventilation passages.
 10. Verify that tap-changer is set at correct ratio for rated output voltage under normal operation conditions.
 11. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.
- B. Electrical Tests:
 1. Insulation Resistance Tests:

- a. Applied megohmmeter dc voltage for 1 minute in accordance with NETA-ATS, Table 100.5 for each:
 - (i) Winding-to-winding.
 - (ii) Winding-to-ground.
 - b. Results temperature corrected in accordance with NETA-ATS, Table 100.14.
 - c. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
 - d. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform turns ratio tests at all tap positions. Turns ratio test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio.
 3. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

3.03 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

- A. Visual and Mechanical Inspection:
 1. Inspect Each Individual Exposed Power Cable No. 4 and Larger for:
 - a. Physical damage.
 - b. Proper connections in accordance with single-line diagram.
 - c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
 - d. Color-coding conformance with specifications.
 - e. Proper circuit identification.
 2. Mechanical Connections For:
 - a. Proper lug type for conductor material.
 - b. Proper lug installation.
 - c. Bolt torque level in accordance with NETA-ATS, Table 10.12, unless otherwise specified by manufacturer.
 3. Shielded Instrumentation Cables For:
 - a. Proper shield grounding.
 - b. Proper terminations.
 - c. Proper circuit identification.
 4. Control Cables For:
 - a. Proper termination.
 - b. Proper circuit identification.
 5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.
- B. Electrical Tests for Conductors No. 4 and Larger:
 1. Insulation Resistance Tests:
 - a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
 - b. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.
 - c. Evaluate ohmic values by comparison with conductors of same length and type.
 - d. Investigate values less than 50 megohms.
 2. Continuity test by ohmmeter method to ensure proper cable connections.

3.04 SAFETY SWITCHES, 600 VOLTS MAXIMUM

- A. Visual and Mechanical Inspection:
 - 1. Proper blade pressure and alignment.
 - 2. Compare equipment nameplate data with drawings and specifications.
 - 3. Proper operation of switch operating handle
 - 4. Adequate mechanical support for each fuse.
 - 5. Proper contact-to-contact tightness between fuse clip and fuse.
 - 6. Cable connection bolt torque level in accordance with NETA-ATS, Table 100.12.
 - 7. Proper phase barrier material and installation.
 - 8. Verify that fuse sizes and types correspond to one-line diagram.
 - 9. Perform mechanical operational test and verify mechanical interlocking system operation and sequencing.

- B. Electrical Tests:
 - 1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA-ATS, Table 100.1.
 - b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
 - c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
 - 2. Contact Resistance Tests:
 - a. Contact resistance in microhms across each switch blade and fuse holder.
 - b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.05 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

- A. General: Inspection and testing limited to circuit breakers rated 100 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

- B. Visual and Mechanical Inspection:
 - 1. Proper mounting.
 - 2. Proper conductor size.
 - 3. Feeder designation according to nameplate and one-line diagram.
 - 4. Cracked casings.
 - 5. Connection bolt torque level in accordance with NETA-ATS, Table 100.12.
 - 6. Operate breaker to verify smooth operation.
 - 7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
 - 8. Verify that terminals are suitable for 75°C rated insulated conductors.

- C. Electrical Tests:
 - 1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA-ATS, Table 100.1.
 - b. For 1 minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole.

- c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
- 2. Contact Resistance Tests:
 - a. Between the line and load stab of closed contact resistance in microhms across each pole.
 - b. Investigate deviation of 25 percent or more from adjacent poles and similar breakers.
- 3. Determine long-time pickup and delay by primary current injection.
- 4. Determine short-time pickup and delay by primary current injection.
- 5. Determine ground-fault pickup and time delay by primary current injection.
- 6. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
- 7. Verify correct operation of auxiliary feature such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function, and trip unit battery condition. Reset all trip logs and indicators.
- 8. Verify operation or charging mechanism.
- 9. Control Wiring Tests:
 - a. Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid-state components.
 - b. Insulation resistance to be 1 megohm minimum.

3.06 PROTECTIVE RELAYS

- A. Visual and Mechanical Inspection:
 - 1. Compare equipment nameplate data with drawings and specifications.
 - 2. Inspect relays and cases for physical damage. Remove shipping restraint material.
 - 3. Verify the unit is clean.
 - 4. Relay Case:
 - a. Tighten case connections.
 - b. Inspect cover for correct gasket seal.
 - c. Clean cover glass. Inspect shorting hardware, connection paddles, and knife switches.
 - d. Remove any foreign material from the case.
 - e. Verify target reset.
 - 5. Set relays in accordance with coordination study.
- B. Electrical Tests:
 - 1. Inspect indicators.
 - a. Verify operation of all light-emitting diode indicators.
 - b. Set contrast for liquid-crystal display readouts.
 - 2. Control verification:
 - a. Functional tests - Verify that each relay contact performs its intended function in the control scheme including breaker trip tests, close inhibit tests, 86 lockout tests, and alarm functions.
 - b. In-service monitoring – After the equipment is initially energized, measure magnitude and phase angle of all inputs and compare to expected values.

3.07 INSTRUMENT TRANSFORMERS

- A. Visual and Mechanical Inspection:
1. Visually Check Current, Potential, and Control Transformers For:
 - a. Cracked insulation.
 - b. Broken leads or defective wiring.
 - c. Proper connections.
 - d. Adequate clearances between primary and secondary circuit wiring.
 2. Verify Mechanically That:
 - a. Grounding and shorting connections have good contact.
 - b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
 3. Verify proper primary and secondary fuse sizes for potential transformers.
 4. Bolt torque level in accordance with NETA-ATS, Table 100.12.
- B. Electrical Tests:
1. Current Transformer Tests:
 - a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 1 minute.
 - b. Polarity test. Polarity results shall agree with transformer markings.
 - c. Ratio-verification test using the voltage or current method in accordance with ANSI/IEEE C57.13.1.
 - d. Excitation test on transformers used for relaying applications in accordance with ANSI/IEEE C57.13.1.
 - e. Measure current circuit burdens at transformer terminals in accordance with ANSI/IEEE C57.13.1. Measured burdens shall be compared to instrument transformer ratings.
 - f. When applicable, perform insulation-resistance tests on the primary winding with the secondary grounded. Test voltages shall be in accordance with Table 100.5.
 - g. When applicable, perform dielectric withstand tests on the primary winding with the secondary grounded.
 - (i) Test voltages shall be in accordance with Table 100.9.
 - (ii) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary winding is considered to have passed the test.
 - h. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data.
 - i. Verify that current transformer secondary circuits are grounded and have only one grounding point in accordance with ANSI/IEEE C57.13.3. That grounding point should be located as specified by the ENGINEER in the project drawings.
 2. Potential Transformer Tests:
 - a. Insulation resistance test at test voltages in accordance with NETA - ATS, Table 100.5 for 1 minute on:
 - (i) Winding-to-winding.
 - (ii) Winding-to-ground.
 - b. Insulation resistance measurement shall not be less than that calculated by formula in NETA-ATS, Table 100.5.

- c. Polarity test to verify polarity marks or H1-X1 relationship as applicable. Polarity results shall agree with transformer markings.
- d. Turns-ratio test on all tap positions. Ratio errors shall be in accordance with C57.13.
- e. Measure voltage circuit burdens at transformer terminals. Measured burdens shall be compared to instrument transformer ratings.
- f. When applicable, perform dielectric withstand tests on the primary winding with the secondary grounded. The test voltage shall be applied for one minute.
 - (i) Test voltages shall be in accordance with Table 100.9.
 - (ii) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary winding is considered to have passed the test.
- g. Power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data.
- h. Verify that voltage transformer secondary circuits are grounded and have only one grounding point in accordance with ANSI/IEEE C57.13.3. The grounding point should be located as specified by the ENGINEER in the project drawings.

3.08 METERING AND INSTRUMENTATION

- A. Visual and Mechanical/Electrical Inspection:
 - 1. Verify meter and instrument connections in accordance with appropriate diagrams.
 - 2. Verify meter multipliers
 - 3. Verify that meter and instrument types and scales conform to Contract Documents.
 - 4. Check calibration of meters at cardinal points.
 - 5. Check calibration of transducers and transmitters.
 - 6. Check set-point and operation of pressure switches.
 - 7. Verify operation of heat trace systems.
 - 8. Check tightness of electrical connections.
 - 9. Verify unit is grounded in accordance with manufacturer's instructions.
 - 10. Set all required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements.
 - 11. Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.

3.09 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

- A. Visual and Mechanical Inspection:
 - 1. Verify System Wiring:
 - a. Compare wiring to elementary diagrams.
 - b. Check for proper conductor lacing and bundling.
 - c. Check for proper conductor identification.
 - d. Check lugs and terminations.
 - 2. Verify labels and nameplates.

3. Verify component equipment and instrumentation conforms to Contract Documents.
 4. Verify component electrical and mechanical connections conform to manufacturer's instructions.
- B. Operational Testing:
1. Check each control panel display and switch for proper control loop function.
 2. Verify each Input/Output point from the end element to the remote central operations center.
 3. Verify calibration and scale of each analog quantity.
 4. Verify performance of uninterruptible power supply. Verify on-battery voltage and waveform.

3.10 GROUNDING SYSTEMS

- A. Visual and Mechanical Inspection:
1. Ground system in compliance with drawings, specifications, and NFPA 70 National Electrical Code Article 250.
 2. Grounding system electrical and mechanical connections free of corrosion.
 3. Equipment and circuit grounds in motor control centers and switchgear assemblies for proper connection and tightness.
 4. Ground bus connections in motor control centers and switchgear assemblies for proper termination and tightness.
 5. Effective transformer core and equipment grounding.
 6. Accessible connections to grounding electrodes for proper fit and tightness.
 7. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.
- B. Electrical Tests:
1. Fall-Of-Potential Test:
 - a. In accordance with ANSI/IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
 - b. Main ground electrode system resistance to ground to be no greater than 5 ohms for large commercial or industrial systems and 1.0 ohm or less for generating or transmission station grounds unless otherwise specified by the OWNER.
 - c. Investigate point-to-point resistance values that exceed 0.5 ohm..

3.11 AC INDUCTION MOTORS

- A. General: Inspection and testing limited to motors rated 5 hp and larger.
- B. Visual and Mechanical Inspection:
1. Proper electrical and grounding connections.
 2. Shaft alignment.
 3. Blockage of ventilating air passageways.
 4. Operate Motor and Check For:
 - a. Excessive mechanical and electrical noise.
 - b. Overheating.
 - c. Correct rotation.
 - d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.

- e. Excessive vibration.
 - 5. Check operation of space heaters.
 - 6. Cable connection bolt torque level in accordance with NETA-ATS, Table 100.12.
- C. Electrical Tests:
- 1. Insulation Resistance Tests:
 - a. In accordance with ANSI/IEEE 43 at test voltages established by NETA-ATS, Table 100.1 for:
 - (i) Motors above 200 hp for 10-minute duration with resistance's tabulated at 30 seconds, 1 minute, and 10 minutes.
 - (ii) Motors 200 hp and less for 1-minute duration with resistance's tabulated at 30 and 60 seconds.
 - b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
 - 2. Calculate polarization index ratios for motors 200 hp and above. Investigate index ratios less than 2.0 for Class B or Class F insulation.
 - 3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
 - 4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.
 - 5. Perform insulation power-factor or dissipation-factor tests. Values shall be compared to manufacturer's published data.
 - 6. Perform resistance tests on resistance temperature detector (RTD) circuits.

3.12 LOW VOLTAGE MOTOR CONTROL CENTERS

- A. Visual and Mechanical Inspection:
- 1. Insulator damage and contaminated surfaces.
 - 2. Proper barrier and shutter installation and operation.
 - 3. Proper operation of indicating devices.
 - 4. Proper overload protection.
 - 5. Blockage of air-cooling passages.
 - 6. Integrity and contamination of bus insulation system.
 - 7. Check Nameplates for Proper Identification of Each.
 - a. Equipment title and tag number with latest one-line diagram.
 - b. Pushbutton.
 - c. Control switch.
 - d. Pilot light.
 - e. Control relay.
 - f. Circuit breaker.
 - g. Indicating meter.
 - 8. Verify that fuse sizes and types conform to Contract Documents.
 - 9. Check Bus Connections for High Resistance by Low Resistance Ohmmeter and Calibrated Torque Wrench Applied to Bolted Joints:
 - a. Ohmic value to be zero.
 - b. Bolt torque level in accordance with NETA-ATS, Table 100.12, unless otherwise specified by manufacturer.
 - 10. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems By:
 - a. Closure attempt for locked open devices.

- b. Opening attempt for locked closed devices.
 - c. Key exchange to operate devices in OFF-NORMAL positions.
 - 11. Verify performance of each control device and feature furnished as part of the motor control center.
 - 12. Control Wiring:
 - a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
 - b. Check for proper conductor lacing and bundling.
 - c. Check for proper conductor identification.
 - d. Check for proper conductor lugs and connections.
 - 13. Exercise active components.
 - 14. Inspect Magnetic Contactors For:
 - a. Correct mechanical operations.
 - b. Correct contact gap, wipe, alignment, and pressure.
 - c. Correct torque of connections.
 - 15. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.
- B. Electrical Tests:
1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA-ATS, Table 100.1.
 - b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
 - c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
 - d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
 - e. Test values to comply with NETA-ATS, Table 100.1.
 2. Bottle integrity test for vacuum contactors in accordance with manufacturer's procedure.
 3. Test by Primary Current Injection:
 - a. Overload units at sensors using 300 percent of motor full-load current.
 - (i) Overload trip times to be in accordance with manufacturer's published data.
 - b. Check voltage levels at each point on terminal boards and each device terminal.
 4. Control Wiring Tests:
 - a. Apply secondary voltage on control power and potential circuits.
 - b. Check voltage levels at each point on terminal boards and at each device terminal.
 - c. Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid-state components.
 - (i) Insulation resistance to be 1 megohm minimum.
 5. Test indicating and monitoring devices for proper operation.
 6. Perform setup and testing of solid-state relays and multifunction microprocessor based protective devices in accordance with manufacturer's instructions.
 7. Measure Contact and Power Fuse Resistance:
 - a. Contact resistance shall not exceed manufacturer's recommended values.
 - b. Resistance of power fuses not to deviate more than 15 percent between identical fuses.

3.13 THERMOGRAPHIC SURVEY

- A. General:

1. Equipment to be inspected shall include all current-carrying devices including but not limited to switchboards, panelboards, breakers, fuse holders, switches and bus connections/joints.
- B. Visual and Mechanical Inspection:
1. Perform thermographic survey when load is applied to the system.
 2. Remove all necessary covers prior to thermographic inspection. Use appropriate caution, safety devices, and personal protective equipment.
 3. Perform a follow-up thermographic survey within 12 months of final acceptance by the OWNER.
- C. Report:
1. Provide a report which includes the following:
 - a. Description of equipment tested.
 - b. Discrepancies.
 - c. Temperature difference between the area of concern and the reference area.
 - d. Probable cause of temperature difference.
 - e. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
 - f. Identify load conditions at time of inspection.
 - g. Provide photographs and/or thermograms of the deficient area.
 - h. Recommended action.
- D. Test Parameters:
1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1° C at 30° C.
 2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 3. Thermographic surveys should be performed during periods of maximum possible loading. Refer to ANSI/NFPA 70B, Section 21.17.

END OF SECTION



DIVISION 17

INSTRUMENTATION

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SECTION 17300**INSTRUMENTATION - GENERAL PROVISIONS****PART 1 - GENERAL**

1.01 SCOPE:

- A. Furnish all labor, materials and equipment required to provide, install, test and make fully operational, a Process Instrumentation and Control System as specified herein and as shown on the Drawings.
- B. The work shall include furnishing, installing and testing the equipment and materials detailed in each Section of Division 17.
- C. Equipment furnished as a part of other Divisions, and shown on the Electrical Drawings shall be integrated into the overall Process Instrumentation and Control System under this Division. Instrumentation specified in other Divisions shall meet the Specification requirements of this Division.
- D. The Contractor shall provide the services of a Process Control Systems Integrator (PCSI) who shall perform all work necessary to select, furnish, configure, customize, debug, install, connect, calibrate, and place into operation all instrumentation and control hardware specified within this Division, except for application software programming, which is specified in Section 17305, Application Services. The PCSI shall coordinate with the Owner, Engineer and ASP (Application Services Provider, defined in paragraph 1.06 below) for all scheduling, installation, and startup services. The PCSI shall have qualifications as described herein
- E. The PCSI shall coordinate and schedule all required testing with the General Contractor, Owner, Engineer and Applications Services Supplier (ASP).
- F. The work shall include the following:
 - 1. Furnish and install new SCADA (PLC) Panels as shown on the contract drawings.
 - 2. Furnish, install, configure and calibrate all instruments as shown in Specification 17310 FIELD INSTRUMENTS and Specification 17410 FIELD INSTRUMENT LIST.
 - 3. Furnish, configure, calibrate and install all instruments as listed in the Instrument List (Specification Section 17310) and shown on the Drawings.
 - 4. Surge suppression devices shall be provided at control panels interfacing the instruments and at the instruments as shown on the Drawings and specified in Division 17 Instrumentation and Controls specification sections.
 - 5. Furnish and install all communications network devices required per the Contract Drawings.
 - 6. Coordinate with the ASP and equipment suppliers to deliver a complete and fully functional process control system.
 - 7. Coordinate all PCSI work giving consideration to specified construction sequencing constraints.

8. Make connections, including field connections and interfacing between instrumentation, controllers, control devices, control panels and instrumentation furnished under other Divisions. The PCSI shall coordinate his construction schedule and instrumentation and control interface with the supplier of instrumentation and control equipment specified under other Divisions.
9. Make wiring terminations for all field-mounted instruments furnished and mounted under other Divisions, including process instrumentation primary elements, transmitters, local indicators and control panels. Install vendor furnished cables specified under other Divisions.
10. Auxiliary and accessory devices necessary for system operation or performance to interface with existing equipment or equipment provided by other suppliers under other Sections of these specifications, shall be included whether or not they are shown on the Drawings. These devices include but are not limited to, transducers, current isolators, signal conditioners or interposing relays.
11. Equipment shall be fabricated, assembled, installed, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations by the equipment manufacturer as approved by the Engineer.
12. Actual installation of the system need not be performed by the PCSI's employees; however, the PCSI shall provide the on-site technical supervision of the installation.
13. The PCSI shall furnish equipment which is the product of one manufacturer to the maximum practical extent. Where this is not practical, all equipment of a given type shall be the product of one manufacturer.
14. All materials, equipment, labor, and services necessary to achieve the monitoring and control functions described herein shall be provided in a timely manner so that the monitoring and control functions are available when the equipment is ready to be placed into service.
15. Provide all electrical relocation work associated with the relocation of equipment for the existing and new facilities, including disconnecting all existing wiring and conduits and providing new wiring and conduit to the relocated equipment.
16. Coordinate the sequence of demolition with the sequence of construction to maintain pump station operation. Remove and demolish equipment and materials in such a sequence that the existing and proposed pump station will function properly with no disruption of water service.
17. Modifications to existing instrumentation and control systems as required to new and existing equipment to maintain the pump station in operation.
18. All bidders shall visit the site of the project, prior to submitting a bid, and satisfy themselves as to any question that they might have, relating to existing equipment, condition or construction.

19. Each calibration/recalibration certificate shall be signed and dated by an authorized representative of the CONTRACTOR. Three copies of each completed certificate shall be submitted to the ENGINEER.
20. Required calibration data are listed in Part 3 Testing.

1.02 RELATED SECTIONS:

- A. Where references are made to the Related Work paragraph in each Specification Section, referring to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or work as may be required in those references, and include such information or work as may be specified.
- B. All Instrumentation work related to Process and Mechanical Divisions equipment that is shown on the Instrumentation Drawings shall be provided under Division 17.
- C. All instrumentation work provided under any Division of the Specifications shall fully comply with the requirements of Division 17.
- D. Related Sections:
 1. Section 17302 Testing
 2. Section 17305 Application Services
 3. Section 17310 Field Instruments
 4. Section 17325 Control Panels
 5. Section 17327 Panel Mounted Equipment
 6. Section 17400 Control Loop Descriptions
 7. Section 17405 Input/Output List
 8. Section 17410 Field Instrument List
 9. Section 17500 Programmable Logic Controller (PLC)
 10. Section 17515 Communications Interface Equipment

1.03 SUBMITTALS

- A. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc. sufficient to confirm that the equipment provides every specified requirement. Any options or exceptions shall be clearly indicated.
- B. Submittals for equipment specified herein, for other Sections or Divisions, shall be made as a part of equipment submittals furnished under other Sections or Divisions.
- C. General Requirements:

1. Refer to Section 01300 for general submittal requirements.
2. Other Division 17 Sections have additional submittal requirements. Refer to other Division 17 Sections for details.
3. Shop drawings shall be submitted as detailed herein. Shop drawings shall demonstrate that the equipment and services to be furnished comply with the provisions of these Specifications and shall provide a complete record of the equipment as manufactured and delivered.
4. Submittals shall be complete, giving equipment specifications, details of connections, wiring, ranges, installation requirements, and specific dimensions. Submittals consisting of only general sales literature shall not be acceptable.
5. Submittals shall be bound in separate three-ring binders, with an index and sectional dividers, with all Drawings reduced to a maximum size of 11-inch by 17- inch, then folded to 8.5-inch by 11-inch for inclusion within the binder. Maximum binder size shall be 3 inches.
6. The submittal Drawings' title block shall include, as a minimum, the PCSI's registered business name and address, Owner and project name, Drawing name, revision level, and personnel responsible for the content of the Drawing.
7. Each Section submittal shall be complete, contain all of the items listed in the Specification Section, and shall be clearly marked to indicate which items are applicable on each cut sheet page. All submittals shall list any exceptions to the Specifications and Drawings, and the reason for such deviation. Shop drawings, not so checked and noted, will be returned without review.
8. The Contractor shall check shop drawings for accuracy and compliance with the requirements of the Contract Documents prior to submittal to the Engineer. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specifications and Drawings. Shop drawings shall be stamped with the date checked and a Statement indicating that the shop drawings conform to Specifications and Drawings. Only one Specification Section submittal will be allowed per transmittal unless it has been indicated that grouping is permitted in the individual sections.
9. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "EXCEPTIONS NOTED", "RESUBMIT (RETURNED FOR CORRECTION)" or "REJECTED".
10. Shop Drawings, O&M Manuals, and other documentation, shall be submitted as listed in each of the individual specification Sections.
 - a. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Division 1. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists and operating and maintenance instructions.
 - b. Manuals shall include the following as a minimum:

- 1) A comprehensive index
 - 2) A complete "As-Built" set of approved shop drawings.
 - 3) A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.
 - 4) A table listing of the "as left" settings for all timing relays and alarm and trip setpoints
 - 5) System schematic drawings "As-Built", illustrating all components, piping and electric connections of the systems supplied under this Division.
 - 6) Detailed service, maintenance and operation instructions for each item supplied.
 - 7) Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
 - 8) The operating instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.
 - 9) Complete parts list with stock numbers, including spare parts.
11. Record Drawings shall be promptly furnished when the equipment installation is complete. Payment will be withheld until Record Drawings have been furnished and approved. The PCSI shall provide markups on all Process and Instrumentation Contract Drawings.
12. At the time of delivery of the equipment, the Contractor shall have an approved shop drawing in his possession for the Owner's Inspector and Owner's Engineer's verifications.
- D. Installation experience documentation shall be submitted for approval with the Section Equipment Submittal.
- E. Operations and Maintenance Manuals:
1. Operations and Maintenance manuals shall be constructed in accordance with Division 1 and shall include the following information:
 - a. Manufacturer's contact address and telephone number for parts and service.
 - b. Instruction books and/or leaflets
 - c. Recommended renewal parts list
 - d. Record documents for the information required by the Submittals section above.
- 1.04 REFERENCE CODES AND STANDARDS:
- A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
1. National Electrical Safety Code (NESC)
 2. Occupational Safety and Health Administration (OSHA)
 3. National Fire Protection Association (NFPA)
 4. National Electrical Manufacturers Association (NEMA)
 5. American National Standards Institute (ANSI)
 6. Insulated Cable Engineers Association (ICEA)
 7. International Society of Automation (ISA)

8. Underwriters Laboratories (UL)
 9. UL 508, the Standard of Safety for Industrial Control Equipment
 10. UL 508A, the Standard of Safety for Industrial Control Panels
 11. UL 50, the Standard of Safety for Enclosures for Electrical Equipment
 12. NFPA 79, Electrical Standard for Industrial Machinery
 13. Factory Mutual (FM)
 14. City of San Antonio, Texas Electrical Code
 15. All equipment and installations shall satisfy applicable Federal, State, and local codes.
 16. All meters, relays and associated equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.
 17. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- C. All material and equipment, for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without the UL label affixed.
- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents shall take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Owner/Engineer.
- E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times.
- F. All control panels shall be constructed and the labeling shall be affixed in a UL 508 facility.
- 1.05 PROCESS CONTROL SYSTEMS INTEGRATOR (PCSI):
- A. The Contractor shall provide the services of a Process Control Systems Integrator (PCSI) for work under this Division and other Divisions, as described in this Division and other Divisions.
 - B. Where shown on the Bid Documents, the Contractor shall name the proposed PCSI. Qualifications:

1. The PCSI shall be a "systems house," regularly engaged in the design and installation of control and instrumentation systems and their associated subsystems as they apply to the municipal water or wastewater industry. For the purposes of this and other applicable Divisions, a "systems house" shall be interpreted to mean an organization that complies with all of the following criteria.
2. Employs a registered professional Control Systems Engineer or Electrical Engineer in the state of Texas to supervise or perform the work required by this Specification Section.
3. Employs personnel on this project who have successfully completed a manufacturer's training course on the hardware configuration and implementation of the specific programmable controllers, computers, and software proposed for this project.
4. Has been in the water/wastewater industry performing the type of work specified in this specification section for a minimum of five (5) continuous years.
5. The PCSI shall maintain a fully equipped office/production facility with full-time employees capable of fabricating, configuring, installing, calibrating, troubleshooting, and testing the system specified herein. Qualified repair personnel shall be available and capable of reaching the facility within 24 hours.

C. Recommended PCSIs:

1. Control Panels USA
16310 Bratton Lane, Suite 100
Austin, Texas 78728
Attn: Martin Salyer
Phone: 512.863.3224
2. Prime Controls
815 Office Park Circle
Lewisville, Texas 75057
Attention: Gary McNeil
Telephone: 972.221.4849
3. Richardson Logic Control
8115 Hicks Hollow
McKinney, Texas 75071
Attention: Michel Cunningham
Telephone: 972.542.7375
4. Wunderlich – Malec
2855 Trinity Square Drive, Suite 100
Carrollton, Texas 75006
Attention: Adrian Beaty
Telephone: 469.574.2500

- D. The listing of specific PCSI organizations above does not imply acceptance of their products and capabilities that do not meet the specified ratings, features and functions. PCSI's listed above are not relieved from meeting these specifications in their entirety.

1.06 APPLICATION SERVICES PROVIDER (ASP):

- A. The PCSI shall procure the services of an Application Services Provider (ASP) for application software programming for the Allen Bradley and Human Machine Interface (HMI) computers as specified in Section 17305.
- B. All other configuration, programming, and integration, including but not limited to, PLC configuration and/or programming, loading of software for process devices, Ethernet configuration and communications verification shall be performed by the PCSI as specified in other Sections.
- C. Qualifications:
 - 1. The ASP shall perform all work necessary to configure, customize, debug, install, connect, and place into operation all HMI and DCS software specified within this Division and other related divisions. The PCSI shall coordinate with the ASP all scheduling, installation, and startup services. The PCSI shall be on site at all times when the ASP is working on site.
- D. Recommended ASPs:
 - 1. Control Panels USA
16310 Bratton Lane, Suite 100
Austin, Texas 78728
Attn: Martin Salyer
Phone: 512.863.3224
 - 2. Hierholzer Engineering, Inc.
P.O. Box 300
Seguin, Texas 78156-0300
Attn: Jeremy Davenport
Phone: 830.372.4808
 - 3. Prime Controls
815 Office Park Circle
Lewisville, Texas 75057
Attn: Gary McNeil
Phone: 972.221.4849
 - 4. Schneider Electric
Business Development, Water Wastewater Competency Center
12121 Wickchester Lane, Suite 400
Houston, Texas 77079
Attn: Mike Ford
Phone: 832.816.0028
 - 5. Signature Automation
900 NE Loop 410, Suite D317
 - 6. Transdyn
San Antonio, TX 78209
Attn: Rick Hidalgo
Phone: 210-807-7434

1.07 QUALITY ASSURANCE:

- A. The manufacturer of this equipment shall have produced similar instrumentation equipment for a minimum period of five (5) years. When requested by the OWNER/ENGINEER, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. The equipment as submitted shall be located as shown on the project plans and shall fit within this location. Equipment which does not fit in the space as shown on the project plans is not acceptable.
- C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.08 ENCLOSURE TYPES FOR AREA CLASSIFICATIONS:

- A. Unless otherwise specified herein or shown on the Drawings, enclosures and associated installations shall have the following ratings:
 - 1. Provide NEMA 4X 316 Stainless Steel enclosures for outdoor, wet locations or specifically shown on the Drawings.
 - 2. NEMA 1 or 1A enclosures will not be permitted, unless specifically stated on the Drawings.
 - 3. All enclosures shall be lockable and provided with a padlock location.

1.09 CODES, INSPECTION AND FEES:

- A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.
- B. Obtain all necessary permits and pay all fees required for permits and inspections.

1.10 RECORD DRAWINGS:

- A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings". The Record Drawings and Specifications shall be kept up to date throughout the project.
- B. Record Drawings shall accurately show the installed condition of the following items:
 - 1. One-line Diagram(s)
 - 2. Raceways and pull boxes
 - 3. Conductor sizes
 - 4. Panel Schedule(s)
 - 5. Control Wiring Diagram(s) including all wire tags
 - 6. Process Instrumentation Diagram(s)

7. Mounting Details
 - C. Submit a typical example of a schedule of control wiring raceways and wire numbers, including the following information:
 1. Circuit origin, destination and wire numbers.
 2. Field wiring terminal strip names and numbers with field connection wire color.
 - D. As an alternate, submit a typical example of point-to-point connection diagrams showing the same information, may be submitted in place of the schedule of control wiring raceways and wire numbers.
 - E. Submit the record drawings and the schedule of control wiring raceways and wire numbers (or the point-to-point connection diagram) to the Owner/Engineer.
 - F. The Contractor's retainage shall not be paid until the point-to-point connection diagrams have been furnished to and approved by the Owner/Engineer.
- 1.11 EQUIPMENT INTERCONNECTIONS:
- A. Review shop drawings of equipment furnished under other related Divisions and prepare coordinated wiring interconnection diagrams or wiring tables. Submit copies of wiring diagrams or tables with Record Drawings.
 - B. Furnish and install all equipment interconnections.
- 1.12 MATERIALS AND EQUIPMENT:
- A. Materials and equipment shall be new, except where specifically identified on the Drawings to be re-used.
 - B. The Contractor shall not bring onsite, material or equipment from a manufacturer, not submitted and approved for this project. Use of any such material or equipment, will be rejected, removed and replaced by the Contractor, with the approved material and equipment, at his own expense.
 - C. Material and equipment shall be UL listed, where such listing exists.
 - D. The Contractor shall be responsible for all material, product, equipment and workmanship being furnished by him for the duration of the project. He shall replace the equipment if it does not meet the requirements of the Contract Documents.
- 1.13 DELIVERY, STORAGE AND HANDLING:
- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two (2) copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner.
 - B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Accessories shall be packaged and shipped separately.

- C. Equipment shall be equipped to be handled by crane. Where cranes are not available, equipment shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.
- D. Equipment shall be installed in its permanent, finished location shown on the Drawings within seven (7) calendar days of arriving onsite. If the equipment cannot be installed within seven (7) calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor's expense, until such time that the site is ready for permanent installation of the equipment.
- E. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters during jobsite storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.14 EQUIPMENT IDENTIFICATION:

- A. Identify equipment furnished under Division 17 with the name of the equipment it serves. Control panels, Instruments, meters junction or terminal boxes, etc, shall have nameplate designations as shown on the Drawings.
- B. Nameplates shall be engraved, laminated impact acrylic, black lettering on a white background, matte finish, not less than 1/16-in thick by 3/4-in by 2-1/2-in, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2". Prior to installing the nameplates, the metal surface shall be thoroughly cleaned, with a 70% alcohol solution, until the metal surface residue has been removed. Epoxy adhesive or foam tape is not acceptable.

1.15 WARRANTY:

- A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for two (2) years from the date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the CONTRACTOR at no expense to the OWNER.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 PCSI COORDINATION MEETINGS:

- A. The PCSI shall schedule and administer a minimum of three (3) mandatory Coordination Meetings during the submittal phase of the project. The PCSI shall make arrangements for the meetings and prepare and send a proposed agenda to all participants at least one (1) week before scheduled meetings. The PCSI shall be responsible for promptly preparing and distributing meeting minutes to all attendees.
- B. The PCSI shall prepare meeting minutes and distribute them to all attendees and others affected by any decisions made at the meetings. The meeting minutes shall be distributed within one (1) week following the meeting.

- C. The meetings shall be held at the General Contractor's field office at the project site and shall include, at a minimum, attendance by the Owner, Engineer, General Contractor's project engineer, PCSI project engineer, ASP's project engineer, and the electrical subcontractor.
1. The First Coordination Meeting shall be held in advance of the first Shop Drawing submittal. The purpose of the first meeting shall be for the PCSI to:
 - a. Summarize their understanding of the project
 - b. Discuss any proposed deviations, substitutions or alternatives
 - c. Present the PCSI project schedule
 - d. Schedule testing and delivery milestone dates
 - e. Provide a forum for the PCSI to coordinate hardware and software related issues
 - f. Request any additional information required from the Owner and/or Engineer.
 - g. The PCSI shall bring a draft version of shop drawings to the meeting to provide the basis for the Owner/Engineer's input into their development.
 2. The Second Coordination Meeting shall be held after the Field Instruments and Control Panel submittals have been reviewed and returned to the PCSI. The purpose of the second meeting shall be for the PCSI to:
 - a. Discuss comments made during submittal process
 - b. Refine schedule milestone dates
 - c. Coordinate installation activities
 - d. Discuss any remaining coordination requirements.
 3. The Third Coordination Meeting shall be held no more than one month prior to site testing for each location. The purpose of the third meeting shall be to discuss any remaining coordination needs and requirements.
 4. A typical agenda may include, but shall not be limited to, the following:
 - a. Review minutes of previous meetings
 - b. Review of work progress
 - c. Field observations, problems, and decisions
 - d. Identification of problems which may impede planned progress
 - e. Review of submittal schedule and submittal status
 - f. Review of offsite fabrications and delivery schedules
 - g. Maintenance of progress schedule
 - h. Corrective measures to regain projected schedules
 - i. Planned activities for subsequent work period
 - j. Coordination of projected progress
 - k. Maintenance of quality and work standards
 - l. Effect of proposed changes on progress schedule and coordination
 - m. Other business relating to work

3.02 INTERPRETATION OF DRAWINGS:

- A. Raceways and conductors for switches and other miscellaneous low voltage power and signal systems as specified are not shown on the Drawings. Raceways and conductors shall be provided as required for a complete and operating system. Refer to riser diagrams for signal system wiring.

- B. The Contractor shall run all conduit and wire to PLC Termination Cabinets, where designated on the Drawings. The conduit and wire, as shown on the interface drawings, may not necessarily be shown on the floor plan.
- C. Install conductors carrying low voltage signals (typically twisted shielded pair cables) in raceways totally separate from all other raceways containing power or 120 volt control conductors, Refer to NEC article 725. DC and AC control wiring shall be installed in separate raceways.
- D. Raceways and conductors for the fire alarm, sound and page party systems are not shown on the Drawings. Provide raceways and conductors as required by the system manufacturer for a complete and operating system. All raceways and power conductors shall be in accordance with Division 16. Raceways shall be installed concealed in all finished spaces and may be installed exposed or concealed in process spaces.
- E. Redesign of electrical or mechanical work, which is required due to the Contractor's use of a pre-approved alternate instrumentation or control item, or arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the Owner/Engineer for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.

3.03 INSTRUMENTATION EQUIPMENT PADS AND SUPPORTS:

- A. Equipment pads and supports, of concrete or steel including structural reinforcing and foundations, are shown on the Structural Drawings.

3.04 SLEEVES AND FORMS FOR OPENINGS:

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for Electrical and Instrumentation work and form before concrete is poured.
- B. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.
- C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Owner/Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.
- D. Seal all openings, sleeves, penetration and slots as specified in Section 16110.

3.05 CUTTING AND PATCHING:

- A. Cutting and patching shall be done in a thoroughly workmanlike manner. Saw cut all concrete and masonry prior to breaking out sections.
- B. Core drill holes in concrete floors and walls as required. Contractor shall obtain written permission from the Owner/Engineer before core drilling any holes larger than 2 inches.
- C. Install work at such time as to require the minimum amount of cutting and patching.
- D. Do not cut joists, beams, girders, columns or any other structural members.
- E. Cut opening only large enough to allow easy installation of the conduit.

- F. Patching to be of the same kind and quality of material as was removed
- G. The completed patching work shall restore the surface to its original appearance or better.
- H. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.
- I. Remove rubble and excess patching materials from the premises.
- J. When existing conduits are cut at the floor line or wall line, they shall be filled with grout of suitable patching material.

3.06 INSTALLATION:

- A. Any work not installed according to the Drawings and this Section shall be subject to change as directed by the Owner/Engineer. No extra compensation will be allowed for making these changes.
- B. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.
- C. Equipment shall be protected at all times against mechanical injury or damage by water. Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters as required by each Specification Section. Do not install equipment in its permanent location until structures are weather-tight. If any apparatus has been subject to possible injury by water, Equipment shall be thoroughly dried out and tested as directed by the Owner/Engineer, or shall be replaced at no additional cost at the Owner/Engineer's discretion.
- D. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the Owner/Engineer's discretion.
- E. Repaint any damage to the factory applied paint finish using touch-up paint furnished by the equipment manufacturer. If the metallic portion of the panel or section is damaged, the entire panel or section shall be replaced, at no additional cost to the Owner.

3.07 MANUFACTURER'S SERVICE:

- A. Provide manufacturer's services for testing and start-up of the equipment as listed in each individual Specification Section.
- B. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturer's warranty repairs.
- C. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by schematics, wiring diagrams and Control Descriptions.
- D. Testing shall be scheduled and coordinated with the Owner/Engineer at least two weeks in advance. Provide qualified test personnel, instruments and test equipment.
- E. Refer to the individual Instrumentation Equipment Sections for additional specific testing requirements.
- F. Make adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

3.08 TESTING:

- A. Test systems and equipment furnished under Division 17 and repair or replace all defective work. Make adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.
- B. Make the tests and checks prior to energizing instrumentation equipment in accordance with Section 17302, and the individual Specification sections.
- C. Testing shall be scheduled and coordinated with the Owner/Engineer at least two weeks in advance. Provide qualified test personnel, instruments and test equipment, including manufacturer's services, as specified in the individual Specification sections.
- D. Where test reports show unsatisfactory results, the Owner/Engineer will require the removal of all defective or suspected materials, equipment and/or apparatus, and their replacement with new items, all at no cost to the Owner. The Contractor shall bear all cost for any retesting.

3.09 TRAINING:

- A. The Contractor shall provide manufacturer's training as specified in each individual section of the Specifications.

END OF SECTION

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SECTION 17302**PROCESS INSTRUMENTATION AND CONTROL SYSTEM TESTING****PART 1 – GENERAL**

1.01 SCOPE:

- A. The PCSI shall provide, in coordination with the ASP as required, all labor and materials necessary to coordinate and perform the testing of the Process Instrumentation and Control System as specified herein.
- B. The Process Control Systems Integrator (PCSI) shall supervise and/or perform the requirements of this Section. As part of these services, the PCSI shall include, for those equipment items not manufactured by him, the services of an authorized manufacturer's representative to check the equipment installation and place that portion of the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation, and maintenance of the manufacturer's equipment.
- C. The Contractor shall provide all test equipment necessary to perform the testing as specified herein.
- D. All Process Instrumentation and Control System hardware and software shall be thoroughly tested to verify proper operation as an integrated system.
- E. Any defects or problems found during the testing activities shall be corrected by the Contractor and then retested to demonstrate proper operation.
- F. Check and confirm the proper installation of all instrumentation and control components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation.
- G. Conduct a complete system checkout and adjustment, tuning of control loops, checking operation functions, and testing of final control actions. All problems encountered shall be promptly corrected to prevent any delays in startup of the various unit processes.
- H. The PCSI shall be responsible for initial operation of the Process Instrumentation 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.
- I. All spare parts must be on site and accepted prior to commencement of field testing.
- J. The Contractor shall provide the following documentation for use during the testing activities.
 - 1. Complete panel schematic and internal point-to-point wiring interconnect drawings.
 - 2. Complete electrical control schematics in accordance with JIC standards.
 - 3. Complete panel layout drawings.
 - 4. Complete field wiring diagrams.
 - 5. Complete instrument loop diagrams.

6. Completed Calibration/Recalibration Certificates for all field and panel devices that require adjustment or calibration.
 7. Contractor to provide a complete test procedure and I/O List.
 - K. Contractor shall provide one set of the above listed documentation for the Owner's personnel, one set for the Engineer's use, one set for field use, and the required number of sets for the Contractor's use.
 - L. The drawings corrected and modified during testing shall form the basis for the "As-Built" record drawing requirement.
 - M. Contractor shall furnish to Engineer two copies of 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 system supplier.
- 1.02 TESTS – GENERAL:
- A. The PCSI shall test all equipment at the prior to shipment to the project site. Unless otherwise specified in the individual specification sections, all equipment provided by the PCSI shall be tested as a single fully integrated system as far as possible.
 - B. At a minimum, the testing shall include the following:
 - C.
 1. Factory Testing
 - a. Un-witnessed Factory Test (UFT)
 - 1) The Un-witnessed Factory Test shall be performed by the PCSI at his facility.
 2. Field Testing
 - a. Operational Readiness Test (ORT)
 - 1) The Operational Readiness Test shall be a joint test performed by the PCSI and ASP, with coordination as required, with the electrical subcontractor and other subcontractors or equipment suppliers if needed.
 - b. Functional Demonstration Tests (FDT)
 - 1) The Functional Demonstration Tests shall be performed by the PCSI in coordination with the ASP as necessary to demonstrate the system operating in compliance with the requirements of the Contract Documents. The FDT(s) shall be conducted by the PCSI and witnessed by the Owner's representative(s) and the Engineer.
 - c. 30-Day Site Acceptance Tests (SAT)
 - 1) The SAT shall be a 30-day field test of the fully operating system as detailed below in this Section.

- D. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement shall be satisfied.
- E. All tests shall be conducted in accordance with prior Engineer-approved procedures, forms, and check lists. Each specific test shall be described and followed by a section for sign off by the appropriate party after its satisfactory completion.
- F. Copies of these sign off test procedures, forms, and check lists will constitute the required test documentation.
- G. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provides suitable means of simulation. Define these simulation techniques in the test procedures.
- H. The General Contractor shall require the Integration Subcontractor to coordinate all testing with the Engineer, all affected Subcontractors, and the Owner.
- I. The Engineer reserves the right to test or retest all specified functions whether or not explicitly stated in the prior approved Test Procedures.
- J. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.
- K. No equipment shall be shipped to the Project Site until the Engineer has received all test results and approved the system as ready for shipment.
- L. The PCSI shall furnish the services of servicemen, all special calibration and test equipment and labor to perform the field tests.
- M. Correction of Deficiencies:
 - 1. All deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet specification requirements at no additional cost to the Owner.
 - 2. Testing, as specified herein, shall be repeated after correction of deficiencies is made until the specified requirements are met. This work shall be performed at no additional cost to the Owner.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 UN-WITNESSED FACTORY TESTS (UFT):

- A. The entire system, except primary elements, final control elements, and field mounted transmitters, shall be interconnected and tested to ensure the system operates as specified. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions, and control devices/functions.
- B. All panels and assemblies shall be inspected and tested to verify that they are in conformance with related submittals, specifications, and Contract Drawings.

- C. During the tests all digital system hardware and software shall have operated continuously for five (5) days without a failure to verify the system is capable of continuous operation. The Un-Witnessed Factory Test results shall be submitted to the Engineer for approval prior to the scheduling of the Operational Readiness Test (ORT).

3.02 OPERATIONAL READINESS TESTS (ORT):

- A. Prior to startup and the Functional Demonstration Test, the entire system shall be certified (inspected, tested, and documented) that it is ready for operation.
- B. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated, and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittals and these Specifications.

1. The Loop/Component Inspections and Tests shall be implemented using Engineer approved forms and check lists.

- a. Each loop shall have a Loop Status Report to organize and track its inspection, adjustment, and calibration. These reports shall include the following information and check off items with space for sign off by the PCSI.

- 1) Project Name
- 2) Loop Number
- 3) Tag Number for each component
- 4) Check offs/sign offs for each component

- b. Tag/identification
- c. Installation
- d. Termination – wiring
- e. Calibration/adjustment – Check offs/sign offs for the loop
- f. Panel interface terminations
- g. I/O interface terminations
- h. I/O signal operation
- i. Inputs/outputs operational: received/sent, processed, and adjusted
- j. Total loop operation – Provide space for comments
- k. Each active Analog Subsystem element and each I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry, and a space for sign off by the PCSI:

- 1) Project Name
- 2) Loop Number
- 3) Component Tag Number of I/O Module Number
- 4) Component Code Number Analog System
- 5) Manufacturer (for Analog system element)
- 6) Model Number/Serial Number (for Analog system)
- 7) Summary of Functional Requirements:

- a) Indicators: Scale
- b) Transmitters/Converters: Scale
- c) Computing Elements: Function
- d) Controllers: Action (direct/reverse) control Modes (PID)
- e) Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), Preset (AUTO/MANUAL)
- f) I/O Modules: Input or output

2. Calibrations:
 - a. Analog Devices: Required and actual inputs and outputs at 0, 25, 50, 75, and 100 percent of span, rising and falling.
 - b. Discrete Devices: Required and actual trip points and reset points
 - c. Controllers: Mode settings (PID)
 - d. I/O Modules: Required and actual inputs or outputs for 0, 25, 50, 75, and 100 percent of span, rising and falling.
 - 1) Provide space for comments
 - 2) Space for sign off by the PCSI
3. The General Contractor shall require the PCSI to maintain the Loop Status Reports and Component Calibration Sheets at the job-site and make them available to the Engineer/Owner at any time.
4. These inspections and tests do not require witnessing. However, the Engineer shall review and initial all Loop Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the Operational Readiness Test. Any deficiencies found shall be corrected.

3.03 FUNCTIONAL DEMONSTRATION TEST (FDT):

- A. Prior to startup and the 30-Day Test, the entire installed instrument and control system shall be certified that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the Operational Readiness Tests. The FDT will be a joint test by the PCSI and the Equipment suppliers.
- B. Once the facility has been started up and is operating, a witnessed Functional Demonstration Test shall be performed on the complete system to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph and loop-by-loop basis.
- C. Loop-specific and non-loop-specific tests shall be the same as specified under Functional Demonstration Tests except that the entire installed system shall be tested and all functionality demonstrated.
- D. Updated versions of the documentation specified to be provided for during the tests shall be made available to the Engineer at the job-site both before and during the tests. In addition, one (1) copy of all O&M Manuals shall be made available to the Engineer at the job-site both before and during testing.
- E. The daily schedule specified to be followed during the tests shall also be followed during the Functional Demonstration Test.
- F. The system shall operate for 100 continuous hours without failure before this test shall be considered successful.
- G. Demonstrate communication failure and recovery.

3.04 30-DAY SITE ACCEPTANCE TEST (SAT):

- A. After completion of the Operational Readiness and Functional Demonstration Tests, the PCSI shall be responsible for operation of the entire system for a period of 30 consecutive days,

under conditions of full pump station process operation, without a single non-field repairable malfunction.

- B. During this test, station operating and PCSI personnel shall be present as required. For this test, the PCSI is expected to provide personnel who have an intimate knowledge of the system hardware and software.
- C. While this test is proceeding, the Owner shall have full use of the system. Only station operating personnel shall be allowed to operate equipment associated with live station processes.
- D. Any malfunction during the tests shall be analyzed and corrected by the PCSI. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.
- E. During this 30 consecutive day test period, any malfunction which cannot be corrected within 24 hours of occurrence by PCSI personnel, or more than two similar failures of any duration, will be considered a non-field-repairable malfunction.
- F. Upon completion of repairs by the PCSI, the test shall be repeated as specified herein.
- G. In the event of rejection of any part or function, the PCSI shall perform repairs or replacement within 90 days.
- H. The total availability of the system shall be greater than 99.5 percent (99.5%) during this test period. Availability shall be defined as:
 - 1. $\text{Availability} = (\text{Total Testing Time} - \text{Down Time}) / \text{Total Testing Time}$
- I. Down times due to power outages or other factors outside the normal protection devices or back-up power supplies provided shall not contribute to the availability test times above.
- J. Upon successful completion of the 30-day site acceptance test and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete, and the two year warranty period shall commence.

3.05 TRAINING:

- A. General:
 - 1. The cost of training programs for the Owner's personnel shall be included in the Contract price. Where practical, the training and instruction shall be directly related to the system being supplied.
 - 2. Training shall be conducted at the Owners facilities.
 - 3. All Technicians, Operators, Engineers, and Managers of the Facility shall require training on the Process Control System (PCS). The training courses shall address operation, maintenance, and troubleshooting of the system provided. The courses shall be designed specifically for the type of personnel attending, such as Operators, Engineers, etc.
 - 4. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule.

5. Provide detailed training manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.
6. The trainer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, all training materials shall be delivered to Owner.
7. The Owner reserves the right to videotape all training sessions. All training tapes shall become the sole property of the Owner.

B. Training:

1. Manufacturer's Training:

a. Rockwell Plantpax: This training shall be provided by the ASP.

- 1) Provide two weeks of manufacturer's standard training course for six (6) of Owner's personnel in the operation, configuration, programming, and installation of the Rockwell Plantpax software.
- 2) The following training shall be provided as a minimum:
 - a) Designing and maintaining control logic
 - b) Designing graphics
 - c) System administration
 - d) Troubleshooting
 - e) Network administration
 - f) Database generation
 - g) Alarm system and configuration
 - h) Historical data system configuration
 - i) Report generation
 - j) Security system
 - k) Trending system
 - l) Remote communications
 - m) Software configuration
 - n) OLE applications
 - o) Test, adjustment, and calibration procedures
- 3) Training shall include classroom and hands-on instruction such that a student with experience in process instrumentation can configure the HMI with no guidance or with only minimal supervision when attempting complex problems.

b. Programmable Logic Controller (PLC) Hardware and Software:

- 1) Provide manufacturer's standard training course for ten (10) of the Owner's personnel in the operation, configuration, programming, installation, and maintenance of the PLC hardware and software supplied. The courses shall be conducted in two groups for one week each.
- 2) The hardware and software courses shall not be concurrent
- 3) The following hardware training shall be provided as a minimum:
 - a) Rockwell Training Course #PRS013
 - b) Rockwell Training Course #FTVP
 - c) Rockwell Training Course #CCP299
 - d) Rockwell Training Course #CCV206-LD
 - e) Rockwell Training Course #CCP177

- 4) The following software training shall be provided as a minimum:
 - a) System configuration
 - b) Application specific program development/programming
 - c) Uploading/downloading programs
 - d) Documenting program/configuration
 - e) System backups and reload procedures
 - f) TCP/IP addressing procedures
 - g) Network communications configuration

c. Human Machine Interface (HMI):

- 1) Training personnel shall be intimately familiar with the control system equipment, its manipulation, and configuration. Training personnel shall command knowledge of system debugging, program modification, troubleshooting, maintenance procedure, system operation, and programming, and shall be capable of transferring this knowledge in an orderly fashion to technically oriented personnel.
- 2) Training and instruction shall be specific to the system that is being supplied.
- 3) Training shall consist of classroom and hands-on instruction utilizing the Owner's system.
- 4) Detailed training shall be provided on the actual configuration and implementation for this Contract. Training shall cover all aspects of the system that will allow the Owner's personnel to maintain, modify, troubleshoot, and develop future additions/deletions to the system. The training shall cover the following subjects, as a minimum:
 - a) System overview
 - b) System hardware components and specific equipment arrangements
 - c) System startup, shut down, load, backup, and historical archival/retrieval procedures
 - d) Specific application configuration covering the overall design and implementation of the applications provided under this Contract. The intent is to make the student fully knowledgeable in all aspects of the system provided.
 - e) Periodic maintenance
 - f) Troubleshooting and diagnosis
 - g) Network configuration, communications, and operation
 - h) Windows XP operation and maintenance
 - i) System backups and reload procedures
 - j) TCP/IP addressing procedures

C. Field Training:

1. Field Instruments:

- a. Provide a minimum of one 8-hour hardware training and instruction on the maintenance of the field instrumentation for ten (10) of the Owners instrumentation technicians. This training shall be conducted before the Functional Demonstration Test, but no more than one (1) month before and at a time suitable to the Owner. This training shall take place at the Owners facility. As a minimum the following shall be included:
 - 1) Training in standard hardware maintenance for the instruments provided

- 2) Specific training for the actual instrumentation configuration to provide a detailed understanding of how the equipment and components are arranged, connected, and set up for this Contract.
- 3) Test, adjustment, and calibration procedures
- 4) Troubleshooting and diagnosis
- 5) Periodic maintenance

2. Panel Instruments:

- a. Provide a minimum of one 8-hour hardware training and instruction in the maintenance of the panel instrumentation for ten (10) of the Owners technicians. Training should be conducted before the Functional Demonstration Test, but not more than one (1) month before and at a time suitable to the Owner. This training shall be provided at the Owners facility and at a minimum the following shall be included:
 - 1) Training in standard hardware maintenance for the instruments provided
 - 2) Specific training for the actual instrumentation configuration to provide a detailed understanding of how the equipment and components are arranged, connected, and configured for this Contract
 - 3) Test, adjustment, and calibration procedures
 - 4) Troubleshooting and diagnosis
 - 5) Periodic maintenance

END OF SECTION

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SECTION 17305**APPLICATION SERVICES****PART 1 - GENERAL**

1.01 SCOPE:

- A. The PCSI shall furnish the services of qualified personnel to perform the work as defined herein, in the Related Work Paragraph of this Section, and other Specification Sections as specified herein. The service personnel shall be referred to as the Application Services Programmer (ASP). The pre-qualified ASP shall be as specified in Section 17300.
- B. It shall be the responsibility of the PCSI to obtain and provide any and all information required from other Divisions, as listed in the related work below, to complete the work under this Section.
- C. The ASP shall be responsible for providing all new applications programming and configuration services of the Owner's existing SCADA control system to accomplish the control and monitoring functions as described in the Contract Documents. The ASP shall provide all programming functions including, but not limited to, control strategies and communications for the pump station PCS PLC controller and HMI. The ASP shall also provide all applications programming and configuration services necessary to produce the HMI (graphic displays, reports, trends, historical archive, etc.) as described in the contract specifications and drawings.
- D. The ASP shall provide all modifications to the control system database, control logic, graphic screens, etc. required to correctly reflect the removal of equipment and instruments, including, but not limited to pressure transmitters, flow meters and other equipment and instruments included under the scope of this Contract.
- E. At a minimum the ASP shall:
 - a. Provide for and test communications and functionality between new instrumentation and PLC.
 - b. Configure and test data collection and interactivity between all software packages and Operator Workstations and Servers in order to provide a comprehensive working system of data collection, storage and reporting.
 - c. All Applications Software Development and Programming shall be performed in accordance with the Owner's pre-established programming conventions.
 - d. All Applications Software Development and Programming (i.e., Rockwell Plantpax screens, configurations, and associated attributes) shall be performed at the ASP facility before being loaded in the field on the existing Rockwell Plantpax system.
 - e. All Applications Software Development and Programming shall be performed by ASP approved personnel.
 - f. All commands issued at the Rockwell Plantpax Control System (equipment start/stop, reset, set point entry, etc.) shall be security protected.

- g. ASP shall perform back-ups of the Rockwell Plantpax Control System prior to loading graphical screens, configurations, and associated attributes to SAWS Rockwell Plantpax Control System. The ASP shall coordinate with SAWS I&C.
- h. ASP shall ensure that data is free of viruses, malware, adware, spyware, etc. or any other malicious programs prior to loading graphical screens, configurations, and associated attributes to SAWS Rockwell Plantpax system the ASP shall coordinate with SAWS I&C.

1.02 RELATED WORK:

- A. Mechanical Equipment Division
- B. Electrical Equipment Division
- C. Section 17300 Instrumentation General Provisions
- D. Section 17302 Testing
- E. Section 17310 Field Instruments
- F. Section 17325 Control Panels
- G. Section 17327 Panel Mounted Equipment
- H. Section 17400 Control Loop Descriptions
- I. Section 17405 Input/Output List
- J. Section 17410 Field Instrument List
- K. Section 17500 Programmable Logic Controller (PLC)
- L. Section 17515 Communications Interface Equipment

1.03 SUBMITTALS:

- A. Pre-submittal Conference:
 - 1. Prior to the Submittal Process, the Application Services Provider (ASP) shall hold workshops, in which the Engineer and Owner may observe the displays and control strategies prior to submitting database, trends, graphics, reports, and control strategies. No display generation, programming, etc. shall begin until standards have been approved.
 - 2. Prior to commencement of any applications work, the ASP shall submit and receive approval from the Owner and Engineer for all required I/O Lists.
- B. Submittal Process:
 - 1. Submittals shall be made in accordance with the requirements of Division 1, Section 17300, and as specified herein.

2. All electronic submittals shall be submitted in an ISO/IEC 26300:2006 or Comma Separated Values (CSV) readable electronic file format on a CD-Rom and an 8 ½-inch by 11-inch hard copy. Programs shall be submitted in the native format of the PLC as suggested by the manufacturer.

C. Submittal Content:

1. Submittals shall contain the following:

- a. Controller Programming:

- 1) I/O List with register assignments. I/O tags shall be assigned by the ASP and shall conform with SAWS existing I/O tagging format.
- 2) Diagrams of the process control functions by each strategy.
- 3) Listing of inputs to the control function.
- 4) A short narrative of each control strategy.
- 5) Listing of all Operator inputs and outputs to and from the control function. Any special displays related to the function shall be illustrated. A description of the operation of any display shall be described as it relates to the control function.
- 6) Cross references of all I/O, showing to which I/O modules or software modules, they are in.
- 7) Failure contingencies shall be described in detail.
- 8) An annotated program, submitted in both hard copy and electronic format.

- b. Human Machine Interface Programming:

- 1) I/O List with register assignments. I/O tags shall be assigned by the ASP and shall conform with SAWS existing I/O tagging format.
- 2) Displays for each process area including all necessary pop ups.
- 3) Listing of data points on each display.
- 4) A short narrative of each control usage.
- 5) Listing of all Operator inputs and outputs to and from the control function. Any special displays related to the function shall be illustrated. A description of the operation of any display shall be described as it relates to the control function.
- 6) Cross references of all I/O, showing which software module at each point used.
- 7) Failure contingencies shall be described in detail.
- 8) A complete listing of all historical points.
- 9) Listing of all required configuration files for each SCADA client.

2. Submit a proposed Schedule of Work.

1.04 REFERENCE CODES AND STANDARDS:

- A. Instrumentation equipment, materials and installation shall comply with the National Electrical Code (NEC and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)
2. Occupational Safety and Health Administration (OSHA)
3. NEMA ICS 1-101 Diagrams, Designations and Symbols

4. ANSI/ISA-5.06.01-2007 - Functional Requirements Documentation for Control Software Applications.
5. ISA-TR20.00.01-2001 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.
6. ISA-5.4-1991 Instrument Loop Diagrams.
7. ISA-5.5-1985 Graphic Symbols for Process Displays.
8. ISA-5.1-1984 (R1992) Instrumentation Symbols and Identification.
9. ISA-5.3-1983 Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
10. ISA-20-1981 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
11. ISA-5.2-1976 (R1992) Binary Logic Diagrams for Process Operations
12. NEMA ICS 6 Enclosures for Industrial Controls and Systems
13. National Fire Protection Association (NFPA)
14. National Electrical Manufacturers Association (NEMA)
15. American National Standards Institute (ANSI)
16. Insulated Cable Engineers Association (ICEA)
17. International Society of Automation (ISA)
18. Underwriters Laboratories (UL)
19. UL 508, the Standard of Safety for Industrial Control Equipment
20. UL 508A, the Standard of Safety for Industrial Control Panels
21. UL 50, the Standard of Safety for Enclosures for Electrical Equipment
22. NFPA 79, Electrical Standard for Industrial Machinery
23. Factory Mutual (FM)
24. NFPA 70 National Electrical Code (NEC)
25. NFPA 70E Standard for Electrical Safety in the Workplace
26. ANSI C37.90.2 Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers

27. NEMA ICS 4 Terminal Blocks for Industrial Use
28. NEMA LS1 Low Voltage Surge Protection Devices
29. UL 1283 Standard for Safety-Electromagnetic Interference Filters
30. UL 1449 Third Edition Surge Protective Devices
31. City of San Antonio, Texas Electrical Code

- B. All equipment and installations shall conform to applicable Federal, State, and local codes. All equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 WARRANTY:

- A. Provide 2 year equipment warranty which begins after final acceptance of facility. Refer to the requirements of Division 1.

1.06 SYSTEM FINAL DOCUMENTATION

- A. Prior to final acceptance of the system and owner training, operating and maintenance manuals covering instructions on the operation and maintenance on each type of equipment shall be furnished in accordance with the Section 01730.
- B. The documents shall be provided bound in three ring binders with Drawings reduced or folded for inclusion. In addition, documentation shall be provided in electronic format, either in MS Word or Excel, as applicable. Submit electronic files on CD or DVD.
- C. As a minimum, the following information shall be provided:
1. A comprehensive index.
 2. A complete "As Constructed" set of approved shop Drawings.
 3. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.
 4. Full specifications on each item.
 5. System schematic drawings "As Constructed," illustrating all components, piping and electrical connections of the systems supplied under this Section.
 6. Detailed service, maintenance and operation instructions for each item supplied.
 7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
 8. Operating instructions which incorporate a functional description of the entire system with references to the systems schematic Drawings and instructions.

9. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.
- D. The final documentation shall be new documentation written specifically for this project, but may include standard and modified standard documentation. Modifications to existing hardware or software manuals shall be made on the respective pages or inserted adjacent to the modified pages. All standard documentation furnished shall have all portions that apply clearly indicated. All portions that do not apply shall be lined out.
- E. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.
- F. If the PCSI's ASP transmits any documentation or other technical information which he considers proprietary, such information shall be designated. Documentation or technical information which is designated as being proprietary will be used only for the design, construction, operation, or maintenance of the System and, to the extent permitted by law, will not be published or otherwise disclosed.
- G. The requirements for the final documentation are as follows:
 1. As built documentation shall include all previous submittals, as described in this Specification, updated to reflect the as built system as well as any corrections or modifications to the System resulting from the Factory and/or Functional Demonstration Tests.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 COORDINATION MEETINGS:

- A. The ASP shall be responsible to coordinate the work with the PCSI and/or the Contractor. He shall schedule and administer a minimum of three (3) coordination meetings for the purpose of discussing progress of the work under this Section. The ASP shall make arrangements for the meetings and prepare and send a proposed agenda to all participants at least two (2) weeks before scheduled meetings. The ASP shall be responsible for promptly preparing and distributing meeting minutes to all attendees.
- B. The meetings shall be held at the Owner's designated location and shall include, at a minimum, attendance by the Owner, Engineer, General Contractor's project engineer, ASP, and PCSI if necessary.
 1. The First Coordination Meeting shall be held in advance of the first ASP Shop Drawing submittal. The first meeting may run concurrent to a PCSI coordination meeting, if desired and timed to meet all other contract requirements. The purpose of the first meeting shall be for the ASP to:
 - a. Summarize their understanding of the project
 - b. Discuss any proposed deviations, substitutions or alternatives

- c. Present the ASP project schedule
 - d. Schedule testing and delivery milestone dates
 - e. Provide a forum for the ASP and Owner to coordinate hardware and software related issues
 - f. Request any additional information required from the Owner and/or Engineer
 - g. The ASP shall bring a draft version of shop drawings to the meeting to provide the basis for the Owner/Engineer's input into their development
 - h. Discuss format of required reports to be developed
2. The Second Coordination Meeting shall be held after all ASP shop drawings have been reviewed and returned to the ASP. Attendance by the Owner, Engineer, General Contractor's project engineer, ASP, and PCSI shall be required. The purpose of the second meeting shall be for the ASP to:
- a. Discuss comments made during submittal process
 - b. Refine schedule milestone dates
 - c. Coordinate installation activities
 - d. Discuss any remaining coordination requirements
3. A typical agenda may include, but shall not be limited to, the following:
- a. Review minutes of previous meetings
 - b. Review of work progress
 - c. Field observations, problems, and decisions
 - d. Identification of problems which may impede planned progress
 - e. Review of submittal schedule and submittal status
 - f. Review of offsite fabrications and delivery schedules
 - g. Maintenance of progress schedule
 - h. Corrective measures to regain projected schedules
 - i. Planned activities for subsequent work period
 - j. Coordination of projected progress
 - k. Maintenance of quality and work standards
 - l. Effect of proposed changes on progress schedule and coordination
 - m. Other business relating to work
- 3.02 TESTING:
- A. Refer to Section 17302.
- 3.03 OPERATIONAL READINESS TEST (ORT):
- A. Refer to Section 17302.
 - B. Each active Analog Subsystem element and each I/O module shall have a Component Calibration Sheet. These sheets shall have spaces for data entry, space for sign off by the ASP and the PCSI, and the following information:
 - 1. Project Name
 - 2. Loop Number
 - 3. Component Tag Number of I/O Module Number

4. Component Code Number Analog System
 5. Manufacturer (for Analog system element)
 6. Model Number/Serial Number (for Analog system)
 7. Summary of Functional Requirements:
 - a. Indicators: Scale
 - b. Transmitters/Converters: Scale
 - c. Computing Elements: Function
 - d. Controllers: Action (direct/reverse) control Modes (PID)
 - e. Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), Preset (AUTO/MANUAL)
 - f. I/O Modules: Input or output
 8. Calibrations:
 - a. Analog Devices: Required and actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling
 - b. Discrete Devices: Required and actual trip points and reset points
 - c. Controllers: Mode settings (PID)
 - d. I/O Modules: Required and actual inputs or outputs for 0, 10, 50, and 100 percent of span, rising and falling
 - e. Space for comments
 - f. Space for sign off by the General Contractor
- 3.04 FUNCTIONAL DEMONSTRATION TEST (FDT):
- A. Refer to Section 17302.
- 3.05 30-DAY SITE ACCEPTANCE TEST (SAT):
- A. Refer to Section 17302.
- 3.06 TRAINING:
- A. General:
 1. The cost of Owner training programs shall be included in the Contract price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance of the system.
 2. All instructors shall be intimately familiar with the operation and control of the Owner's facilities.
 3. Training shall be provided to accommodate shift personnel. Coordinate with Owner.
 4. Owner reserves the right to record (video and/or audio) all training sessions. All training tapes shall become the sole property of the Owner.
 - B. Maintenance Training

- C. Refer to Section 17302 for additional training requirements
- D. Scheduling of all training sessions shall be coordinated with the Owner:
 - 1. Controller Software:
 - a. The training and instruction, insofar as practicable, shall be directly related the System being supplied. The training shall include a field training program consisting of hands-on instruction utilizing the Owner's System.
 - b. One 2-day training session shall be provided for the Owner's designated personnel on software and hardware operation and maintenance at the Owner's facility. Software training shall provide classroom and hands-on instruction such that a student with experience in process instrumentation can configure the system with no guidance or with only minimal supervision when attempting complex problems. The training shall cover the following subjects as a minimum:
 - 1) System overview covering the basic system design and purpose
 - 2) System hardware covering the specific hardware elements and specific equipment arrangements provided are covered.
 - 3) Specific application configuration instruction shall cover the overall design and implementation of the applications as provided under this Contract The intent shall be to make the student fully knowledgeable in all aspects the system provided, along with methods for making additions, modifications, and deletions to the process system.
 - 4) Development of new control loops and strategies
 - 5) Complete system backup and reload procedures
 - c. These courses shall not be concurrent with those offered by the PCSI. The above listing is only a guide and is not intended to be complete.
 - 2. Operator Interface Software
 - 3. Refer to Section 17302 for additional training requirements.
 - 4. Operator Training
 - a. Refer to Section 17302 for additional training requirements.
 - 5. Pump Station Operator field training sessions shall include the following:
 - a. Pump Station Operator field training shall be structured specifically for operations type personnel. The ASP and PCSI shall be prepared to answer any questions the Operators may ask regarding pump station operation via the Control System. Training personnel shall be prepared to walk-through the logic used to control the equipment and how the Control System executes that logic. Training personnel shall be prepared to show the Operators how to operate the pump station from the Control System level in the event of Control Room equipment failure. Additionally, such topics as changing printer ribbon, changing printer or video copier paper, printing reports on demand, copying graphic displays, signing onto the system, creating graphic generated trends, etc. shall be discussed.
 - b. The ASP and PCSI shall, at a minimum, have the following teaching aids available for distribution during pump station Operator field training sessions:

- 1) Copies of all complete generated graphic displays and reports
6. Operator Interface Functions:
 - a. Provide a minimum of two separate 2-day training sessions as scheduled by the Owner for the Owner's designated operations personnel on the detailed operation of the Operator Work Station Controls. This training should be conducted within two weeks of the completion of the Functional Demonstration Test at a time suitable to the Owner. This training shall be provided at the Owner's facility and as a minimum include the following:
 - 1) Specific training for the actual instrumentation configuration to provide a detailed understanding of how the equipment and components are arranged, connected, and set up for this Contract.
 - b. Provide a minimum of four (4) days of instructor on-call tutoring services. After the completion of the training sessions described above, the instructor shall be at the site to provide these services.

END OF SECTION

SECTION 17310

FIELD INSTRUMENTS

PART 1 - GENERAL

1.01 SCOPE:

- A. The CONTRACTOR shall furnish, install and test all field instruments, process control devices and appurtenances, as shown on the project plans, specified in the Related Sections and Divisions as specified herein.
- B. Field instruments specified in other Divisions shall be manufactured in accordance with this Section and submitted as part of the equipment specified in the other Divisions.
- C. The CONTRACTOR shall furnish to the ENGINEER certified calibration/recalibration (for existing Instruments) reports for field instruments and devices specified herein immediately upon completion of calibration:
 - 1. Receipt of any calibration/recalibration certificate shall in no way imply acceptance of any work or instrument.
 - 2. Each calibration/recalibration certificate shall be signed and dated by an authorized representative of the CONTRACTOR. Three copies of each completed certificate shall be submitted to the ENGINEER.
 - 3. Required calibration data are listed in Part 3 Testing.

1.02 RELATED SECTIONS:

- A. Division 16
- B. Process Equipment Divisions
- C. Mechanical Equipment Divisions
- D. Section 17300 Instrumentation General Provisions
- E. Section 17302 Testing
- F. Section 17305 Application Services
- G. Section 17327 Panel Mounted Equipment
- H. Section 17400 Control Loop Descriptions
- I. Section 17405 Input/Output List
- J. Section 17410 Field Instrument List
- K. Section 17500 Programmable Logic Controller (PLC)
- L. Section 17515 Communications Interface Equipment

1.03 SUBMITTALS:

- A. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc. sufficient to confirm that the equipment provides every specified requirement. Any options or exceptions shall be clearly indicated.
- B. Submittals for equipment specified herein, for other Sections or Divisions, shall be made as a part of equipment submittals furnished under other Sections or Divisions.
- C. Installation experience documentation shall be submitted for approval with the Section Equipment Submittal.
- D. Operations and Maintenance Manuals:
 - 1. Operations and Maintenance manuals shall be constructed in accordance with Division 1 and shall include the following information:
 - a. Manufacturer's contact address and telephone number for parts and service.
 - b. Instruction books and/or leaflets
 - c. Recommended renewal parts list
 - d. Record documents for the information required by the Submittals section above.

1.04 REFERENCE CODES AND STANDARDS:

- A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
 - 1. All meters, relays and associated equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.
 - 2. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.05 QUALITY ASSURANCE:

- A. The manufacturer of this equipment shall have produced similar instrumentation equipment for a minimum period of five (5) years. When requested by the OWNER/ENGINEER, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. The equipment as submitted shall be located as shown on the project plans and shall fit within this location. Equipment which does not fit in the space as shown on the project plans is not acceptable.
- C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.06 WARRANTY:

- A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for two (2) years from the date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty the Manufacturer shall promptly

furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the CONTRACTOR at no expense to the OWNER.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. All devices shall be Factory Mutual (FM) approved:
 - 1. Explosion Proof for Class I division 1 group B, C, and D.
 - 2. Dust-Ignition Proof for Class II and Class III, division 1, group E, F and G.
 - 3. Factory Sealed.
- B. Hardware:
 - 1. All hardware used for outdoor instrument mounting shall be 316 Stainless Steel.
- C. Instrument Stand:
 - 1. 2"Schedule 80 Double Dipped Galvanized steel pipe.
- D. Process Pipe:
 - 1. All tubing and fitting shall be made of 316 Stainless Steel.

2.02 PRESSURE SWITCHES:

- A. Bourdon tube pressure switch:
 - 1. Adjustable deadband. Separately externally adjustable high and low pressure operating points.
 - 2. Fully automatic, no manual reset required.
 - 3. Visible calibrated dial.
 - 4. Visible On-Off operation.
 - 5. SPST mercury switch, opens on increase in pressure.
 - 6. To be provided with DELRIN Bushed Movement.
 - 7. Outdoor application:
 - a. NEMA 4X enclosure.
- B. Ratings:
 - 1. 1/8 to 20 psig.

2. 10 amperes at 120 Vac.

C. Manufacturer: Mercoid: Series D-30, Type DAW33-153-3A.

2.03 TEMPERATURE SWITCHES (ELECTRICAL AND SCADA BUILDING HIGH TEMP):

A. Temperature switch:

1. Adjustable from 50-90°F.
2. SPDT bimetal operated snap switch.
3. Indoor application.
4. UL Listed
5. Provide nameplate indicating “Electrical Room High Temperature Switch – Not for HVAC Control” and “SCADA Room High Temperature Switch - Not for HVAC Control”

B. Manufacturer: Columbus Electric: Model ETD-5S-6S or equal

2.04 PRESSURE TRANSMITTER (TANK LEVEL):

A. Electronic Gage Pressure Transmitter:

1. Local and remote indication.
2. Provide with Ray self-cleaning pressure snubbers.
3. Input isolated with silicone filled stainless steel diaphragms.
4. Local indication LCD meter scaled in FEET and mounted integral to the transmitter. Transmitter operation ranges should operate at bottom 25% of full-scale range of transmitter.
5. Outdoor application:
 - a. NEMA 4 housing
 - b. View port for local indication
 - c. Stainless steel flanges
 - d. 2” pipe mount
6. Stainless Steel certification tag for Factory Mutual (FM) Explosion Proof rating.

B. Ratings:

1. Overpressure Limit without damage: 1500 psi
2. Input Range: 150 psi
3. Accuracy: +/- 0.075% of span
4. Analog Output: 4 – 20 mA
5. Power Supply: 24 Vdc

6. Operating Temperature Limits: -4° to 175°F
- C. Manufacturer: Rosemount, Model: 2088, Model Number 2088 G 2 S 22 A 1 M4 B4 DW.
- 2.05 PRESSURE TRANSMITTER (PRESSURE IN PSI):
- A. Electronic Gage Pressure Transmitter:
1. Local and remote indication.
 2. Provide with Ray self-cleaning pressure snubbers.
 3. Input isolated with silicone filled stainless steel diaphragms.
 4. Local indication LCD meter scaled in PSI (0-150PSI) and mounted integral to the transmitter. Transmitter operation ranges should operate at bottom 25% of full-scale range of transmitter.
 5. Outdoor application:
 - a. NEMA 4 housing
 - b. View port for local indication
 - c. Stainless steel flanges
 - d. 2" pipe mount
 6. Stainless Steel certification tag for Factory Mutual (FM) Explosion Proof rating.
- B. Ratings:
1. Overpressure Limit without damage: 1500 psi
 2. Input Range: 150 psi
 3. Accuracy: +/- 0.075% of span
 4. Analog Output: 4 – 20 mA
 5. Power Supply: 24 Vdc
 6. Operating Temperature Limits: -4° to 175°F
- C. Manufacturer: Rosemount, Model: 2088, Model Number 2088 G 2 S 22 A 1 M4 B4 DW.
- 2.06 FLOW METER AND TRANSMITTER (HIGH SERVICE PUMPS ONE, TWO, THREE AND FOUR):
- A. Electromagnetic Transmitter.
1. Electromagnetic

2. Indication at transmitter.
3. Shall be provided with external surge suppression equipment to protect 120 VAC input and Modbus RS485 output.
4. External grounding rings to be included.
5. PTFE Coating on inside.
6. 12" diameter size.
7. Remote display mount inside a NEMA 4X panel with sunshield
8. Modbus RS485 output.
9. Bi-Directional where applicable.
10. NSF61 rated or equivalent.
11. Equipment supplied must be 100% compatible with Modbus Protocol and suitable for conversion at a later date for Profibus or Foundation Fieldbus.
12. Totalizer readings shall be in MG and interface directly with Modbus based monitoring and control systems. Flow readings shall be in GPM locally, converted to MGD on the SCADA system.
13. All meters will have a non-resettable totalizer except through direct interface password protection.
14. Manufacture cables to be included.
15. Calibration Flow: 0.2%, 3-point

B. Ratings:

1. Minimum accuracy required: +/- 1.0%.
2. Power supply: 110 – 120 Vac
3. Ambient temperature: -5° – 140°F

C. Manufacturers and Models:

1. Endress & Hauser, Proline Promag W500:

2.07 CHLORINE AND FLUORIDE ANALYZER:

A. Analyzer General:

1. The analyzer function incorporated into the instrument shall be designed for continuous measurement of as many as four measurements simultaneously.

2. The analyzer supports the following continuous measurements: free chlorine, pH, and fluoride.
 3. The analyzer measurements chosen shall be displayed on the instrument's display in numerical and graphical format.
 4. The analyzer shall be designed for continuous measurement of the sample stream without the need for reagent addition and consist of the following measurement choices: Free chlorine, pH, and fluoride. The free chlorine measurement shall be amperometric by way of either a bare electrode flow cell with hydro-mechanical cleaning or by way of a membrane-type sensor. Up to two measurements shall be analyzed within a single flowcell and displayed on the electronics. The continuous measurement options all include the following components: a measurement specific sensor, a sensor cable and a pre-calibrated sensor input card specific to the measurement chosen.
 5. The sensors shall be housed in a molded clear plastic flow cell.
- B. Flow Cell shall consist of the following at minimum:
1. sample flow control device
 2. built-in mesh filter screen to remove large debris in the sample water
- C. Free Chlorine Measurement Via Electrodes:
1. Measurement ranges: 0 – 100 µg/l, 0 - 200 µg/l, 0 – 500 µg/l, 0 – 1.00 mg/l, 0 – 2.00 mg/l, 0 – 5.00 mg/l, 0 – 10 mg/l, 0 – 20 mg/l, 0 – 50.0 mg/l, 0 – 100 mg/l and 0 – 200 mg/l.
 2. Accuracy: 10 µg/l or ±2% of full scale, whichever is greater
 3. Sensitivity: 10 µg/l or ±1% of full scale, whichever is greater
 4. Repeatability: 10 µg/l or ±2% of full scale, whichever is greater
 5. Stability: 2% of full scale per month
 6. Response Time: 90% of change within 20 seconds of sample entry
 7. Sampling rate continuous @ 550 ml/min
 8. Inlet pressure of flow cell: 3 to 60 psig
 9. Inlet sample temperature: 41 to 122 degrees Fahrenheit
- D. pH Measurement (combined hydrogen ion selective and reference electrodes):
1. Measurement range 0 – 12 pH units
 2. Measurement Sensitivity: 0.01 pH units
 3. Repeatability: 0.05 per cent of span
 4. Sampling rate continuous @ 550 ml/min
 5. Inlet pressure of flow cell: 3 to 60 psig
 6. Inlet sample temperature: 41 to 104 degrees Fahrenheit
- E. Fluoride Measurement (fluoride ion selective):
1. Measurement range: 0.2 to 2.0 mg/l
 2. Measurement sensitivity: 0.01 mg/l
 3. Repeatability: 0.05 percent of span
- F. One Dual Channel Analyzer for Chlorine:
1. Manufacturer: Rosemount Analytical Model FCL-56 system which includes sensor, connecting cable, 56 transmitter, and flow controller
- G. One Dual Channel Analyzer for Fluoride:
1. Manufacturer: Rosemount Analytical Model LIQ-PDS-FMS system which includes sensor, connecting cable, 56 transmitter, and flow controller.

H. One separate flow switch equal to GEMS FS Series PVC clear flow switch.

2.08 FLUORIDE LEVEL TRANSMITTER AND SENSOR - RADAR TYPE

A. Requirements::

1. Local and remote indication
2. Non-contacting level instrument
3. Outdoor application
 - a. NEMA 4X polycarbonate enclosure
4. Units in Feet.
5. Compatibility: Equipment manufacturer shall provide written statement certifying that transmitter is compatible with the chemical use specified.

B. Ratings:

1. Measuring Range: 49.21 ft
2. Deviation: +-2mm
3. Process Temp: -40C to 80C
4. Operating Voltage: 9.6 Vdc to 36 Vdc

C. Manufacturer:

1. Vega VegaPuls WL61 with remote mount VEGADIS 82 with 4-20ma output.
2. Vendor supplied cable

2.09 LEVEL ELECTRODE SYSTEM:

A. Flanged holder with stainless steel wire-suspended electrodes to be mounted on top of tank as shown on the Contract Drawings. CONTRACTOR shall measure the levels of the existing electrodes prior to removal and provide levels as part of the submittal for installation and level setting of the new probes. Proposed levels are shown on the plans but may require adjustment based on existing probe levels and/or adjustments requested by Owner.

1. Level Electrodes:
 - a. Manufacturer: B/W Controls Series 6013-W2.
2. Electrode Holder:
 - a. Manufacturer: B/W Controls Series 6012-E554-13E.
3. Level Relays:
 - a. Manufacturer: B/W Controls Series 1500-*-L1-S7-OC-X (*- function as per plans)
4. Suspension Wire:
 - a. Manufacturer: B/W Controls Series 6013-SW-** (**- length in feet)
5. Wire Connectors:
 - a. Manufacturer: B/W Controls Series 6013-C-SS

B. Electrode Holder:

1. Manufacturer: B/W Controls Series 6012-E556-13E.

2.10 LEVEL FLOAT SWITCH (FOR SUMP PUMPS):

- A. Shall be suitable for wastewater applications.
- B. Shall have non-mercury construction.
- C. Maximum Applied Voltage: 250 Vac
- D. Manufacturer:
 - 1. Flygt ENM-10, or equal.

2.11 LEAK DETECTION PANEL (FOR FLUORIDE):

- A. The leak detection system shall be manufactured by Guardian a Division of IPEX, Inc. Thermoplastics of Baltimore, MI, or Engineer approved equal. The leak detection system shall be housed in a NEMA 4X panel and be able to identify the manhole the leak occurs. The model number shall be equivalent to IPEX Centra-Guard 8 zone panel #631248.

PART 3 - EXECUTION

3.01 INSTALLER'S QUALIFICATIONS:

- A. Installer shall be specialized in installing this type of equipment with minimum 5 years documented experience.

3.02 EXAMINATION:

- A. Examine installation area to assure there is sufficient clearance to install the equipment.
- B. Verify that the equipment is ready to install.
- C. Verify field measurements are as instructed by the manufacturer.

3.03 INSTALLATION:

A. FLOWMETERS:

- 1. Prior to installation of the meters, CONTRACTOR shall ensure that the meter is compatible with OWNER'S communication instrumentation.
- 2. All flowmeters shall be set up and calibrated by the Manufacturer's field service representative. The Manufacturer shall certify all installations as correct and meeting the standards set forth by this specification.
- 3. Manufacturer shall provide a certified calibration report for each flowmeter.
- 4. Manufacturer shall provide one (1) copy of the calibration software to OWNER.
- 5. Manufacturer shall provide a minimum of a two (2) year warranty on each meter.

B. PRESSURE TRANSMITTERS AND PRESSURE SWITCHES:

1. Shall be installed with heat trace freeze protection around the fluid housing of the instrument and all piping, valves, and fittings.
2. Installation of the process line:
 - a. A ½” bore through the process line shall be done along the upper half of the radius of that line.
 - b. A ½” NPT weld a-let shall be installed over the bore
 - c. A ½” NPT block (root) valve shall be installed after the weld a-let for the isolation of the process from the pressure device.
 - d. A ½” NPT to ¼” NPT bushing will be installed on the isolation valve to bush down to allow for the installation of ¼” static or process lines from the process to the pressure measuring device.
 - e. A 4” expansion loop shall be made after a 1’ straight run off the root valve.
 - f. A ¼” tubing isolation valve shall be installed and a calibration port shall be installed at the device for bleeding off pressure and calibrations can be performed.

3.04 HEAT TRACE SYSTEM:

- A. Reference Section, 16940, INSTRUMENTATION HEAT TRACE SYSTEM.

3.05 CONDUIT AND IDENTIFICATION:

- A. When the use of flexible conduit is required a minimum of 18” shall be provided but the flexible conduit shall not exceed 36”.
- B. All Instrumentation runs shall be the full length of the conduit no splices will be allowed.
- C. The following nomenclature shall be used for identification:
 1. tag # (0-10) for instrumentation info: tags, devices type and termination point
 2. jb# (0-10) for junction box, power panel lighting panel and termination point
 3. r# (0-10) for rack location and termination point
 4. s# (0-10) for slot location and termination point
 5. p# (0-10) for point location and termination point
- D. Install stainless steel instrument labels with instrument ID, secured with safety wire.

3.06 RACEWAY SEALING:

- A. Where raceways enter terminal boxes, junction boxes, or instrumentation equipment, all entrances shall be sealed with 3M 1000NS Watertight Sealant.

3.07 FIELD QUALITY CONTROL:

- A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.
- B. Check tightness of all accessible electrical connections. Minimum acceptable values shall be specified in the manufacturer’s instructions.

3.08 FIELD ADJUSTING:

- A. Adjust all equipment for proper range and field conditions, as described in the manufacturer's instructions.
- B. Any field adjustments, required for proper system operation, shall be included in the Final O&M Manuals.

3.09 TESTING:

- A. Perform all electrical field tests recommended by the manufacturer.
- B. Full testing (loop check) shall be done on all instrumentation and all SCADA I/O points and will be witnessed by the OWNER.
- C. A calibration sheet shall be supplied for all the instruments and at the time of any instrument test.

1. Analog device calibration sheet shall include the following:

- a. Time of calibration
- b. Date of calibration
- c. Name of the person performing the calibration
- d. Name of the witness, OWNER
- e. Test equipment used and their calibration dates
- f. Device identification S/N, device name and tag number
- g. As found voltage reading
- h. As left voltage reading
- i. As found milliamp reading @ 0%, 25%, 50%, 75% and 100%
- j. As left milliamp reading @ 0%, 25%, 50%, 75% and 100%
- k. Calibration ranges
- l. I/O points

2. I/O point data sheet for each I/O analog and discrete through SCADA:

- a. Field point location
- b. Analog or Discrete
- c. Software point location
- d. Point function
- e. Time of verification
- f. Date of verification
- g. Name of the person verifying the point
- h. Name of the witness, OWNER

3.10 CLEANING:

- A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.11 EQUIPMENT PROTECTION AND RESTORATION:

- A. Touch up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.12 MANUFACTURER'S CERTIFICATION:

- A. A qualified factory-trained and certified representative shall certify in writing that the equipment has been installed, adjusted, including all settings as defined in the Contract Documents.

3.13 TRAINING:

- A. Provide the representatives, services for training of OWNER's personnel in operation and maintenance of the equipment furnished under this Section and Section 01650.
- B. The training for each type of equipment shall be for a period of not less than one (1) eight hour day.
- C. The cost of training program to be conducted with OWNER's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.
- D. Provide detailed O&M Manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.
- E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, motor starters, protective devices, metering, and other major components.
- F. The OWNER reserves the right to videotape the training sessions for the OWNER's use.

END OF SECTION

SECTION 17325
CONTROL PANELS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. Furnish and install fully functional SCADA panel to manually or automatically operate the pump station as specified in the detailed requirements of this Section, and logic and schematics as shown on the Electrical and Instrumentation Drawings.
- B. Control panels as specified in Electrical Equipment Division or Mechanical Equipment Divisions, except as specifically stated herein shall not be submitted under this Section.
- C. Provide the following SCADA panel as depicted in the Drawings and as specified herein.

1.02 RELATED WORK:

- A. Division 16
- B. Section 17300 Instrumentation General Provisions
- C. Section 17327 Panel Mounted Control Equipment
- D. Section 17302 Testing
- E. Section 17305 Application Services
- F. Section 17310 Field Instruments
- G. Section 17327 Panel Mounted Equipment
- H. Section 17400 Control Loop Descriptions
- I. Section 17405 Input/Output List
- J. Section 17410 Field Instrument List
- K. Section 17500 Programmable Logic Controller (PLC)
- L. Section 17515 Communications Interface Equipment

1.03 SUBMITTALS:

- A. Submittal Process:
 - 1. Submittals shall be made in accordance with the requirements of Section 01300, Section 17300 and as specified herein.
 - 2. Submittals require information on related equipment to be furnished under this Specification, and described in the related Sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will be returned un-reviewed.
- B. Submittal Content:

1. The original equipment manufacturer shall create all equipment shop drawings, including all wiring diagrams, in the manufacturer's Engineering department. All equipment shop drawings shall bear the original equipment manufacturer logo, drawing file numbers, and shall be maintained on file in the original equipment manufacturers archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.

C. Required Submittals:

1. Copies of previously Approved Related Work submittals
2. Documentation confirming that the Panel Assembly Facility is a UL-508 certified panel shop
3. Facsimile of the UL label that is to be applied to the completed panels
4. Shop Drawings:
 - a. Shop Drawings shall include the following:
 - 1) Drawings shall be to scale and shall show the location of panel mounted devices, including doors, louvers, and sub panels
 - 2) Equipment outline drawings showing elevation, plan and interior views, front panel arrangement, dimensions, weight, shipping splits, conduit entrances and anchor bolt pattern. Indicate all options, special features, ratings and deviations from this Section's requirements.
 - 3) The first sheet of each Panel Drawing Packet shall contain a Bill of Materials for that panel. The Bill of Materials shall list all devices mounted within the panel, and shall include the tag number, description, manufacturer, and model number of each item.
 - 4) Following the Bill of Material shall be a listing, uniquely identifying each component of the Panel, and a description of the item used, i.e. devices by their assigned tag numbers, nameplate inscriptions, service legend, and annunciator inscriptions.
 - 5) Power and control schematics including external connections. Show wire and terminal numbers and color-coding.
 - b. Interconnecting Wiring Diagrams:
 - 1) Provide interconnecting wiring diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
 - 2) Diagrams shall show component and panel terminal board identification numbers, and external wire and cable numbers.
 - 3) Circuit names corresponding to the Circuit and Raceway Schedule shall be shown. The diagram shall include intermediate terminations between field elements and panels (e.g., terminal junction boxes, pull boxes, etc.).
5. Factory Tests:
 - a. Submittals shall be made for factory tests as specified herein. Owner/Engineer approval of required factory tests is required prior to shipment of the equipment.

6. Field Tests:
 - a. Submittals shall be made for field tests as specified herein
7. Operation and Maintenance Manuals:
 - a. Operation and maintenance manuals shall include the following information:
 - 1) Manufacturer's contact address and telephone number for parts and service
 - 2) Instruction books and/or leaflets
 - 3) Recommended renewal parts list
 - 4) Record Documents for the information required by the Submittals paragraph above

D. Operation and Maintenance Manuals:

1. Operation and maintenance manuals shall include the following information:
 - a. Manufacturer's contact address and telephone number for parts and service
 - b. Instruction books and/or leaflets
 - c. Recommended renewal parts list
 - d. Record Documents for the information required by the Submittals paragraph above

1.04 REFERENCE CODES AND STANDARDS:

- A. Instrumentation equipment, materials and installation shall comply with the National Electrical Code (NEC and with the latest edition of the following codes and standards:
 1. National Electrical Safety Code (NESC)
 2. Occupational Safety and Health Administration (OSHA)
 3. NEMA ICS 1-101 Diagrams, Designations and Symbols
 4. ANSI/ISA-5.06.01-2007 - Functional Requirements Documentation for Control Software Applications
 5. ISA-TR20.00.01-2001 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005
 6. ISA-5.4-1991 Instrument Loop Diagrams
 7. ISA-5.5-1985 Graphic Symbols for Process Displays
 8. ISA-5.1-1984 (R1992) Instrumentation Symbols and Identification
 9. ISA-5.3-1983 Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems
 10. ISA-20-1981 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves

11. ISA-5.2-1976 (R1992) Binary Logic Diagrams for Process Operations
12. NEMA ICS 6 Enclosures for Industrial Controls and Systems
13. National Fire Protection Association (NFPA)
14. National Electrical Manufacturers Association (NEMA)
15. American National Standards Institute (ANSI)
16. Insulated Cable Engineers Association (ICEA)
17. International Society of Automation (ISA)
18. Underwriters Laboratories (UL)
19. UL 508, the Standard of Safety for Industrial Control Equipment
20. UL 508A, the Standard of Safety for Industrial Control Panels
21. UL 50, the Standard of Safety for Enclosures for Electrical Equipment
22. NFPA 79, Electrical Standard for Industrial Machinery
23. Factory Mutual (FM)
24. NFPA 70 National Electrical Code (NEC)
25. NFPA 70E Standard for Electrical Safety in the Workplace
26. ANSI C37.90.2 Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference From Transceivers
27. NEMA ICS 4 Terminal Blocks for Industrial Use
28. NEMA LS1 Low Voltage Surge Protection Devices
29. UL 1283 Standard for Safety-Electromagnetic Interference Filters
30. UL 1449 Third Edition Surge Protective Devices
31. City of San Antonio, Texas Electrical Code
32. All equipment and installations shall conform to applicable Federal, State, and local codes

1.05 QUALITY ASSURANCE:

- A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of five (5) years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

- B. The control panels shall be assembled in a UL-certified panel shop, experienced in the assembled of control panels for wastewater and water treatment systems. A submittal of the documentation, that certifies the panel fabrication shop is a UL-certified shop, is required.
- C. Equipment components and devices shall be UL labeled wherever UL standards exist for such equipment. The completed control panel shall be UL Labeled in accordance with UL 508 and 508A and other applicable UL standards. The panel shall also be UL labeled for the environment in which it is to be placed. A UL label shall be affixed to the inside of the external door by the panel fabrication assembly. Submit a facsimile of the UL label in the submittal information.
- D. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.

1.06 DELIVERY STORAGE AND HANDLING:

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two (2) copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner/Engineer.
- B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Accessories shall be packaged and shipped separately.
- C. Within (5) five days after shipment of all equipment, Manufacturer shall ship all software, supplied under this Section of the Specifications, by Registered Mail or Approved Courier, to the Owner's Representative, with a copy of the Shipment Manifest
- D. Visibly damaged panels shall be returned to the Manufacturer's UL 508 facility, for examination and damaged equipment replaced at no expense to the Owner.
- E. Equipment shall be installed in its permanent finished location shown on the Drawings within seven (7) calendar days of arriving onsite. If the equipment cannot be installed within seven (7) calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor's expense, until such time that the site is ready for permanent installation of the equipment.
- F. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters during storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.07 WARRANTY:

- A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for two (2) years from date of final acceptance of the equipment. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Manufacturer, at no expense to the Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Subject to compliance with the Contract Documents, the following enclosure Manufacturers are acceptable:

1. Hoffman Enclosures
2. Rittal Enclosures

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 RATINGS

- A. Enclosure Ratings for Area Classifications:
1. Unless otherwise specified herein or shown on the Drawings, enclosures and associated installations shall have the following ratings:
 2. Provide NEMA 4X 316 Stainless Steel enclosures for outdoor, wet locations. In addition NEMA 4X Aluminum enclosures will be allowed on an individual basis, but only where specifically designated herein or specifically shown on the Drawings.
- B. The complete control panel assembly shall be UL certified or carry a UL listing for "Industrial Control Panels".
- C. The control panel shall meet all applicable requirements of the National Electrical Code.
- D. For additional ratings and construction notes, refer to the Drawings.
- E. The service voltage shall be as specified and as shown on the Drawings. The overall short circuit withstand and interrupting rating of the equipment and devices shall be equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the Control Panel, but not less than 10,000 amperes at 120 volts single phase.
- F. The Manufacturer shall produce and install on each panel, an Arc Flash Warning Label listing the information, calculated from NFPA 70E (2018 Edition), Annexes, as listed below:
1. Arc Flash Boundary
 2. (Available Incident Energy and the Corresponding Working Distance) Or (Arc Flash PPE Category for the equipment)
 3. Site Specific Level of PPE
 4. Minimum Arc Rating of Clothing
 5. Nominal System Voltage
- G. Provide an Arc Flash Warning Label, printed in color and affixed to the front of each panel provided.
1. Shown below is a typical label. Size of each label shall be not less than 8 inches wide and 6 inches tall.



2.03 CONSTRUCTION:

A. General:

1. Refer to the Drawings for: schematics, actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.

B. Enclosures:

1. Free Standing:

- 1) Enclosures shall be of factory gray painted steel, rear and side panels, with lifting eyes, without knockouts or holes. Enclosures shall have fully sized rear and side panels. Panels shall have factory cutouts where required for environmental ducts. Enclosures shall not be less than 12 gauge metal. All enclosures shall have continuous hinged, foam-in-place gasketed doors with handle latch, 3-point. All enclosures shall have bonding provisions on door.
2. Each enclosure less than 4 ft. wide shall be shall have one overhead interior florescent light fixture, with Off/On switch, powered from a dedicated non UPS circuit. Each enclosure greater than 4 ft. wide shall have one overhead florescent light for every 4 ft. of length, or every fraction thereof.
3. Each enclosure shall have receptacles as indicated on the plans.
4. Each enclosure shall have, factory installed, full sized removable back and side panels, on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs for wall mounted enclosures, and 316 SS hardware for free standing enclosures.
5. The enclosure outer door shall have a rear mounted pocket in the lower portion, which shall containing laminated copies of the panel schematics and wiring.
6. Electrical tables shall be laminated and adhered to the inside of the door.
7. All enclosures shall be pad lockable.

8. All operating control devices, indicators, and instruments shall be securely mounted on the swing panel door. All controls and indicators shall be 30mm, clearly labeled to indicate function and shall be NEMA 12 rated (NEMA 4X for outdoor panels or panels in corrosive areas). Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.
 - a. All indicating lamps shall be LED push-to-test type. Equipment shall have Run indicating lamps. Lens color shall be red for RUN and amber for FAIL or ALARM. For all control applications, indicator lamps shall incorporate a push-to-test feature.
 - b. Mode selector switches (HAND-OFF-AUTO, etc) shall be as shown on the Drawings. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring as shown on the contract drawings.
 - c. Push-buttons shall be momentary or maintained contacts as required by the Drawings. Contact arrangement shall be as required.

C. Environmental Controls:

1. Enclosure Condensate Heaters:

- a. A self-contained enclosure condensation heater with thermostat and fan shall be mounted inside the control panel, if panel is mounted outdoors or in a non-air-conditioned spaced.
 - 1) Enclosure heaters shall be energized from 120 volt, single-phase power supply and sized to prevent condensation within the enclosure.
 - 2) Locate enclosure heaters to avoid overheating electronic hardware or producing large temperature fluctuations on the hardware.
 - 3) Enclosure heaters shall have an internal fan for heat distribution and shall be controlled with adjustable thermostats. The thermostat shall have an adjustment range of 40 degrees Fahrenheit to 90 degrees Fahrenheit. Provide a circuit breaker or fused disconnect switch within the enclosure.
 - 4) Enclosure heaters shall be Hoffman type DAH.
- b. Strip heaters may be provided if they are 240 volt rated, powered at 120 volts AC and do not have a surface temperature higher than 60°C. Strip heaters and thermostats shall be as manufactured by Chromalox.
 - 1) Strip heaters shall be Chromalox, Type OT, 1.5-in wide, 240 Volts, single phase, 150 watts, energized at 120 volts, with rust resisting iron sheath, Catalog No. OT-715, Product Code No. 129314. Provide sufficient wattage in heaters to prevent condensation should the interior temperature of the enclosure drop below the dew point.
 - 2) A control thermostat mounted inside the control Panel shall be Chromalox, Type WR, single stage, Catalog No. WR-80, Product Code No.263177.
 - 3) The strip heater terminals shall be guarded by a protective terminal cover.
 - 4) High temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be No. 12 AWG stranded nickel-plated copper with Teflon glass insulation and shall be the product of Chromalox, Catalog No. 6-CFI-12, and Product Code No. 263783.

2. NEMA 4X Enclosure Air Conditioner:
 - a. NEMA 4X enclosures containing electronic devices or electrical equipment shall have air conditioners that will maintain the internal temperature at or below the equipment rating without violating the NEMA 4X rating of the enclosure.
 - b. The panel builder shall provide panel internal heat rise calculations to show that the panel internal temperatures will be maintained below the maximum operating temperatures of the panel components.
 - 1) For enclosures mounted indoors in non-air-conditioned spaces, include an ambient air temperature of 40 degree C and a humidity of 100% non-condensing
 - 2) For enclosures mounted in direct sunlight add the appropriate solar heat gain component to the calculation, and raise the ambient temperature to 60 degrees C.
 - 3) The calculation shall show all the internal and external heat gain loads, the expected internal temperature rise in degrees C above the specified ambient without the air conditioner. Provide a calculation showing the expected temperature rise in degrees C above the specified ambient with the air conditioner running.
 - c. The air conditioner shall have the following features:
 - 1) Use CFC-free R134a refrigerant
 - 2) Have fully gasketed flanges on all four mounting edges for a watertight seal that maintains NEMA 4X rating of the panel.
 - 3) Thermostatic low temperature control to provide energy efficient operation and prevents over-cooling.
 - 4) EMI/RFI suppressor to minimize transient spikes during compressor on/off cycling.
 - 5) Separated blower-driven evaporator and condenser air systems for closed loop cooling.
 - 6) UL listed
 - 7) Stainless steel enclosure
 - 8) Internal corrosion resistant coating and/or galvanized steel components.
 - 9) Low ambient kit
 - 10) Short cycle protector
 - 11) Provide an air conditioner manufactured by Pentair.

2.04 PANEL EQUIPMENT:

A. Equipment Requirements:

1. The requirements for equipment, controls, meters, converters, etc, for the SCADA Panel, shall be as shown on the Drawings, panel schematics, and the functions specified in the Loop Descriptions.
2. The PLC shall be as specified in Section 17500 Programmable Logic Controller System.
3. Communications equipment shall be as specified in Section 17515 Communications Interface Equipment.
4. All other equipment, controls, meters, converters that are designed as a part of the control panel, shall be as specified in Section 17327 Panel Mounted Equipment, Related Work Sections specified herein, as shown on the Drawings, panel schematics, and the functions specified in the Loop Descriptions.

5. Provide a main circuit protective device, DIN rail mounted, to protect the panel equipment.

2.05 EQUIPMENT INSTALLATION:

A. Equipment Mounting:

1. The location of the installed equipment shall be as shown on the Panel Layouts on the Drawings.
2. Each piece of equipment shall be securely mounted to the backplate or side plate in accordance with the manufacturer's installation instructions. All mounting hardware shall be from the front of the backplate or side plate with threaded screws. Attaching hardware shall not be installed from the rear of the backplate or side plate. Removal of any piece of equipment shall not require the removal or loosening of any other piece of equipment.
3. Operator interface equipment installed on the door shall be arranged as shown on the Drawings in accordance with the manufacturer's installation instructions. No penetrations of the door shall be made except for equipment mounting. Provide adequate clearance between pieces of equipment and door latching mechanisms.

B. Nameplates:

1. Furnish nameplates for each device as indicated in Drawings. Nameplates shall be engraved, laminated impact acrylic, matte finish, black lettering on a white background, not less than 1/16-in thick by 1/2-in by 1-1/2-in, Rowmark 322402. Nameplates shall be attached to the backplate with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2". Prior to installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residues has been removed. Epoxy adhesive or foam tape is not acceptable.

C. Wiring Trough and Terminal Block Installation:

1. Space between wiring troughs and equipment shall be such that space for terminal blocks is provided for termination of each conductor or group of conductors before connection to the equipment. Removal of equipment for service shall not leave any exposed conductors hanging unconnected.
2. Install the wiring troughs such that one may be removed without interference from the other. Troughs shall be installed such that trough covers may be removed without cover interference.
3. Install terminal blocks on DIN rail with adequate space for access to the terminal with clear view of the wire identification label. All incoming or outgoing wiring shall enter or leave the panel on terminal blocks. Terminal blocks or wiring troughs shall not be installed on the doors. Provide terminal blocks on side plates/backplate for all door mounted equipment.
4. In no case shall internal and external wiring share a wiring trough.
5. Provide 600 volt rated terminal blocks for any conductor carrying any voltage over 120 volts to ground.

6. Provide 600 volt rated strap screw terminal blocks for any power conductors carrying over 20 amps, at any voltage. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits.
7. Power conductors carrying over 20 amps, at any voltage shall be terminated to strap-screw type terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Do not terminate more than one conductor in any lug, and do not land more than two conductors under any strap-screw terminal point.
8. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.
9. Do not land more than two conductors per terminal point. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating common or ground conductors.
10. Twisted shielded pair or triad cables shall have each individual conductor and shield drain wire landed on individual terminal blocks. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating the shield drain wire conductors.
11. Provide an AC ground bar bonded to the panel enclosure, if metal, with 20 percent spare terminals.
12. Provided ground terminal blocks for each twisted-shielded pair drain wire.

D. Internal Panel Wiring:

1. Power and control wiring shall be tinned stranded copper, minimum size No. 14 AWG, with 600 volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation. Line side power wiring shall be sized for the full fault current rating or frame size of the connected device, and as shown on the Drawings.
2. Analog signal wires shall be 600 Volt Class, insulated stranded tinned copper, twisted shielded #16 AWG pair.
3. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. Field wiring shall not be terminated directly on any panel-mounted device.
4. All wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE.
5. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover. Plan wire routing such that no low twisted shielded pair cable conducting analog 4-20 mA signals or low voltage analog signals are routed in the same wire trough as conductors carrying discrete signals or power.
6. All control panel wiring shall use the following color code:

- a. Black: AC power at line voltage
- b. Red: switched AC power
- c. Orange: May be energized while the main disconnect is in the off position
- d. White: AC neutral
- e. Orange/white stripe or white/orange stripe: separate derived neutral
- f. Red/white stripe or white/red stripe: switched neutral
- g. Green or green w/ yellow tracer: ground/earth ground
- h. Blue: Ungrounded DC power
- i. Blue/white stripe or white/blue stripe: DC grounded common
- j. Purple: 480V AC 3 phase - phase A
- k. Yellow: 480V AC 3 phase - phase B
- l. Brown: 480V AC 3 Phase - phase C

E. Field Entrance Internal Wiring:

1. Field entrance internal wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.
2. All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE.
3. All conduit entering or leaving equipment shall be coordinated, in advance with the panel installer, so that the conduit entrances to the enclosure are directly below the termination area for immediate termination. Conduits shall not enter the top or side of the panel unless approved in writing by the Owner/Engineer.

F. PLC / RTU Inputs and Outputs:

1. All PLC and RTU Analog inputs and outputs shall be individually fused for each channel. All Discrete inputs and outputs shall be buffered with relays from the field connections. Discrete points shall be fused for each circuit group with no less than one fuse per card.

2.06 FACTORY TESTING:

- A. The entire control panel shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.
- B. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards.
- C. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.
- D. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards, and shall be subject to the Owner/Engineer's approval.

PART 3 - EXECUTION

3.01 INSTALLER'S QUALIFICATIONS:

- A. Installer shall be specialized in installing this type of equipment with minimum 5 years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

3.02 EXAMINATION:

- A. Examine installation area to assure there is enough clearance to install the equipment. Housekeeping pads shall be included for the floor mounted panels as detailed on the Drawings.
- B. Check concrete pads and base plates for uniformity and level surface.
- C. Verify that the equipment is ready to install.
- D. Verify field measurements are as instructed by manufacturer.

3.03 INSTALLATION:

- A. The Contractor shall install all equipment per the manufacturer's recommendations and Contract Drawings.
- B. Conduit hubs for use on raceway system pull and junction boxes shall be watertight, threaded aluminum, insulated throat, stainless steel grounding screw, as manufactured by T&B H150GRA Series.
- C. Conduits entering a control Panel or box containing electrical equipment shall not enter the enclosure through the top.
- D. Install required safety labels.

3.04 RACEWAY SEALING:

- A. Where raceways enter junction boxes or control panels containing electrical or instrumentation equipment, all entrances shall be sealed with 3M 1000NS Watertight Sealant.
- B. This requirement shall be strictly adhered to for all raceways in the conduit system.

3.05 FIELD QUALITY CONTROL:

- A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.
- B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

3.06 FIELD ADJUSTING:

- A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.
- B. The breaker protective devices shall be set in the field by a qualified representative of the manufacturer, retained by the Contractor, in accordance with settings designated in a coordinated study of the system as required in Section 16411 Power System Study.

3.07 FIELD TESTING:

- A. Perform all electrical field tests recommended by the manufacturer. Disconnect all connections to solid-state equipment prior to testing.
- B. Test all control logic before energizing the equipment.

3.08 CLEANING:

- A. Remove all rubbish and debris from inside and around the panel. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.09 EQUIPMENT PROTECTION AND RESTORATION:

- A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.10 MANUFACTURER'S CERTIFICATION:

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, including all settings designated in the Power System Study, and tested in accordance with the manufacturer's recommendations.
- B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.11 TRAINING:

- A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment provided under this Section.
- B. The training for each type of equipment shall be for a period of not less than one (1) eight hour day.
- C. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.
- D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.
- E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, motor starters, protective devices, metering, and other major components.
- F. The Owner reserves the right to videotape the training sessions for the Owner's use.

END OF SECTION

SECTION 17327**PANEL MOUNTED EQUIPMENT****PART 1 - GENERAL**

1.01 SCOPE OF WORK:

- A. This Section of the Specifications describes the requirements for panel mounted equipment to be furnished under other Sections of the Specifications as listed in the Related Work paragraph of this Section.
- B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.
- C. Provide all flow rate displays configured to also display corresponding totalized flow.

1.02 RELATED WORK:

- A. Section 17300 Instrumentation General Provisions
- B. Section 17302 Testing and Commissioning
- C. Section 17305 Application Services
- D. Section 17310 Field Instruments
- E. Section 17400 Control Loop Descriptions
- F. Section 17405 Input/Output List
- G. Section 17410 Field Instrument List
- H. Section 17500 Programmable Logic Controller (PLC)
- I. Section 17515 Communications Interface Equipment
- J. Section 16050 Basic Electrical Materials and Methods

1.03 SUBMITTALS:

- A. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned un-reviewed.
- B. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., sufficient to confirm that the equipment provides every specified requirement. Any options or exceptions shall be clearly indicated.
- C. Operation and Maintenance Manuals:
 - 1. Operation and Maintenance manuals shall include the following information:
 - a. Manufacturer's contact address and telephone number for parts and service.

- b. Instruction books and/or leaflets
- c. Recommended renewal parts list
- d. Record Documents for the information required by the Submittals above.

1.04 REFERENCE CODES AND STANDARDS:

- A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
 1. NEMA/ISCI 109 Transient Over voltage Withstand Test
 2. IEEE Std. 472/ANSI C37.90.2 Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
 3. IEC 255.4 Surge Withstand Capability Tests.
 4. NEMA/ICS 1 General Standard for Industrial Control Systems.
 5. NEMA/ICS 4 Terminal Blocks for Industrial Use.
 6. NEMA/ICS 6 Enclosures for Industrial Control Systems.
 7. NEMA LS 1 Low Voltage Surge Protective Devices.
 8. UL 1449 Third Edition – Surge Protective Devices
- B. All equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.
- C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.05 QUALITY ASSURANCE:

- A. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the OWNER/ENGINEER, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.
- C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.06 WARRANTY:

- A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for two (2) year from date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the CONTRACTOR at no expense to the OWNER.

PART 2 - PRODUCTS

2.01 WIRE TROUGHS:

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Panduit
 - 2. Taylor
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 DIN RAILS:

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Phoenix Contact
 - 2. Entrelec
 - 3. Weidmuller
 - 4. Allen Bradley
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.03 SIGNAL ISOLATORS, BOOSTERS, CONVERTERS:

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Phoenix Contact
 - 2. Acromag Inc.
 - 3. Moore Industries
 - 4. Lantronix
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
 - 1. Type:
 - a. Externally powered solid state electronic type. Loop powered devices are not acceptable.

2. Functional/Performance:
 - a. Accuracy - 0.15 percent.
 - b. Inputs - Current, voltage, frequency, temperature, or resistance as required.
 - c. Outputs - Current or voltage as required.
 - d. Isolation - There shall be complete isolation between input circuitry, output circuitry, and the power supply.
 - e. Adjustments - Zero and span adjustment shall be provided.
 - f. Protection - Provide RFI protection.
 - g. 24 Volt DC power input.
3. Physical:
 - a. Mounting - Suitable for DIN Rail mounting in an enclosure or instrument rack.
Options/Accessories Required:
 - (i) Mounting rack or general purpose enclosure as required.

2.04 RELAYS AND TIMERS:

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 1. Square D
 2. IDEC
 3. Potter-Broomfield
 4. Allen-Bradley
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- C. Type:
 1. Relays shall be type of shown in the project plans. The relay shall be equipped with an indicating light to indicate when its coil is energized.
 2. Units shall be of the general purpose plug-in type.
- D. Functional/Performance:
 1. Coil voltage shall match supply voltage.
 2. Contact arrangement/function shall be as required to meet the specified control function.
 3. Mechanical life expectancy shall be in excess of 10,000,000 cycles.
 4. Duty cycle shall be rated for continuous operation.

5. Units shall be provided with integral indicating light to indicate if relay is energized.
6. Solid state time delays shall be provided with polarity protection (DC units) and transient protection.
7. Time delay units shall be adjustable and available in ranges from .1 second to 4.5 hours.
8. Plug-in general purpose relay.
9. Blade connector type.
10. Contact material: Silver cadmium oxide.
11. Relay sockets are DIN rail mounted.
12. Internal neon or LED indicator is lit when coil is energized.
13. Clear polycarbonate dust cover with clip fastener.
14. Operating temperature: -20 to +150 °F.
15. UL listed or recognized.

E. Ratings:

1. For 120VAC service provide contacts rated 10 amps at 120VAC, for 24VDC service provide contacts rated 5 amps at 28VDC, for electronic (milliamp/ millivolt) switching applicator provide gold plated contacts rated for electronic service.
2. Relays shall be provided with dust and moisture resistant covers.

F. Physical:

1. DIN Rail mounting base
2. Screw Terminals

G. Options/Accessories Required:

1. Provide mounting sockets with pressure type terminal blocks rated 300 volt and 10 amps.
2. Provide mounting rails/holders as required.

2.05 ANALOG SIGNAL SURGE PROTECTORS (SPDS):

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. AGM Electronics
2. Acromag Inc.
3. Moore Industries

- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.06 DIGITAL INDICATORS:

- A. Digital indicators shall be NEWPORT Electronics Model 202A-P, ma process receiver, or Precision Digital Model PD 765-6RO.

2.07 POWER SUPPLIES:

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. IDEC
2. PULS Silverline
3. Phoenix Contact
4. Sola

- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

- C. Design and fabrication:

1. Converts 120 VAC input to DC power at required voltage.
2. Sized as required by the load. Minimum 2.4 A output.
3. AC input: 120 VAC +10 percent -13 percent; 47 to 63 HZ.
4. Provision for output fail alarm contact.
5. All Power Supplies shall be redundant pairs.

2.08 FLUORIDE HMI:

- A. Furnish and install an Allen Bradley Panelview 5000 7" HMI screen housed inside a NEMA 4X panel. The HMI touchscreen shall be sun shielded with a cover. The HMI shall be programmed for fluoride control, status and operation in coordination with SAWS.

2.09 NAMEPLATES:

- A. Furnish nameplates for each device as indicated in Drawings. Nameplates shall be engraved, laminated impact acrylic, matte finish, black lettering on a white background, not less than 1/16-in thick by 1/2-in by 1-1/2-in, Rowmark 322402. Nameplates shall be attached to the backplate with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2". Prior to

installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residues has been removed. Epoxy adhesive or foam tape is not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. All equipment specified herein shall be factory installed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

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SECTION 17328**SINGLE PHASE UNINTERRUPTIBLE POWER SUPPLY****PART 1 GENERAL****1.01 SCOPE OF WORK**

- A. Section includes:
1. Process Control System Integrator (PCSI) shall provide labor, equipment, supervision and materials for the installation, testing and startup of the Uninterruptible Power Supply (UPS) as shown on the Drawings and as specified herein.
 2. Factory trained technician for startup and field acceptance testing for each UPS.
 3. On-site operation and maintenance training for each UPS
 4. Sizes included in the listing below should be considered the minimum requirement. Exact sizing shall be calculated by the PCSI and those calculations shall be submitted to the Engineer for review and approval.

1.02 RELATED WORK

- A. Section 16000 – Electrical – General Provisions.
- B. Section 16120 – Cables (600 Volt Maximum)

1.03 SUBMITTALS

- A. Submittals shall be in accordance with Sections 17300 and Division 16010. Submittals shall include shop drawings and product data, for the following:
1. Product brochure
 2. Bill of materials listing all components provided.
 3. Deviation list indicating all propose exceptions.
 4. Power single line and control schematics drawings. All external connections and their terminal block locations shall be fully detailed. All internal wiring shall include terminal numbers and color coding.
 5. UPS specifications as follows:
 - a. kVA rating
 - b. Input and output voltage and phase
 - c. Run time at full and half load.
 - d. Voltage (output regulation, input tolerance, unbalance, transfer/retransfer voltage, etc.).
 - e. Heat rejection
 6. Instruction and replacement parts manuals
 7. Name, address, and telephone number of the nearest service facility.
 8. Battery specifications and warranty
 9. Battery sizing calculations

1.04 REFERENCE STANDARDS

- A. ANSI/IEEE C62.41- Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
- B. FCC (Federal Communications Commission) Rules and Regulations, Part 15, Subpart J, Class A certified compliance.
- C. UL (Underwriters Laboratories) 1778 Listed (Rev. Jan 5, 2000), UL497A
- D. CSA 22.2, No. 107.1 M95 AND 107.2
- E. IEC 62040-2 Emission and Immunity
- F. IEC 62040-3 (Uninterruptible Power Systems, Part 3)
- G. EN 60529 Equipment Protection
- H. National Electric Code (NFPA-70)
- I. ISO 9001

1.05 QUALITY ASSURANCE

- A. UPS systems shall utilize a field proven design. The UPS manufacturer shall demonstrate at least ten years of continuous field operating experience with equipment of similar size and design.
- B. Submit the name and address of the factory authorized service and parts organization. The manufacturer shall have a complete selection of service options that may include onsite service by factory-employed service engineers and factory depot quick-return service plan options.
- C. Equipment shall be UL or ETL labeled.
- D. The UPS manufacturer shall have ISO 9001 certification.
- E. The system shall meet or exceed the following theoretical Mean Time Between Failures (MTBF):
 - 1. Single module UPS operation (represents UPS module operation only): 140,000 MTBF hours

1.06 SYSTEM DESCRIPTION

- A. The UPS shall be a continuous-duty, on-line, solid state, dual conversion, single-phase uninterruptible power system. The UPS shall provide power conditioning and power backup for computer, communication, and other critical electronic loads as indicated on the Drawings.
- B. The UPS shall be installed in a stand-alone cabinet and distribute power to the Security Panel, Communications Panel and SCADA Panel. The stand alone cabinet shall be rack mountable.

- C. The UPS system shall consist of the following major components:
 - 1. Rectifier and battery charger
 - 2. Inverter
 - 3. Sealed maintenance-free VRLA batteries and battery disconnect switch.
 - 4. Automatic static bypass switch
 - 5. Optional maintenance bypass switch.
 - 6. Integral control and monitoring panel
 - 7. Other features as described in this specification and as indicated on the Drawings.
- D. Refer to the Drawings for additional requirements and details.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Refer to Electrical Specification Division.
- B. Store the equipment indoors in a clean, dry, heated storage facility until ready for installation. Do not install the equipment in its final location until the facilities are permanently weather tight. Furnish, install and wire temporary electric space heaters in the equipment until the permanent heating equipment is operational. Protect the equipment at all times from exposure to moisture and chemicals.

1.08 OPERATING INSTRUCTION

- A. After approval, during and after construction, operating manuals covering instruction and maintenance on each type of equipment shall be furnished in accordance with Sections 17300.

1.09 WARRANTY

- A. Battery: In addition to the basic warranty, the UPS manufacturer shall warrant the batteries for a period of 36 months from the date of equipment startup or 42 months from date of receipt by end user, whichever occurs first.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. All cabling required to interconnect all components of the UPS system (including but not limited to the maintenance bypass, external battery enclosure, etc) shall be provided by the UPS manufacturer.
- B. Battery protection shall be provided an internal circuit breaker disconnect. Battery cabinets shall be protected by an internal circuit breaker.
- C. Current limiting circuitry shall protect the inverter output under any load condition. High speed semiconductor fusing shall protect the static bypass in the event of an output short circuit.

- E. The AC output neutral shall be electrically isolated from the UPS chassis. The UPS chassis shall have an equipment ground terminal. Provisions for installation of a bonding connector shall be provided.
- F. The UPS shall be suitable for installation at the location as shown on the Drawings.

2.02 PERFORMANCE REQUIREMENTS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Tripp Lite SmartOnline SU/750/1000/1500/2200/3000 XLCD with additional SNMPWEBCARD card and battery packs as needed to provide 2 hours runtime at 125% of constant load.
 - 2. If 3000kVA is exceeded, provide an additional UPS and batteries as needed.
 - 3. UPS and batteries shall be rack mountable U form in a Tripp Lite SR5 series cabinet.
- B. Ratings
 - 1. Output power: Reference section above.
 - 2. Battery runtime: 2 hours at full load.
- C. The UPS shall comply with the following requirements:
 - 1. Environment:
 - a. Ambient temperature: 0 to 40° C.
 - b. Elevation: Up to 500-ft above mean sea level
 - c. Relative humidity: 0 to 95 percent non-condensing
 - 2. System Input – Primary source:
 - a. Single input: Reference table under section 1.01.A
 - b. Frequency: 60 Hertz plus or minus 5 percent.
 - c. Input Power Factor: 0.96 lag minimum, 50 to 100 percent load.
 - d. Input Current Total Harmonic Distortion (THD) : <33 percent.
 - e. Input Surge Withstand Rating: Per IEEE 587/ANSI C62.41. Category A and B, (6kV)
 - 3. System Output:
 - a. 120 VAC
 - b. Frequency: 60 Hertz plus or minus 3 Hertz.
 - c. 100 percent load with 3:1 Crest Ratio
 - d. Frequency Slew Rate: 1 Hz/second. (Adjustable at startup)
 - 4. AC to AC Efficiency: (100 percent load @ rated PF): 91 percent
 - 5. Acoustical Noise: Noise generated by the UPS under normal operation shall not exceed 65 dBA (60 dBA typical) at one meter from any surface, measured at 25 degrees C (77 degrees F) and full load.
 - 6. EMI Suppression: The UPS shall meet FCC Rules and Regulation 47, Part 15, Subpart J, for Class A devices.

2.03 MODES OF OPERATION

- A. The UPS shall operate as a double conversion on-line, fully automatic system in the following modes:
 - 1. Normal: The critical load shall be continuously supplied with filtered and regulated AC power by the inverter. The rectifier/battery chargers shall derive power from the

preferred AC source and supply DC power to the inverter while simultaneously floats charging the batteries.

2. Emergency: Upon failure of the preferred ac power source, the critical load shall continue to be supplied by the inverter. Inverter power shall be supplied without switching from the storage battery. There shall be no interruption to the critical load upon failure or restoration of the preferred ac sources. If neither AC source can be restored before the battery discharges to its low voltage dropout value, the UPS shall automatically shut itself down in an orderly manner.
3. Recharge: Upon restoration of the preferred ac source, the rectifier/battery charger shall power the inverter and simultaneously recharges the batteries. This shall be an automatic function causing no interruption to the critical load.
4. Bypass Mode: The automatic bypass shall transfer the critical load to the commercial AC source, bypassing the UPS' inverter/rectifier, in the case of an overload, load fault, or internal failure.
5. Maintenance Mode: If the UPS is taken out of service for maintenance or repair, the external manual bypass switch shall be operated to transfer the load to the alternate source. This transfer shall occur without interruption.
6. Downgrade: If the batteries alone are taken out of service, they shall be disconnected by battery circuit breakers. The UPS shall continue to function and meet all of the performance criteria specified herein, except for the reserve time capability.

2.04 RECTIFIER/CHARGER

- A. The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging. The rectifier/charger shall be a solid-state SCR/IGBT power transistor type with constant voltage/current limiting control circuitry.

2.05 INVERTER

- A. The inverter shall include all solid-state equipment and controls to convert DC power from the rectifier/charger or battery to a regulated AC power for powering the critical load. The inverter shall use Insulated Gate Bipolar Transistors (IGBTs) in a phase-controlled, pulse width modulated (PWM) design capable of providing the specified AC output.
- B. The inverter shall be capable of supplying current and voltage for overloads exceeding 100 percent. The inverter is to provide 150 percent of full load for 30 seconds and 125 percent of full load for 2 minutes. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.
- C. The output voltage shall be maintained to within plus or minus 4 percent.
- D. The output voltage total harmonic distortion shall not be greater than 5 percent for all loads. For 100 percent rated load of 3:1 crest factor nonlinear loads, the output voltage total harmonic distortion shall not be greater than 4 percent. The output rating shall not be derated in kVA or kW due to the 100 percent nonlinear load with 3:1 crest factor.
- E. The inverter shall use software control to adjust the output voltage from plus or minus 5 percent of the nominal value.

2.06 BATTERIES

- A. The batteries shall be VRLA (valve-regulated lead-acid), sealed, maintenance-free, high-rate discharge, lead-acid cells suitable for use indoors with no off gassing, water addition requirements. Batteries shall not require special ventilation. The battery shall consist of one or more battery banks with the number of cells required to meet the requirements of the rest of these specifications.
- B. Battery Design Life: 5 year
- C. Run time operation of the UPS shall be accomplished using batteries mounted within the UPS enclosure and supplemented as required with an external battery enclosure to provide the battery runtime specified.

2.07 STATIC TRANSFER SWITCH

- A. A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be a naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously. The switch shall have an overload rating adequate to clear a 20-ampere load branch circuit breaker.
- B. The static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS, or for bypassing the UPS for maintenance.
- C. The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:
 - 1. Inverter overload
 - 2. Critical AC load over voltage or under voltage
 - 3. Battery protection period expired
 - 4. UPS fault condition
- D. The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present:
 - 1. Inverter/bypass voltage difference exceeding preset limits
 - 2. Bypass frequency out of limits
 - 3. Bypass out-of-synchronization range with inverter output
- E. Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:
 - 1. Bypass out of synchronization range with inverter output
 - 2. Inverter/bypass voltage difference exceeding preset limits
 - 3. Overload condition exists in excess of inverter full load rating
 - 4. UPS fault condition present

2.08 MAINTENANCE BYPASS

- A. Internal Maintenance Bypass Switch
 - 1. A manually operated make-before-break maintenance bypass switch shall be incorporated into the UPS cabinet to directly connect the critical load to the bypass AC input power source, bypassing the rectifier/charger, inverter, and static transfer switch.
 - 2. All energized terminals shall be shielded to ensure that maintenance personnel do not inadvertently come in contact with energized parts or terminals. A means to de-energize the static switch shall be provided when the UPS is in the maintenance bypass mode of operation.
 - 3. With the critical load powered from the maintenance bypass circuit, it shall be possible to check out the operation of the rectifier/charger, inverter, battery, and static transfer switch.

- B. External Maintenance Bypass Switch
 - 1. A matching external make-before-break maintenance bypass switch installed in a separate cabinet shall be provided to enable the UPS module to be completely isolated from the electrical system while the critical load is powered through the external maintenance bypass line.
 - 2. This maintenance bypass switch shall provide make-before-break operation for transfers to and from the external maintenance bypass line with a single rotary switch.
 - 3. The following components shall be included: input and output circuit breakers, single rotary switch with auxiliary contacts, inter-cabinet wiring, casters, and leveling feet. Voltage matching transformers and isolation transformers shall be included as required for proper system operation.
 - 4. This matching cabinet shall bolt to the side of the UPS module with a barrier shield to separate the two cabinets. Only front access shall be required for installation and service.

2.09 CONTROLS

- A. Microprocessor-controlled circuitry: Fully automatic operation of the UPS shall be provided through the use of a microprocessor-based controller. All operating and protection parameters shall be firmware-controlled. The logic shall include system test capability to facilitate maintenance and troubleshooting. Startup, battery charging, and transfers shall be automatic functions. The UPS shall be capable of being programmed for auto-restart.

- B. Graphical Display: The UPS control panel shall utilize an LCD graphical display for all UPS control, monitoring, alarming, configuration and diagnostic functions. The graphical display shall have the following features:
 - 1. System mimic diagram with an outlined power path and current operating mode.
 - 2. Menu driven display with pushbutton or soft key navigation
 - 3. Real time clock display (time and date)
 - 4. Alarm history display (with time and date stamp) for displaying a historical log of the latest 500 system events
 - 5. Configuration, setup and system information: Display serial communication port configuration, firmware revision and other system setup and statistic information.

- C. Controls: As a minimum, the following operational controls and indicators shall be provided on the UPS control panel:
1. UPS On/Off control
 2. Emergency Power Off control
 3. Alarm reset control
 4. Battery in operation status
 5. Rectifier / charger in operation status
 6. Load on Inverter status
 7. Load on By-Pass status
 8. UPS malfunction alarm
- D. Metering: The following parameters shall be provided with 1 percent minimum accuracy metering on the UPS control panel:
1. AC input voltage (line to line)
 2. AC input current (each phase)
 3. AC input power (kW, KVA and power factor)
 4. DC battery voltage
 5. Battery current (charge and discharge)
 6. AC output voltage (line to line and line to neutral)
 7. AC output current (each phase)
 8. AC output frequency
 9. AC output power (kW, KVA and power factor)
- E. Diagnostic Alarms: Specific details for all UPS alarms and status parameters shall be indicated on the graphical panel for diagnosis. As a minimum, the following parameters shall be provided in user friendly text format:
1. Input power out of tolerance
 2. Battery charger problem
 3. Battery failed test
 4. Low battery warning
 5. Low battery shutdown
 6. DC bus over voltage
 7. Bypass frequency out of range
 8. Load transferred to bypass
 9. Excessive retransfers
 10. Static bypass switch failure
 11. UPS output not synchronized to bypass power
 12. Output under voltage
 13. Output over voltage
 14. Output over current
 15. System overload
 16. Over temperature
 17. AC input current (each phase)
 18. External shutdown control activated
- F. Each UPS shall provide Ethernet connectivity to tie into the Plant Control System network. Status alarm and performance information shall be integrated with the HMI for alarming and indication purposes.

2.10 BATTERY RUNTIME/HEALTH MONITORING

- A. Battery Runtime Monitoring: UPS shall monitor battery and provide status to end user of battery run time via front panel, serial communications, or both. Run time calculation to be based on load demand and analysis of battery health.
- B. Battery Health Monitoring: UPS shall continuously monitor battery health and the UPS will provide warnings visually, audibly and/or via serial communications when battery capacity falls below 80% of original capacity. Battery testing may also be user-initiated via the front panel or serial communications.

2.12 FACTORY TESTING

- A. Prior to shipment, the complete UPS system shall undergo the manufacturer's standard factory test.
- B. Certified factory tests shall be submitted for review and approval before shipment. Certified tests shall include the UPS equipment serial number.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install and connect the equipment in accordance with the manufacturer's instructions.
- B. Remove temporary lifting angles, lugs and shipping braces.
- C. Touch up damaged paint finishes.

3.02 FIELD TESTING

- A. Perform the following minimum test and checks before the manufacturer's field service technician is called for testing and adjustment:
 - 1. Verify that all connections are completed in accordance with shop drawings.
 - 2. Verify supply voltage and phase sequence are correct.
 - 3. Check mechanical interlocks for proper operation.
 - 4. Test ground connections for continuity and resistance.
 - 5. Check control circuit interlocking and continuity.
- B. Submit the test plan for review and approval.
- C. In the event of an equipment fault, notify the Engineer and Owner immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the PCSI, the Construction Manager and the equipment manufacturer's factory service technician. Repair or replace the equipment as directed by the Construction Administrator.

3.03 ADJUSTMENT

- A. Make all UPS adjustments necessary for manual and automatic operation of the entire system.

3.04 CLEANING

- A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

3.05 TRAINING

- A. Provide training in accordance with Section 17302.

END OF SECTION

SECTION 17400

CONTROL LOOP DESCRIPTIONS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. This section describes existing and proposed equipment and system components and their intended operation via control loop descriptions which will be used for the programming integration into the proposed La Rosa and existing Pitluk SCADA Systems.

1.02 RELATED WORK:

- A. Division 16, Electrical
- B. Division 17, Instrumentation

1.03 ACRONYMS:

- A. Comp – Computer
- B. GPM – Gallons per Minute
- C. GST – Ground Storage Tank
- D. HMI – Human Machine Interface at SAWS Production Control Room
- E. HSP- High Service Pump
- F. MCC – Motor Control Center
- G. MG – Million Gallon
- H. MGD – Million Gallons per Day
- I. PLC – Programmable Logic Controller
- J. PS – Pump Station
- K. RTD – Resistance Temperature Detectors
- L. SCADA – Supervisory Control and Data Acquisition
- M. SCP – SCADA control panel
- N. SL – Service Level
- O. WP – Well Pump

1.04 TERMS AND DEFINITIONS:

- A. SAWS Production Control Room – SCADA Control Room used by SAWS Headquarters located at the SAWS Main Office just north of downtown at 2800 US Hwy 281, near East Mulberry Avenue.
- B. La Rosa SCADA Panel – The proposed panel located on-site at the La Rosa Facility.

- C. Pitluk SCADA Panel – The existing panel located on-site at the Pitluk Facility.
- D. Local Operation – Describes the manual operation of a device or piece of equipment at the La Rosa and Pitluk Facilities which includes SCADA Panel, MCC, Switchboard and local equipment panels.
- E. Remote Operation – Describes the operation of a device or piece of equipment from the SAWS Production Control Room located at 2800 US Hwy 281 North.
- F. Motor Protection Relay Tripped– Protection feature which analyzes or detects electrical faults from the motor.

1.05 GENERAL DESCRIPTION:

- A. The goal of the La Rosa Facility is to supply water to SAWS pressure zone 790. The main objective of this construction project is to upgrade the system components based on current code and safety requirements. Improvements will include upgrades to the civil, electrical, chemical and mechanical systems of the facility.

Improvements at the Pitluk Facility will include the addition of a fluoride facility, chlorine system upgrades, well pump control upgrades and well pump control valve additions. Only proposed equipment is included in this specification.

- B. The equipment that controls the operating strategy of the La Rosa Facility includes:
 1. Tank Level Electrodes which include B/W Level Control System at an existing GST.
 2. One (1) GST Pressure Indicating Transmitter.
 3. One (1) HSP Discharge Pressure Indicating Transmitter.
 4. Four (4) Proposed Vertical Turbine High Service Pumps.
 5. One (1) HSP PRV.
 6. One (1) Altitude Valve
 7. Four (4) Proposed Electromagnetic Type Flowmeters for High Service Pumps
 8. One (1) Proposed SCADA Panel Internal Temperature Monitor.
 9. Four (4) Proposed Motor Protection Relays.
 10. Proposed Power Supply.
 11. One (1) Proposed Standby Diesel Generator
 12. One (1) Proposed Automatic Transfer Switch
 13. Switches for Electrical Building Doors and SCADA Panel
 14. Temperature Switches for Electrical Building Rooms

15. Two (2) Analyzers for Measurement of pH, Temperature, Fluoride Residual and Chlorine Residual.
16. One (1) Ground Storage Tank Sample Line Flow Switch

C. The equipment that controls the operating strategy of the Pitluk Facility includes:

1. One (1) Proposed Fluoride Facility
2. Two (2) existing Chlorine Booster Pump (Power and Controls to be added for one of the pumps)
3. Two (2) existing Well Pumps. (Controls to be modified to add two control valves)
4. Level from La Rosa Tank to be used to start/stop existing well pumps at Pitluk through the Top End communication.

PART 2 - PRODUCTS

2.01 LA ROSA - TANK ELECTRODE CONTROL SYSTEM AT GROUND STORAGE TANK:

The Level Electrode Control System provides the following monitoring and control functions:

- 1) High Level Alarm
- 2) Low Level Alarm
- 3) Overflow Level Alarm
- 4) Pitluk Lead Well Start/Stop
- 5) Pitluk Lag 1 Well Start/Stop
- 6) Pitluk Lag 2 Well Start/Stop (Future)

Tag Nos.: LE-100, LE-101, LE-102, LE-103, LE-104, LE-105

Local

- None.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- Alarms based for high, low and overflow levels are sent to the SAWS Production Control Room HMI.
- Tank levels for start/stop of wells pump are sent via the Broadband radio network to the SAWS Production Control Facility and back to the Pitluk Facility.

2.02 **LA ROSA - GROUND STORAGE TANK PRESSURE INDICATING TRANSMITTER:**

One (1) proposed pressure indicating transmitter located at the Tank Control Rack.

Tag No.: LIT-101

Local (Manual)

- The operator can read the pressure transmitter from the La Rosa SCADA Panel as well as at the transmitter.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The water level inside the tank is sent to the SAWS Production Control Room HMI.

2.03 **LA ROSA - VERTICAL TURBINE CENTRIFUGAL PUMPS:**

A total of 4 vertical turbine centrifugal pumps are proposed. High service pumps have a rated head and capacity of 140 ft and 4 MGD, respectively.

The pumps will operate based on the following criteria:

- Water Level in the ground storage tank must be greater than XXXX ft (XXXX ft) set by a Mercoid switch with sensing line tapped at the can of each pump.

Tag Nos.: HSP-201, HSP-202, HSP-203, HSP-204

Pump Operation Sequencing Strategy:

1) Each HS Pump can be started by one of the following methods:

a. Manually by Operator in SAWS Production Control Room:

- Pumps turn on by receiving a digital output from PLC (via K3 and K5 relays) from SAWS SCADA System.
- SCP/MCC Switch (HS-1) on SCADA panel must be in SCP position.
- COM/Manual Switch (HS-2) on SCADA panel must be in COM position.

b. Manually from MCC:

- SCP/MCC Switch (HS-1) on SCADA Panel must be in MCC position.
- Start/Stop Switch (CS1) at MCC must be turned to Start position.

- c. Manually from SCADA Panel:
 - i. SCP/MCC Switch (HS-1) on SCADA panel must be in SCP position.
 - ii. COM/Manual Switch (HS-2) on SCADA panel must be in Manual position.
 - iii. Start/Stop Switch (HS-3) on SCADA Panel must be turned to Start position.

2) Upon startup, a HS Pump remains in operation until one of the following occurs:

- a. Automatically shut off by the Mercoird switch with tap located in the pump's column pipe (due to the low water level in La Rosa's GST.)
- b. Automatically shut off due to the activation of lockout relay:
 - i. Motor Protection Relay Lockout output alarm is initiated.
 - ii. Valve Incomplete Sequence Alarm is initiated.
- c. Automatically shut off by Motor Thermal Overload Protection.
- d. Automatically shut off by Motor Protection Relay Fail-Safe Trip Alarm initiation.
- e. Manually shut off due to the activation of lockout relay:
 - i. Emergency Stop Pushbutton (PB1) on MCC is pressed.
 - ii. Emergency Stop Pushbutton (PB2) on HSP Local Control Panel is pressed.
- f. Manually shut off by switch CS1 at MCC.
- h. Manually shut off by Operator in SAWS Production Control Room:
 - i. SCP/MCC Switch (HS-1) on SCADA panel must be in SCP position.
 - ii. COM/Manual Switch (HS-2) on SCADA panel must be in COM position.

Local

- The horizontal split-case centrifugal high service pumps can be turned on/off in the field by the MCC, SCADA Control Panel (SCP) or HSP Local Control Panel.
 - Pump On/Off Status can be seen on the SCADA panel and MCC.
 - Lockout Tripped Status can be seen at the MCC.

Remote

- The pumps can be manually turned on/off from the SAWS Production Control Room.

SCADA Interface

- The PLC sends a signal to the SAWS Production Control Room HMI indicating each pumps status:
 - On/Off status
 - The control status of 2 separate modes:
 - Comp/Manual Switch Position

- SCP/MCC Switch Position
- The pump Motor Protection Relay is connected via Ethernet to the switch in the SCADA Panel. SAWS operators can connect to this with a laptop computer to obtain relay status/data.
- The PLC monitors the status of the high service pumps and warns the operator with an alarm:
 - MPR Alarm
 - MPR Trip Alarm
 - Low Water Cutoff (Mercoïd Switch) Alarm
 - Motor Lockout (86) Alarm
 - Soft Starter Fail Alarm

2.04 **LA ROSA - MOTOR OPERATED BALL VALVES FOR VERTICAL TURBINE CENTRIFUGAL HIGH SERVICE PUMPS:**

A total of four (4) motor operated ball valves will be located on the La Rosa Facility High Service Pump discharge piping. The corresponding pump control valve will slowly open when a pump is called to run and slowly close when a pump is called to stop. Pumps will be interlocked with the valve so that they will start when the valve is fully closed.

Tag Nos.: 12-BV-201, 12-BV-202, 12-BV-203, 12-BV-204

Valve Operation Strategy:

- 1) Each Valve can be opened by of the following methods:
 - a. Automatically by Run Indication from HSP:
 - i. Valve opens by receiving a HSP Run contact from MCC HSP Starter.
 - ii. Hand-Off-Auto Switch on Valve Control Panel must be in Auto position.
 - b. Manually from Valve Control Panel:
 - i. Hand-Off-Auto Switch on Valve Control Panel must be in Hand position.
 - ii. Start Pushbutton (PB-3) on Valve Control Panel must be pressed.
- 2) The Valve remains in Open Position until one of the following occurs:
 - a. Valve is Manually closed:
 - i. By Operator in SAWS Production Control Room (via relay K2 when a High Service Pump is called to Stop).
 - ii. Manually from Valve Control Panel:

1. Hand-Off-Auto Switch on Valve Control Panel must be in Hand position.
2. Stop Pushbutton (PB-4) on Valve Control Panel must be pressed.

iii. Manually from MCC HSP Starter:

1. Hand-Off-Auto Switch on Valve Control Panel must be in Auto position.
2. Control Status Switch on SCADA Panel must be in MCC position.
3. Control Switch (CS1) on MCC HSP Starter must be turned to Stop position.

b. Valve is Automatically closed:

- i. By the Mercoid switch with tap located in the pump's column pipe (due to the low water level in La Rosa's GST.)
- ii. By the shutdown of the HSP motor by trip (via MX relay).

Local

- The motor operated ball valves can be opened/closed in the field by the Valve Control Panel.
- Valve open/closed status can be seen on the SCADA panel, Valve Control Panel and MCC HSP Starter.

Remote

- The pumps (interlocked with the valves) can be manually turned on/off from the SAWS Production Control Room.

SCADA Interface

- The PLC sends a signal to the Production Control Room indicating each valve status:
 - Open status
 - Closed status
- The control status:
 - Valve Manual/Auto Mode Switch Status (from Valve Control Panel)

2.05 **LA ROSA – HIGH SERVICE PUMP PRV:**

One (1) proposed PRV located at HSP area.

Tag No.: PRV-101

Local (Manual)

- Valve Open and Closed status can be read from the SCADA Panel.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- Valve Open and Closed Status is sent to the SAWS Production Control Room HMI.

2.06 **LA ROSA – ALTITUDE VALVE:**

One (1) proposed altitude valve.

Tag No.: AV-101

Local (Manual)

- Valve Open and Closed status can be read from the SCADA Panel.
- Valve can be put in Hand, Off or Auto mode from the SCADA Panel.

Remote Manual

- Valve Open command is sent to the valve from the SAWS Production Control Room HMI.

Remote Automatic

- None.

SCADA Interface

- Valve Open and Closed Status is sent to the SAWS Production Control Room HMI.
- Valve in Auto Mode status is sent to the SAWS Production Control Room HMI.

2.07 **LA ROSA - MAGNETIC TYPE FLOWMETERS:**

SAWS operators will be able to monitor the flow at various points via the La Rosa Facility SCADA system. The amount of water flow through (and totalized flow) the following will be monitored by the SCADA system:

- High Service Pump Discharge (4 new)

Tag Nos.: 12-FM-201, 12-FM-202, 12-FM-203, 12-FM-204

Local (Manual)

- Operators can locally see a flow reading at each flowmeter panel and at the SCADA Panel.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC sends a signal back to the SAWS Production Control Room indicating the individual real-time flow from each flowmeter.
- Flowmeters send data by MODBUS to the PLC.
- The range of the meters shall be calibrated and recorded in MGD on Production Control

Room HMI and in GPM on the local display based on pump capabilities.

2.08 **LA ROSA - PRESSURE TRANSMITTERS: SYSTEM PRESSURE**

One (1) pressure indicating transmitter will be located at the site. The transmitter will be installed on the High Service Pump discharge header.

Tag No.: PIT-101

Local (Manual)

- The operator can read the pressure transmitter from SCADA Panel as well as at the transmitter.
- The PLC calculates and provides high and low pressure indication via indication lights at the SCADA Panel.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC sends a signal to the control room indicating the pressure at the installed location.

2.09 **LA ROSA - SCADA PANEL INTERNAL TEMPERATURE MONITORS:**

The SCADA Panel uses an internal temperature sensor/transmitter (RTD) to monitor the temperature of the SCADA Panel. The temperature transmitter is only monitored by the SCADA system.

Tag Nos.: SPT-101

Local (Manual)

- None.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC sends the temperature to the SAWS Production Control Room. The operators can read the temperature in degrees Fahrenheit.
- The PLC monitors the status of the temperature transmitters and alerts the Production Control Room operator with a high temperature alarm.

2.10 LA ROSA - MOTOR PROTECTION RELAY:

This relay is a multifunction relay device used to monitor and protect the pump motors. Select information provided by the relay will be monitored by the SCADA system.

Tag Nos.: MPR-01, MPR-02, MPR-03, MPR-04

Local

- Status, Alarms and other data can be obtained directly from the relay located in each pump MCC section.
- The relay can be programmed in the field by connection directly to the relay of the network switch located in the SCADA Panel

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC monitors the status of the relay via an Ethernet connection.
- The PLC monitors two outputs from the relay:
 - MPR Alarm (via interposing relay)
 - RTD Alarm (via interposing relay)

2.11 LA ROSA - DOOR SWITCHES:

Door switches will be installed on the following Electrical Building doors. Switches shall be as specified in Section 17550 and shared with security system.:

- SCADA Room Door #1
- SCADA Room Door #2
- Electrical Building Door #1
- Electrical Building Door #2

Tag Nos.: DS-1, DS-2, DS-3, DS-4

Local

- None.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC monitors the status of the door switches and sends an alarm to the SAWS Production Control Room HMI when a door is opened. The door name will be indicated with the alarm.

2.12 **LA ROSA – ELECTRICAL BUILDING TEMPERATURE SWITCHES:**

One switch will be installed in the Electrical Room and one switch will be installed in the SCADA room

Tag Nos.: TS-1, TS-2

Local

- None.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC monitors the status of the temperature switches and alerts the SAWS Production Control Room HMI with a high temperature alarm. Each room to have separate alarm.

2.13 **LA ROSA – ANALYZERS FOR MEASUREMENT OF PH, TEMPERATURE, FLUORIDE RESIDUAL AND CHLORINE RESIDUAL:**

Two (2) analyzers will each be installed on each Ground Storage Tank sample tap line.

Tag Nos.: AIT-101, AIT-102

Local

- Local display indicating the measured parameter can be read at each analyzer.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The following data will be sent to the SAWS Production Control Room HMI :
 - GST Chlorine Residual (PPM)
 - GST Fluoride Residual (PPM)
 - GST Temperature
 - GST pH Level

2.14 **LA ROSA – GROUND STORAGE TANK SAMPLE LINE FLOW SWITCH:**

One switch will be installed on the sample line of the Ground Storage Tank.

Tag Nos.: FS-101

Local

- None.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC monitors the status of the flow switches and alerts the SAWS Production Control Room HMI with an alarm.

2.15 **LA ROSA - POWER SUPPLY:**

- The SCADA system monitors additional parameters related to the Power Supply. UPS data including system health, battery voltage and status via Ethernet connection can be obtained over SAWS network system as this data is not monitored by the PLC.

Tag Nos.: UPS-01, K7 relay

Local

- None.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC monitors the status of the SCADA panel K7 relay (which is used for SCADA System Power Status) and reports it to the SAWS Production Control Room HMI

2.16 **LA ROSA - STANDBY DIESEL GENERATOR:**

This generator will be installed to provide back-up power for the, Electrical System, SCADA Panels, Security Panel, Instrumentation and Communication System

Tag Nos.: GEN-01

Local

- Operators can locally see generator status at the generator Local Control Panel supplied by the manufacturer.

Remote Manual

- None.

Remote Automatic

- An Automatic Transfer Switch will monitor the power and send a start signal to the generator as necessary.

SCADA Interface

- The PLC monitors the generator status and sends data back to the SAWS Production Control Room HMI indicating the following:
 - Generator Run Status
 - Generator Fuel Leak
 - Generator Low Fuel
 - Generator General Alarm

2.17 **LA ROSA - AUTOMATIC TRANSFER SWITCH:**

This transfer switch will be installed to provide back-up power for the, Electrical System, SCADA Panels, Security Panel, Instrumentation and Communication System.

Tag Nos.: ATS-01

Local

- Operators can operate the switch locally from the switch control panel.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The PLC monitors the switch status sends a signal back to the SAWS Production Control Room HMI indicating the following:
 - Switch in Emergency Mode
 - Switch General Alarm

2.18 **PITLUK - FLUORIDE SYSTEM:**

The SCADA system monitors and controls Fluoride System equipment:

METERING PUMPS:

There will be two (2) of these pumps that will be flow paced based off the existing flow meters connected to each of the groundwater wells. The signal for flow pacing will be routed from the PLC located in the existing SCADA Panel.

Tag Nos.: MP-1, MP-2

Local (Manual)

- The following status information will be viewable at each pump's Local Control Panel:
 - Pump Run Indication
 - Pump Alarm Indication
 - Pump Pressure Alarm High Indication
 - Pump Speed
- The pump can be put in to Hand, Off, or Auto Modes via a switch on the Local Control Panel.
- The pump can reset via a switch on the Local Control Panel.

Local (Automatic)

- The existing PLC will send a 4-20mA speed signal to the pump based on the following data which will form a loop:
 - Total Well Flow
- The existing PLC will send a Start/Stop signal to the pump based on flow set point values.

Remote Manual

- None

Remote Automatic

- None

SCADA Interface

- The following data per pump will be sent to the Production Control Room HMI:
 - Local/Remote Indication
 - Run Status
 - Failed Status
 - Leak Alarm
 - Speed Indication
 - High Discharge Pressure Alarm

FLUORIDE FLOWMETER:

There will one (1) flowmeter monitoring the total fluoride flow.

Tag Nos.: FIT-300

Local

- Operators can locally see a flow reading at each flowmeter panel.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The following data is sent to the SAWS Production Control Room HMI:
 - Fluoride Flow

FLUORIDE STORAGE TANK:

There shall be a storage tank filled with fluorosilicic acid with a level control system.

Tag Nos.: 300-TNK-01, LIT-301

Local

- The following status information will be viewable at the tank's Fill Station Panel via the Level Transmitter (LIT-301):
 - Tank Level Indication
 - Tank High Level Indication (Alarm siren and light is activated also)
 - Low Level Indication (Alarm siren and light is activated also)
- The level alarm siren can be silenced via a switch on the Local Control Panel.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The following data will be sent to the Production Control Room HMI:
 - Tank Level
 - High Level Alarm
 - Low Level Alarm

SUMP PUMP:

There will be two (2) float switches monitoring leaks and one (1) float switch for run permissive. The sump pump will operate only in manual mode so that leaks can be accessed and contained.

Tag Nos.: SP-01, LS-100, LS-200, LS-300

Local

- Operator can view the following at the sump control panel:
 - High and high high level alarm status.
 - Pump run status.
- Operator can perform the following functions at the sump pump control panel
 - Start and Stop Pump.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The following data will be sent to the Production Control Room HMI:
 - Sump Pump High Level
 - Sump Pump High High Level

EYEWASH/SHOWERS:

There will be two (2) eyewash/shower stations. One will be in the Fluoride Building and the other in the Tank Containment Pit.

Tag Nos.: EW-01, EW-02

Local

- None.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The following data will be sent per each eyewash/shower to the Production Control Room HMI:
 - In-Use status.

LEAK CONTAINMENT SYSTEM FOR MANHOLES:

A leak containment system will be installed for the fluoride injection lines. The system will have a control panel which will indicate if leaks are occurring.

Tag Nos.: LS-100

Local

- Operator can view leak status at the Leak Containment System Control Panel.

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The following data will be sent to the Production Control Room HMI:
 - Leak status.

DISCHARGE VALVE:

A motorized valve will be installed on the discharge line of the fluoride tank. It will be installed with a control panel that will accept readings from a flow switch upstream of the valve. The valve shall operate as follows:

- It shall open when any metering pump is running.
- It shall close when both pumps are off.
- It shall close when a leak is detected by way of a high high flow input from the flow switch to the PLC.

Tag Nos.: 300-BV-8, FSH-300

Local

- Operator can view the following at the Valve Control Panel:
 - Valve Open status
 - Valve Closed status
 - Discharge High High Flow
 - Local/Remote status
- Operator can perform the following functions at the Valve Control Panel:
 - Open/Close Valve
 - Select Local, Off or Remote Mode

Remote Manual

- None.

Remote Automatic

- None.

SCADA Interface

- The following data will be sent to the Production Control Room HMI:
 - Valve Open status
 - Valve Closed status
 - Discharge High High Flow
 - Local/Remote status

2.19 **PITLUK - CHLORINE SYSTEM:**

The following equipment will be added to the existing Chlorine System:

- Controls for a 2nd Booster Pump No. 2
- Control modifications for Booster Pump No. 1

Tag Nos.: BP-02

Local

- None.

Remote Manual

- The Booster Pumps can be manually started and stopped from the existing MCC.

Remote Automatic

- None. The Booster Pumps will be electrically interlocked.

SCADA Interface

- The following data will be sent to the Production Control Room HMI:
 - Booster Pump No. 1 Run
 - Booster Pump No. 2 Run

2.20 **PITLUK - WELLS:**

A total of two (2) well pumps are located at the Pitluk Facility. Both Pitluk well pumps will be controlled by the water level in the La Rosa GST. The well controls will be modified as follows:

Tag Nos.: WP-02, WP-03

Local

- Level selector switch to be removed in MCC as shown in plans.

Remote Manual

- No modifications.

Remote Automatic

- Pump Start/Stop signal from the level probes in the La Rosa Tank will be sent via the SCADA Network to the existing Pitluk PLC.

SCADA Interface

- Level probe data from La Rosa Tank will be transmitted over the SCADA network as described above. The following levels will be received from La Rosa:
 - Lead Well Start/Stop
 - Lag 1 Well Start/Stop
 - Lag 2 Well Start/Stop (For future use)

2.21 PTILUK – WELL PUMP CONTROL VALVE:

A total of two (2) new well pump control valves shall be located at the Pitluk Facility. Each control valve shall be downstream of its associated well pump.

Tag No.: FCV-02, FCV-03

Valve Operation Strategy:

The control valve is interlocked with the pump start and stop commands. The control valve is controlled via the well pump hand-off-auto switch.

Local (Manual)

- Valve Open and Closed status are indicated on the well pump MCC section and the SCADA Panel.
- Valve can be placed in Hand, Off or Auto mode from the well pump MCC section.

Remote Manual

- Interlocked with well pump on/off control.

Remote Automatic

- None.

SCADA Interface

- Valve Open and Closed Status is sent to the SAWS Production Control Room HMI.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 17405**INPUT/OUTPUT LIST****PART 1 - GENERAL**

1.01 SCOPE:

- A. This Section includes the Input/Output List.

1.02 RELATED SECTIONS:

- A. Section 17300 Instrumentation General Provisions including coordination meeting required between various parties involved with controls programming.
- B. Section 17400 Control Loop Descriptions

1.03 SUBMITTALS:

- A. Refer to Section 17305 Applications Services and Section 17300 Instrumentation General Provisions.

1.04 SYSTEM DESCRIPTION:

- A. The Input/Output List provides the minimum physical signal requirements of the control loops represented in the Contract Documents. Additional software integrated signals as required to fully implement the strategies as described in these specifications shall be included.
- B. The Input/Output List is not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions, but is rather intended to supplement and complement the drawings and other specification sections. The Input/Output List shall not be considered equal to a bill of materials.
- C. Provide instrumentation hardware and software as necessary to perform control functions specified herein and as shown on drawings.

1.05 INPUT OUTPUT LISTING:

- A. The Input/Output List follows in Appendix A.

PART 2 - PRODUCTS (NOT USED)**PART 3 - EXECUTION**

3.01 INSTALLATION:

- A. All inputs and outputs listed shall be programmed in the system as specified herein and shall be installed, field adjusted and tested as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

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SAWS
La Rosa Pump Station Rehab
LA ROSA FACILITY

I/O LIST - LA ROSA								
Item No.	P&ID	Parameter	Digital Input	Digital Output	Analog Input	Analog Output	Modbus	Ethernet
High Service Pump Status/Control								
		HSP 1 Control Status (Manual/Com)	X					
		HSP 1 Control Status MCC/SCADA Panel (MCC/SCP)	X					
		HSP 1 Running Off/Running	X					
		HSP 1 Discharge Valve Control Status (Manual/Automatic)	X					
		HSP 1 Discharge Valve Position - Closed	X					
		HSP 1 Discharge Valve Position - Open	X					
		HSP 1 Start		X				
		HSP 1 Stop		X				
		HSP 1 Low Water Cutoff	X					
		HSP 1 Lockout Relay Tripped (86 Relay)	X					
		HSP 1 MPR Tripped	X					
		HSP 1 Motor Protection Relay Alarm	X					
		HSP 1 Motor Protection Relay Status						X
		HSP 1 Soft Start Fail	X					
		HSP 2 Control Status (Manual/Automatic)	X					
		HSP 2 Control Status MCC/SCADA Panel (MCC/SCP)	X					
		HSP 2 Running Off/Running	X					
		HSP 2 Discharge Valve Control Status (Manual/Automatic)	X					
		HSP 2 Discharge Valve Position - Closed	X					
		HSP 2 Discharge Valve Position - Open	X					
		HSP 2 Start		X				
		HSP 2 Stop		X				
		HSP 2 Low Water Cutoff	X					
		HSP 2 Lockout Relay Tripped (86 Relay)	X					
		HSP 2 MPR Tripped	X					
		HSP 2 Motor Protection Relay Alarm	X					
		HSP 2 Motor Protection Relay Status						X
		HSP 2 Soft Start Fail	X					
		HSP 3 Control Status (Manual/Automatic)	X					
		HSP 3 Control Status MCC/SCADA Panel (MCC/SCP)	X					
		HSP 3 Running Off/Running	X					
		HSP 3 Discharge Valve Control Status (Manual/Automatic)	X					
		HSP 3 Discharge Valve Position - Closed	X					
		HSP 3 Discharge Valve Position - Open	X					
		HSP 3 Start		X				
		HSP 3 Stop		X				
		HSP 3 Low Water Cutoff	X					
		HSP 3 Lockout Relay Tripped (86 Relay)	X					
		HSP 3 MPR Tripped	X					
		HSP 3 Motor Protection Relay Alarm	X					
		HSP 3 Motor Protection Relay Status						X
		HSP 3 Soft Start Fail	X					
		HSP 4 Control Status (Manual/Automatic)	X					
		HSP 4 Control Status MCC/SCADA Panel (MCC/SCP)	X					
		HSP 4 Running Off/Running	X					
		HSP 4 Discharge Valve Control Status (Manual/Automatic)	X					
		HSP 4 Discharge Valve Position - Closed	X					
		HSP 4 Discharge Valve Position - Open	X					
		HSP 4 Start		X				
		HSP 4 Stop		X				
		HSP 4 Low Water Cutoff	X					
		HSP 4 Lockout Relay Tripped (86 Relay)	X					
		HSP 4 MPR Tripped	X					
		HSP 4 Motor Protection Relay Alarm	X					
		HSP 4 Motor Protection Relay Status						X
		HSP 4 Soft Start Fail	X					
		HSP PRV Open Status	X					
		HSP PRV Closed Status	X					
High Service Pump Flow								
		HSP 1 Flow					X	

SAWS
La Rosa Pump Station Rehab
LA ROSA FACILITY

I/O LIST - LA ROSA								
Item No.	P&ID	Parameter	Digital Input	Digital Output	Analog Input	Analog Output	Modbus	Ethernet
		HSP 2 Flow					X	
		HSP 3 Flow					X	
		HSP 4 Flow					X	
		HSP 1 Flow to Display				X		
		HSP 2 Flow to Display				X		
		HSP 3 Flow to Display				X		
		HSP 4 Flow to Display				X		
Pressure								
		Discharge Pressure			X			
Altitude Valve								
		AV Open Status	X					
		AV Closed Status	X					
		AV Open Command		X				
		AV OCA in Automatic	X					
Ground Storage Tanks Level								
		GST Level			X			
		GST Low Level (Via Electrode)	X					
		GST High Level (Via Electrode)	X					
		GST Overflow Level (Via Electrode)	X					
		GST Level Lead Well Start (For Pitluk)	X					
		GST Level Lag 1 Well Start (For Pitluk)	X					
		GST Level Lag 2 Well Start (For Pitluk)	X					
Chemical Analytical Equipment								
		Chlorine Residual (PPM)			X			
		Fluoride Residual (PPM)			X			
		Water Temp			X			
		Water pH Level			X			
		GST Sample Flow Switch	X					
SCADA Panel								
		SCADA Panel Internal Temperature			X			
		Communications Failure Normal/Fail (Internal to PLC)		X				
		Loss of 120V PLC Control System Power (K7 Relay)	X					
		UPS System Health						X
		UPS Battery Voltage						X
		UPS Status						X
HVAC								
		SCADA Room High Temperature	X					
		Electrical Room High Temperature	X					
Generator								
		Generator Run	X					
		Generator Fuel Leak	X					
		Generator Low Fuel	X					
		Generator General Alarm	X					
		ATS in Emergency Mode	X					
		ATS General Alarm	X					
Data to Local Displays								
		Total Discharge Flow to Display				X		
		Discharge Pressure Low Pressure Alarm		X				
		Discharge Pressure High Pressure Alarm		X				
Door Switches								
		SCADA Panel Door Switch	X					
		SCADA/Security Room Interior Door Open	X					
		SCADA/Security Room Exterior Door Open	X					
		Electrical Room Exterior Door #1 Open	X					
		Electrical Room Exterior Door #2 Open	X					

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 LA ROSA FACILITY

I/O LIST - LA ROSA								
Item No.	P&ID	Parameter	Digital Input	Digital Output	Analog Input	Analog Output	Modbus	Ethernet
		Point Count (Does not include internal PLC I/O)	70	12	7	5		
		Card Capacity	32	32	8	8	N/A	N/A
		Cards Required (includes Spare Capacity)	3*	1	2*	1		

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PITLUCK FACILITY

I/O LIST - PITLUK								
Item No.	P&ID	Parameter	Digital Input	Digital Output	Analog Input	Analog Output	Modbus	Ethernet
Fluoride System - New								
		Fluoride Metering Pump #1 Local/Remote	X					
		Fluoride Metering Pump #1 Run Status	X					
		Fluoride Metering Pump #1 Common Alarm	X					
		Fluoride Metering Pump #1 Leak Detection Alarm	X					
		Fluoride Metering Pump #1 Speed Indication			X			
		Fluoride Metering Pump #1 Speed Command				X		
		Fluoride Metering Pump #1 Alarm Reset		X				
		Fluoride Metering Pump #1 Start/Stop Command		X				
		Fluoride Metering Pump #1 High Discharge Pressure Alarm	X					
		Fluoride Metering Pump #2 Local/Remote	X					
		Fluoride Metering Pump #2 Run Status	X					
		Fluoride Metering Pump #2 Common Alarm	X					
		Fluoride Metering Pump #2 Leak Detection Alarm	X					
		Fluoride Metering Pump #2 Speed Indication			X			
		Fluoride Metering Pump #2 Speed Command				X		
		Fluoride Metering Pump #2 Alarm Reset		X				
		Fluoride Metering Pump #2 Start/Stop Command		X				
		Fluoride Metering Pump #2 High Discharge Pressure Alarm	X					
		Fluoride Flow Rate to Injection Point			X			
		Fluoride Bulk Tank Level			X			
		Fluoride Bulk Tank High Level Alarm	X					
		Fluoride Bulk Tank Low Level Alarm	X					
		Fluoride Leak Detection System for Manholes	X					
		Fluoride Building Area Shower/Eyewash in Use	X					
		Fluoride Containment Area Shower/Eyewash in Use	X					
Fluoride Discharge Valve - New								
		Fluoride Discharge High High Flow	X					
		Fluoride Discharge Valve Open		X				
		Fluoride Discharge Valve Close		X				
		Fluoride Discharge Valve Panel LOR Switch in Local	X					
		Fluoride Discharge Valve Panel LOR Switch in Remote	X					
		Fluoride Discharge Valve Open Status	X					
		Fluoride Discharge Valve Closed Status	X					
Chlorine System - New								
		Chlorine Booster Pump 1 Run	X					
		Chlorine Booster Pump 2 Run	X					
Well Pumps - Existing								
		Well Pump 2 Control Status Hand	X					
		Well Pump 2 Control Status Auto	X					
		Well Pump 2 Run Status Off/Running	X					
		Well Pump 2 Normal/Alarm	X					
		Well Pump 2 MPR Alarm	X					
		Well Pump 2 RTD Alarm	X					
		Well Pump 3 Control Status Hand	X					
		Well Pump 3 Control Status Auto	X					
		Well Pump 3 Run Status Off/Running	X					
		Well Pump 3 Normal/Alarm	X					
		Well Pump 3 MPR Alarm	X					
		Well Pump 3 RTD Alarm	X					
		Well Pump 2 Flow			X			
		Well Pump 3 Flow			X			
		Well Pump 2 Discharge Pressure			X			
		Well Pump 3 Discharge Pressure			X			
		Well Pump 2 Start		X				
		Well Pump 2 Stop		X				

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PITLUCK FACILITY

I/O LIST - PITLUK								
Item No.	P&ID	Parameter	Digital Input	Digital Output	Analog Input	Analog Output	Modbus	Ethernet
		Well Pump 2 Reset		X				
		Well Pump 3 Start		X				
		Well Pump 3 Stop		X				
		Well Pump 3 Reset		X				
		Well Pump 2 High Discharge Pressure		X				
		Well Pump 2 Low Discharge Pressure		X				
		Well Pump 3 High Discharge Pressure		X				
		Well Pump 3 Low Discharge Pressure		X				
Well Discharge Valve - New								
		Well Pump #2 Discharge Valve Closed Status	X					
		Well Pump #2 Discharge Valve Open Status	X					
		Well Pump #3 Discharge Valve Closed Status	X					
		Well Pump #3 Discharge Valve Open Status	X					
Fluoride Sump Pump - New								
		Fluoride Sump Pump High High Level	X					
		Fluoride Sump Pump High Level	X					
SCADA Panel - Existing								
		Power Loss	X					
		Door 1 SCADA Open	X					
		Door 2 SCADA Open	X					
		Door 3 SCADA Open	X					
		UPS Fail	X					
		Temp Sensor			X			
		Communications Failure		X				
		Point Count (Does not include internal PLC I/O)	45	17	9	2		
		Card Capacity	32	32	8	8		
		Cards Required (includes Spare Capacity)	2	1	2	1		

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SECTION 17410**FIELD INSTRUMENT LIST****PART 1 - GENERAL**

1.01 SCOPE:

- A. This Section includes a summary of the Field Instrument List.

1.02 RELATED SECTIONS:

- A. Section 17300 Instrumentation General Provisions including coordination meeting required between various parties involved with controls programming.
- B. Section 17400 Control Loop Descriptions

1.03 SUBMITTALS:

- A. Refer to Section 17305 Applications Services and Section 17300 Instrumentation General Provisions.

1.04 SYSTEM DESCRIPTION:

- A. The Field Instrument List provides a summary of the major process instrumentation requirements as utilized within the control loops represented in the Contract Documents. Additional instruments shall be provided as required to fully implement the strategies as described in these specifications and as recommended by the process and mechanical equipment division suppliers.
- B. The Field Instrument List is not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions, but is rather intended to supplement and complement the drawings and other specification sections. The Field Instrument List shall not be considered equal to a bill of materials.
- C. Provide instrumentation hardware and software as necessary to perform control functions specified herein and as shown on drawings.

1.05 FIELD INSTRUMENT LIST:

- A. The Field Instrument List follows in Appendix A.

PART 2 - PRODUCTS (NOT USED)**PART 3 - EXECUTION**

3.01 INSTALLATION:

- A. All field instruments listed shall be supplied as specified herein and shall be installed, field adjusted and tested as an integral part of overall control systems specified elsewhere in these Specifications.

END OF SECTION

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FIELD INSTRUMENT LIST					
Item No.	Instrument Tag	Description	Instrument Type	Instrument Range or Setpoint	Location
1	LIT-101	GST Level	Pressure Transmitter	? To ? Ft.	La Rosa
2	PIT-101	Discharge Pressure	Pressure Transmitter	? To ? PSI	La Rosa
3	AIT-101	Water Temp at GST Outlet 1	Temperature Transmitter	? Degrees	La Rosa
4	AIT-101	Chlorine Residual at GST Outlet 1	Analyzer	? To ? PPM	La Rosa
5	AIT-103	Fluoride Residual at GST Outlet 1	Analyzer	? To ? PPM	La Rosa
6	AIT-104	PH Level at GST Outlet 1	PH Probe	??	La Rosa
7	FS-101	Flow Switch at GST Outlet 1	Flow Switch	??	La Rosa
8	FIT-201	HSP 1 Flow Rate	Magnetic Flow Transmitter	0-?? MGD	La Rosa
9	FIT-202	HSP 2 Flow Rate	Magnetic Flow Transmitter	0-?? MGD	La Rosa
10	FIT-203	HSP 3 Flow Rate	Magnetic Flow Transmitter	0-?? MGD	La Rosa
11	FIT-204	HSP 4 Flow Rate	Magnetic Flow Transmitter	0-?? MGD	La Rosa
12	DS-1	SCADA Panel Door Open	Door Switch	??	La Rosa
13	DS-2	SCADA/Security Room Interior Door Open	Door Switch	??	La Rosa
14	DS-3	SCADA/Security Room Exterior Door Open	Door Switch	??	La Rosa
15	DS-4	Electrical Room Exterior Door #1 Open	Door Switch	??	La Rosa
16	DS-5	Electrical Room Exterior Door #2 Open	Door Switch	??	La Rosa
17	LEL-100	GST Level Lead Well Start	Level Probe	?? Ft.	La Rosa
18	LEL-101	GST Level Lag 1 Well Start	Level Probe	?? Ft.	La Rosa
19	LEL-102	GST Level Lag 2 Well Start	Level Probe	?? Ft.	La Rosa
20	LEL-103	GST High Level	Level Probe	?? Ft.	La Rosa
21	LEL-104	GST Low Level	Level Probe	?? Ft.	La Rosa
22	LEL-105	GST Overflow Level	Level Probe	?? Ft.	La Rosa
23	PSL-100	HSP 1 Low Water Cutoff	Pressure Switch	1/8 to 20 PSI	La Rosa
24	PSL-101	HSP 2 Low Water Cutoff	Pressure Switch	1/8 to 20 PSI	La Rosa
25	PSL-102	HSP 3 Low Water Cutoff	Pressure Switch	1/8 to 20 PSI	La Rosa
26	PSL-103	HSP 4 Low Water Cutoff	Pressure Switch	1/8 to 20 PSI	La Rosa
27	SPT-101	SCADA Panel Internal Temperature	Temperature Transmitter	? Degrees	La Rosa
28	TS-1	SCADA Room High Temperature	Temperature Switch	? Degrees	La Rosa
29	TS-2	Electrical Room High Temperature	Temperature Switch	? Degrees	La Rosa

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FIELD INSTRUMENT LIST					
Item No.	Instrument Tag	Description	Instrument Type	Instrument Range or Setpoint	Location
30	FIT-300	Fluoride Total Flow	Electromagnetic Flow Transmitter	0-?? GPD	Pitluk
31	FS-300	Fluoride High Flow Switch	Flow Switch	??	Pitluk
32	LE-201	Fluoride Storage Tank Transducer	Radar Level Transducer	? To ? Ft.	Pitluk
33	LIT-300	Fluoride Storage Tank Level Controller	Radar Level Transmitter/Controller	? To ? Ft.	Pitluk
34	PSH-100	Fluoride Metering Pump 1 High Pressure Switch	Pressure Switch	??	Pitluk
35	PSH-200	Fluoride Metering Pump 2 High Pressure Switch	Pressure Switch	??	Pitluk
36	LS-100	Leak Detection from Manholes	Level Switch	??	Pitluk
37	FLS-100	Sump High High Level	Float Switch	?? Ft	Pitluk
38	FLS-200	Sump High Level	Float Switch	?? Ft	Pitluk

SECTION 17500**PROGRAMMABLE LOGIC CONTROLLER****PART 1 - GENERAL**

1.01 SCOPE OF WORK:

- A. This Section of the Specifications describes the requirements for a Programmable Logic Controller (PLC) to be furnished under other Sections of the Specifications as listed in the Related Work paragraph of this Section.
- B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.

1.02 RELATED WORK:

- A. Section 16010 Basic Electrical Requirements
- B. Section 17300 Instrumentation General Provisions
- C. Section 17302 Process Instrumentation and Control System Testing
- D. Section 17305 Application Services
- E. Section 17310 Field Instruments
- F. Section 17327 Panel Mounted Equipment
- G. Section 17400 Control Loop Descriptions
- H. Section 17405 Input/Output List
- I. Section 17410 Field Instrument List

1.03 SUBMITTALS:

- A. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned un-reviewed.
- B. Shop Drawings:
 - 1. Bill of Materials
 - 2. Catalog Cuts
 - 3. Component Data Sheets
 - 4. Panel Construction Drawings, including wiring and component layout
 - 5. List of Labels and Tags
- C. Submit control loop drawings complete with rack, card slot and point configuration.

- D. Submit catalog data sheets for all software licenses provided under this Specification Section.
- E. Operation and Maintenance Manuals:
 - 1. Operation and Maintenance manuals shall include the following information:
 - a. Manufacturer's contact address and telephone number for parts and service.
 - b. Instruction books and/or leaflets
 - c. Recommended renewal parts list
 - d. Record Documents for the information required by the Submittals above.
 - e. Copy of the software license data including serial numbers, license key, etc.
 - f. Complete set of as-built control loop and wiring drawings in "11x17" format.

1.04 REFERENCE CODES AND STANDARDS:

- A. PLC equipment, materials and installation shall comply with the National Electrical Code (NEC and with the latest edition of the following codes and standards:
 - 1. National Electrical Safety Code (NESC)
 - 2. Occupational Safety and Health Administration (OSHA)
 - 3. NEMA ICS 1-101 Diagrams, Designations and Symbols
 - 4. ANSI/ISA-5.06.01-2007 - Functional Requirements Documentation for Control Software Applications.
 - 5. ISA-TR20.00.01-2001 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.
 - 6. ISA-5.4-1991 Instrument Loop Diagrams.
 - 7. ISA-5.5-1985 Graphic Symbols for Process Displays.
 - 8. ISA-5.1-1984 (R1992) Instrumentation Symbols and Identification.
 - 9. ISA-5.3-1983 Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
 - 10. ISA-20-1981 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
 - 11. ISA-5.2-1976 (R1992) Binary Logic Diagrams for Process Operations.
 - 12. NEMA ICS 6 Enclosures for Industrial Controls and Systems
 - 13. National Fire Protection Association (NFPA)
 - 14. National Electrical Manufacturers Association (NEMA)
 - 15. American National Standards Institute (ANSI)

16. Insulated Cable Engineers Association (ICEA)
 17. International Society of Automation (ISA)
 18. Underwriters Laboratories (UL)
 19. UL 508, the Standard of Safety for Industrial Control Equipment
 20. UL 508A, the Standard of Safety for Industrial Control Panels
 21. UL 50, the Standard of Safety for Enclosures for Electrical Equipment.
 22. NFPA 79, Electrical Standard for Industrial Machinery
 23. Factory Mutual (FM)
 24. NFPA 70 National Electrical Code (NEC)
 25. NFPA 70E Standard for Electrical Safety in the Workplace
 26. ANSI C37.90.2 Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference From Transceivers.
 27. NEMA ICS 4 Terminal Blocks for Industrial Use.
 28. NEMA LS1 Low Voltage Surge Protection Devices.
 29. UL 1283 Standard for Safety-Electromagnetic Interference Filters.
 30. UL 1449 Third Edition Surge Protective Devices
 31. Texas Electrical Code
 32. All equipment and installations shall conform to applicable Federal, State, and local codes.
- B. All equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.
- C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.
- 1.05 QUALITY ASSURANCE:
- A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of five (5) years. When requested by the OWNER/ENGINEER, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. Requirements of the CONTRACTOR:
1. Have a local office within one hundred (100) miles of the City of San Antonio or have technicians available on-site within 4 hours of emergency notification.

2. Be able to provide resumes, project experience history and references for all employees that will be qualified to work on the SCADA system.
 3. Have a local full time staff of employees that have developed and commissioned a minimum of three new Allen Bradley based systems within the past twelve months. Must have a minimum five years' experience designing, installing and commissioning SCADA systems.
 4. Have a minimum of three full time employees qualified to perform the SCADA system configuration work.
 5. All proposals submitted to the San Antonio Water System must be accompanied by documentation supporting the qualifications of the CONTRACTOR as detailed above. The San Antonio Water System reserves the right to reject any proposal if the above qualifications are not met.
- C. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.
- D. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.06 WARRANTY:

- A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for 2 years from date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the CONTRACTOR at no expense to the OWNER.

1.07 COMMUNICATIONS PROTOCOL:

- A. The communication protocol used between the SCADA PLC and the Top End HMI (Production Control Room) shall be Modbus TCP. This will be subject to change as SAWS is expected to upgrade the Top End HMI equipment to use EtherNet/IP protocol. Contractor shall coordinate with Engineer and Owner during the equipment submittal process. The PLC System shall communicate to the Top End HMI with the following as minimum capabilities:
1. All data shall be available and/or mirrored within the Modbus or "Holding Register" memory area. The other areas can be optionally supported, but all 0x, 1x, and 3x data shall be readable and writable in the 4x memory area. For digital writes, supports of single-bit writes (function 5) to the 0x area are acceptable on a case by case basis. Products that require access to the 1x and 3x area to operate are not acceptable; access to 1x/3x area shall be optional.
 2. Register 4x00001 shall exist and be readable to allow simple, predictable "communications tests".
 3. Software tools shall function properly with slaves only supporting Modbus functions 3, 4 and 16. Requiring support of diagnostic function 8 is not acceptable.
 4. Software tools shall be configurable to write a single register as either function 6 or 16.

5. Software tools shall allow setting the Modbus "Unit Id" to be a value other than zero. This is required for Ethernet-to-Serial bridging.

PART 2 - PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLER (FOR LA ROSA):

- A. Subject to compliance with the Contract Documents, the following manufacturer is acceptable:

1. Allen Bradley RSLogix Studio 5000 with the latest version in use by SAWS.

- B. Approved Products – NO SUBSTITUTIONS:

<u>DESCRIPTIONS</u>	<u>MANUFACTURER</u>	<u>PART NUMBER</u>
CPU (Processor)	Allen Bradley	1769-L33ER
I/O Power Supply Module	Allen Bradley	1769-PA4
8 Channel Analog Input Module	Allen Bradley	1769-IF8C
Pre-Wired Cable Analog Input	Allen Bradley	1492-ACAB025EE69
8 Channel Analog Output Module	Allen Bradley	1769-OF8C
Pre-Wired Cable Analog Output	Allen Bradley	1492-ACAB025D69
32 Channel Digital DC Input Module	Allen Bradley	1769-IQ32
Digital I/O Ready Cable	Allen Bradley	1492-CAB025RTN32I
32 Channel Digital DC Output Module	Allen Bradley	1769-OB32
Digital I/O Ready Cable	Allen Bradley	1492-CAB025RTN32O
Right to Right bank interconnection	Allen Bradley	1769-CRR3
Right to Left bank interconnection	Allen Bradley	1769-CRL3
Right End Cap/Terminator	Allen Bradley	1769-ECR
Left End Cap/Terminator	Allen Bradley	1769-ECL

- C. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions.

- D. Modbus RTU serial port, Ethernet Modbus/TCP port and USB programming port shall be provided on the CPU (Processor).

- E. Programming:

1. PLC Programming shall be performed by Process Control Systems Integrator (PCSI).

- F. Programming Languages:

1. PLC shall support IEC Standard 61131-3 for all of the following programming language:

- a. Function Block Diagram (FBD)

2. Processor shall have a minimum IEC Program Memory size of 3584 KB.

- G. Input / Output Capacity:

1. Physical Input / Output capacity shall not be less than the following:

- a. Analog – 256

b. Discrete – 1024

H. Physical Construction:

1. The PLC shall be of the modular construction, consisting of a back plane, plug in modules for the processor, communication modules, I/O modules and expansion modules.
2. The power supply shall be 120 Volt 60 Hz, and shall be sized for the total cards; including the power requirement of the spare I/O rack slots.
3. Analog inputs and outputs shall be isolated physically and electronically from each other, and shall be of the 4-20mA type.
4. Discrete inputs shall be 24VDC and individually buffered with relays.
5. Discrete outputs shall be of the relay type and individually buffered with external relays.

I. Spare Equipment:

1. Provide minimum of 20 percent wired spare I/O channels of each type provided.
2. Provide 1 spare I/O card of each type provided.

2.02 PROGRAMMABLE LOGIC CONTROLLER (FOR PITLUK MODIFICATIONS IN EXISTING SCADA CABINET):

- A. Subject to compliance with the Contract Documents, the following manufacturer is acceptable:
1. Schneider Electric Modicon M340 with Unity Pro 6.0 software (or latest version currently in use by SAWS).
- B. Approved Products – NO SUBSTITUTIONS

<u>DESCRIPTION</u>	<u>MANUFACTURER</u>	<u>PART NUMBER</u>
12 Slot Backplane	Modicon	BMXXBP1200
Power Supply Module	Modicon	BMXCPS3500
CPU (Processor)	Modicon	BMXP342020
32 Channel Digital Input Module	Modicon	BMXDDI3202
32 Channel Digital Output Module	Modicon	BMXDDO3202
8 Channel Analog Input Module	Modicon	BMXAMI0810
TELEFAST Analog Input Module	Modicon	ABE-7CPA02
4 Channel Analog Output Module	Modicon	BMXAMO0410
TELEFAST Analog Output Module	Modicon	ABE-7CPA21
TELEFAST Digital Input Module	Modicon	ABE-7H16R21
TELEFAST Digital Output Module	Modicon	ABE-7H16R21
Analog Input Cable	Modicon	BMXFTA300
Analog Output Cable	Modicon	BMXFCA300
Digital Input Cable	Modicon	BMXFCC303
Digital Output Cable	Modicon	BMXFCC303
Communications Module	Modicon	BMXNOR0200H

- C. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions.
- D. Modbus RTU serial port, Ethernet Modbus/TCP port and USB programming port shall be provided on the CPU (Processor).
- E. Programming:
 - 1. PLC Programming shall be performed by Process Control Systems Integrator (PCSI).
- F. Programming Languages
 - 1. PLC shall support IEC Standard 61131-3 for all of the following programming languages:
 - a. Function Block Diagram (FBD)
 - 2. Processor shall have a minimum IEC Program Memory size of 3584 KB.
- G. Input / Output Capacity
 - 1. Physical Input / Output capacity shall not be less than the following:
 - a. Analog – 256
 - b. Discrete – 1024
- H. Physical Construction
 - 1. The power supply shall be 120 Volt 60 Hz, and shall be sized for the total cards; including the power requirement of the spare I/O rack slots.
 - 2. Analog inputs and outputs shall be isolated physically and electronically from each other, and shall be of the 4-20mA type.
 - 3. Discrete inputs shall be 24VDC and individually buffered with relays.
 - 4. Discrete outputs shall be of the relay type and individually buffered with external relays.
- I. Spare Equipment
 - 1. Provide minimum of 20 percent wired spare I/O channels of each type provided.
 - 2. Provide 1 spare I/O card of each type provided.

2.03 ADDITIONAL SPARE PARTS:

- A. Provide the following spare parts for the PLC in the quantities specified:
 - 1. One-half dozen replacement fuses, all types and sizes
- B. Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturer's name, description and part number on the exterior of the package.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All equipment specified herein shall be factory installed, programmed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

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SECTION 17515**COMMUNICATIONS INTERFACE EQUIPMENT****PART 1 - GENERAL**

1.01 SCOPE:

- A. This Section of the Specifications describes the requirements for Communications Interface Equipment and Systems to be furnished under other Sections of the Specifications as listed in the Related Sections paragraph of this Section.
- B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.

1.02 RELATED SECTIONS:

- A. Section 17300 Instrumentation General Provisions
- B. Section 17302 Process Instrumentation and Control System Testing
- C. Section 17305 Application Services
- D. Section 17310 Field Instruments
- E. Section 17327 Panel Mounted Equipment
- F. Section 17400 Control Loop Descriptions
- G. Section 17405 Input/Output List
- H. Section 17410 Field Instrument List
- I. Section 17500 Programmable Logic Controller (PLC)

1.03 SUBMITTALS:

- A. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc. sufficient to confirm that the equipment provides every specified requirement. Any options or exceptions shall be clearly indicated.
- B. Submittals for equipment specified herein shall be made as a part of equipment submittals furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned un-reviewed.
- C. Installation experience documentation shall be submitted for approval with the Section Equipment Submittal.
- D. Operations and Maintenance Manuals:
 - 1. Operations and Maintenance manuals shall be constructed in accordance with Division 1 and shall include the following information:
 - a. Manufacturer's contact address and telephone number for parts and service.
 - b. Instruction books and/or leaflets

- c. Recommended renewal parts list
- d. Record documents for the information required by the Submittals section above.

1.04 REFERENCE CODES AND STANDARDS:

- A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
 - 1. National Electric Code (NEC)
 - 2. National Electrical Safety Code (NESC)
 - 3. International Society of Automation (ISA)
 - 4. Occupational Safety and Health Administration (OSHA)
 - 5. Underwriters Laboratories (UL)
 - 6. UL 508, the Standard of Safety for Industrial Control Equipment
 - 7. Factory Mutual (FM)
 - 8. City of San Antonio, Texas Electrical Code
 - 9. All equipment and installations shall conform to Federal, State and local codes.
- B. All equipment and installations shall conform to the standards and codes listed in the individual device paragraphs.

1.05 QUALITY ASSURANCE:

- A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of five (5) years. When requested by the OWNER/ENGINEER, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. The equipment as submitted shall be located as shown on the project plans and shall fit within this location. Equipment which does not fit in the space as shown on the project plans is not acceptable.
- C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.06 WARRANTY:

- A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for two (2) years from the date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the CONTRACTOR at no expense to the OWNER.

PART 2 - PRODUCTS

2.01 INDUSTRIAL ETHERNET SWITCH (SCADA CABINET):

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. CISCO model IE-3000-8TC-E
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- C. Environmental:
 - 1. Operating temperature: -40°F to 167°F
 - 2. Operating humidity: 10-95% Non-condensing
 - 3. Storage temperature: -13°F to 185°F
- D. Physical:
 - 1. Enclosure: NEMA TS-2. Fully Modular construction.
 - 2. Power supply: 120VAC from proposed UPS source.
 - 3. Microprocessor based managed type.
 - 4. Din rail mountable capability.
 - 5. 19 inch rack mountable where shown in plans.
- E. Functional Performance:
 - 1. Per Port status LED indication.
 - 2. Port based Ethernet MAC security individually port configurable.
 - 3. Wire speed switching, 16 Gigabit Switching Fabric.
 - 4. HSRP Protocol Support.
 - 5. Cisco Express Forwarding Hardware Routing Architecture.
 - 6. SNMP v1, SNMP v2c, and SNMP v3 Support.
 - 7. 802.1d Spanning Tree Protocol Support.
 - 8. HTTPS accessible.
 - 9. Common Industrial Protocol (CIP) Management Objects Support.
 - 10. Smart Templates for Ethernet/IP.

11. PROFINET v2 certification.
12. Alarm contacts for external fault notification.
13. 10/100 Base T ports with RJ-45 connectors for Category 6 cabling.
14. Switch Configuration on removable/configurable via Flash Memory module.
15. Fully managed switch capability.

F. Options and Accessories Required:

1. Provide twenty (20) percent spare port capacity for each port type.
2. Provide expansion modules Cisco model IEM-3000-8TM for additional connections.

2.02 MODBUS SERIAL TO IP CONVERTER(SCADA CABINET):

A. Manufacturer: Digi One IAP

2.03 INDUSTRIAL ETHERNET SWITCH (SECURITY CABINET):

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Cisco WS 3560-24PS-24 POE Ports with Redundant PWR-C2-640 WAC Power Module

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Environmental:

1. Operating temperature: 23°F to 113°F
2. Operating humidity: 5-95% Non-condensing
3. Storage temperature: -40°F to 158°F

D. Physical:

1. Stackable, rack mount enclosure
2. Power supply: 120VAC from proposed UPS source.
3. 640 Watt Power Supply
4. Microprocessor based managed type.

E. Functional Performance:

1. Per Port status LED indication.
2. Port based Ethernet MAC security individually port configurable.

3. HSRP Protocol Support.
4. Cisco Express Forwarding Hardware Routing Architecture
5. SNMP v1, SNMP v2c, and SNMP v3 Support.
6. 802.1d Spanning Tree Protocol Support.
7. Alarm contacts for external fault notification.
8. 10/100 Base T ports with RJ-45 connectors for Category 6 cabling.
9. Switch Configuration on removable/configurable via Flash Memory module.
10. Fully managed switch capability.
11. 12 GE SFP Ethernet Ports

F. Options and Accessories Required:

1. Provide twenty (20) percent spare port capacity for each port type.

2.04 INDUSTRIAL GRADE ROUTER (COMMUNICATIONS CABINET)

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Cisco model IR829GW-LTE-VZ-AK9

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Environmental:

1. Operating temperature in sealed NEMA Cabinet with no air flow: -40°F to 140°F
2. Operating altitude: 13,800 ft.
3. Mounting Options: Panel/door mount

D. Physical:

1. Enclosure: Fully Modular construction to allow for field upgrades for existing and/or future technologies without requiring a platform replacement.
2. Power supply: 120VAC from proposed UPS source.
3. Microprocessor based managed type.
4. 19 inch rack mountable where shown in plans.

E. Options and Accessories Required:

1. Provide twenty (20) percent spare port capacity for each port type.

2. Provide redundant power supply module Cisco PWR-125W-AC
3. WPA Antenna WMMG-7-27-5SP.
4. Female Adapter SMA-TNC.
5. Lighting Arrestor CGR-LA-NF-NF
6. Provide two year extended maintenance CON-SNT-C829H4GV

2.05 RADIO TRANSCEIVER SYSTEM:

- A. Broadband radio to be provided as part of a separate project.
- B. Antennas:
 1. To be provided as part of a separate project.
- C. Antenna Mast:
 1. To be provided as part of a separate project.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. All equipment specified herein shall be factory installed in an overall assembly, field adjusted, tested and cleaned as an integral part of the equipment specified elsewhere in these Specifications.

END OF SECTION

SECTION 17550**SECURITY SYSTEM****PART 1 - GENERAL**

1.01 SCOPE:

- A. This section covers the design, furnishings, and installation of a complete, functional security system including but not limited to a closed circuit television (CCTV) surveillance system and security access system.
- B. The security system's major components shall consist of electrical cable, network cable, relay boxes, conduits, CCTV cameras, connectors, digital video recorder system, power supplies, transformers, Ethernet switch and radio. All require mounting hardware, and other appurtenant items shall be furnished as specified herein or recommended by the equipment manufacturer to make a complete system.
- C. The General Contractor shall procure the service of a Security System Integrator (SSI), as a first-tier subcontractor, who shall furnish the work described within this specification section. The SSI shall have the qualifications described below.
- D. The SSI shall furnish all necessary labor, tools, equipment, ancillary materials and all testing, integration and commissioning services required to provide a complete and fully operational Integrated Security System, as specified herein and shown on the Drawings. The ISS system shall be provided, tested and integrated with the existing SAWS enterprise-wide Integrated Security System.
- E. Requirements for all equipment and work to be provided by the SSI are contained herein, shown in the Drawings and in specification sections listed in Related Work.
- F. The SSI shall coordinate with the General Contractor, PCSI, Owner and Engineer, for all scheduling installation, testing, startup and training services to be provided.
- G. The SSI's work shall include, but not limited to, the following:
 - 1. Furnish and install Security Cabinet, network video recorder (NVR), Ethernet switch, Security Controller, surveillance cameras, and integrated intercom/camera/card reader(s) devices as specified herein and as depicted in the Drawings.
 - 2. Provide all licenses for the video management system for all IP camera's shown in the Drawings plus an additional two licenses.
 - 3. For all devices furnished, provide all necessary software required to achieve a fully functional site security system ready for integration with SAWS's existing enterprise-wide system.
 - 4. Coordinate with PCSI for equipment to be furnished by the PCSI and installed for the Integrated Security System.
 - 5. Coordinate with SAWS IS department and configure communications between this project site and SAWS' existing ISS hardware and software.

6. Develop and configure site ISS application and database for integration with SAWS existing enterprise-wide ISS.
7. Test complete ISS system on a point-by-point basis for correct intended operation. This shall include, but not limited to, testing of access control devices and gate operators, card readers, intercom systems, video recording equipment and surveillance cameras as well as site security communications with SAWS existing enterprise-wide ISS.
8. Perform specified training for Owner's designated staff.

1.02 RELATED WORK

- A. Section 17300 Instrumentation and Controls (I&C) – General Provisions
- B. Section 17302 I&C – Process I&C System Testing
- C. Section 17325 I&C – Control Panels
- D. Section 17327 I&C – Panel Mounted Equipment
- E. Section 17328 I&C – UPS
- F. Section 17515 I&C – Communications Interface Equipment
- G. Section 17320 I&C – Fiber Optics

1.03 SUPPLIER'S QUALIFICATIONS:

- A. The entire system shall be designed, coordinated, supplied, and integrated by a single pre-approved licensed security CONTRACTOR by SAWS prior to Bid Opening. All system integration and testing shall be performed by the pre-approved CONTRACTOR.
- B. SSI Qualifications
 1. The SSI shall perform all work necessary to configure, customize, debug, install, connect, and place into operation all HMI software specified within this division and other related divisions.
 2. The SSI shall provide 24-hour Service Contract for the length of the warranty period.
 3. The SSI shall coordinate all scheduling, installation, training and startup services with the PCSI.
 4. For the purposes of this and other applicable divisions, the SSI shall be an organization that complies with all of the following criteria:
 - a. Holds an adequate Certificate of Insurance for the project work specified herein and in other related sections.
 - b. Employs personnel who have completed and hold certificates for required training.
 - c. Employs personnel who have previously completed five projects of this size or larger in dollar value.

- d. Has been in the water/wastewater industry performing the type of work specified herein for a minimum of five continuous years.
- e. Employs a registered professional Control Systems Engineer or Electrical Engineer in the state of Texas to supervise or perform the work required by this specification section.

1.04 REFERENCE STANDARDS

- A. National Fire Protection Association, (NFPA)
- B. Factory Mutual, (FM)
- C. Institute of Electrical and Electronic Engineers, (IEEE)
- D. National Electrical Code, (NEC)
- E. National Electrical Manufacturers Association, (NEMA)
- F. Underwriter's Laboratories, Inc., (UL)

1.05 REGULATORY REQUIREMENTS

- A. Conform to the requirements of NFPA 70.
- B. Furnish products listed and classified by UL as suitable for the purpose specified herein and as shown on the Drawings.

1.06 DELIVERY STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner.
- B. Equipment must be installed in its permanent location shown on the Drawings within seven calendar days of arriving on site. If the equipment cannot be installed within seven calendar days, the equipment shall not be delivered to the site, but stored offsite, in an air conditioned, bonded, warehouse of the Contractor's choice and at the Contractor's expense, until such time that the site is ready for permanent installation of the equipment.

1.07 POWER REQUIREMENTS:

- A. Primary power supply to CCTV surveillance and security system components will be 120 volts, 60 Hz, single phase, furnished on-site. The licensed security CONTRACTOR shall be responsible for all power supply requirements and shall furnish and install transformers or other power supply equipment required. CONTRACTOR shall provide UPS system for the CCTV installation in the Security Enclosure.

1.08 SYSTEM COMPONENTS:

- A. All CCTV surveillance and security system equipment and materials, devices and assemblies shall be listed and/or labeled by UL or another accepted testing laboratory for the intended purpose. The equipment shall not be altered, installed, or modified in any way that would void the label or listing.

1.09 COORDINATION:

- A. All devices shall be supplied in full conformity with the specifications, engineering data, instructions, and recommendations of the manufacturers. The licensed security CONTRACTOR shall be responsible for coordination of the device locations and wiring requirements.

PART 2 - PRODUCTS

2.01 CLOSED CIRCUIT TELEVISION (CCTV) SYSTEM COMPONENTS:

- A. The following paragraphs shall apply to the CCTV equipment to be provided. The number of components, and general location shall be as shown on the drawings.
- B. Cameras:
 1. The housing shall be vandal resistant and shall include weather shield.
 2. The camera shall be suitable for day and night operation.
 3. The camera shall have automatic backlight suppression.
 4. The camera shall have a varifocal lens.
 5. The signal system shall be NTSC.
 6. Camera shall have a minimum resolution of 5 megapixels or greater.
 7. The minimum illumination shall be 0.3 lux or less in color mode.
 8. Day/night switching on the day/night modes shall occur through the lens with an IR cut filter.
 9. The compression shall be MPEG-4 ASP or H.264 compliant.
 10. The Ethernet connections shall be 10/100 Base-T with an RJ-45 connector.
 11. The camera shall support the following protocols: TCP, UDP, IP, HTTP, DHCP, RTP, RTSP and 802.1X.
 12. The camera shall have password protection configured by the administrator.
 13. Lens shall be 6mm or 122 depending on camera location and view. Final lens configuration shall be coordinated with SAWS security.
 14. Provide all cameras from a single manufacturer. Camera manufacturer shall be:
 1. Axis:
 - a. Fix Dome Cameras:
 - i. Camera Axis model P3375-VE Fixed (outdoor).
 - ii. Camera Axis model P3374-V Fixed (indoor).
 - iii. Pole mount model Axis T91D67
 - iv. Pendant kit model Axis P33-VE network
 - v. Wall mount model Axis T91D61

- b. Fish Eye Cameras:
 - i. Camera Axis model M3058-PLVE Fish eye 360
 - ii. Ceiling mount model Axis T91B51
 - iii. Pipe extension model Axis T91B52
 - iv. Pendant Kit T94F01D
 - c. Pan Tilt Zoom Cameras:
 - i. Camera Axis model Q6055-E PTZ
 - ii. Pole mount T91A57
 - iii. Pendant kit model T91G61
- C. Surge Protection:
- 1. Surge protector shall be rack mountable
 - 2. Data speeds up to 10GbE without signal degradation
 - 3. Individual field replaceable modules (contractor to provide spare replaceable modules at quantity of 50% implemented devices)
 - 4. Complies with IEEE Std. 802.3af and 802.3at for PoE
 - 5. Unit shall have a 20ka surge current protection rating
 - 6. Manufacturers:
 - a. Ditek model DTK-RMNETS series
 - b. Or pre-approved equal by SAWS
- D. Network Video Recorder (NVR):
- 1. Unit shall provide record, live view, playback, and archive video.
 - 2. Unit shall be of a Hybrid NVR type for IP cameras.
 - 3. Unit shall have CPU capable of handling 17 IP camera with a resolution of 5 megapixels at a frame rate of 12 frames per second.
 - 4. Unit shall have storage of up to 50TB.
 - 5. Unit shall provide a network of Quad 1Gbe NICs.
 - 6. System shall be Windows Server 2016.
 - 8. Unit shall have Integrated Graphics Adapter.
 - 9. Unit shall have five USB ports –
 - a. Back – Two, USB 3.0 – compliant.
 - b. Front – Two, USB 2.0 – compliant.
 - c. Front – One, USB 3.0 – compliant.
 - 10. Unit shall have 1 Serial Port –compatible, located in the back (rear).

11. Unit shall be rack mountable 2U form factor.
12. Unit shall have Dual 1100W – 100 to 240VAC auto ranging and redundant power supply.
13. The installer will configure and integrate equipment into existing access control video management system.
14. NVR manufacturer shall be:
 - a. Salient – PowerProtect Enterprise Level
 - b. Or pre-approved better by SAWS
 - c. The video server must have a C partition of greater than 150 gigs for the operating system.
 - d. Must have a capacity of storing 60 days of video not re-compressed on the server, and record at 30 fps.
15. Contractor to coordinate with Salient to configure a NVR server capable of operating seventeen (17) cameras with a minimum of 60 days of storage capacity at a frame rate of 12 frames per second.

E. Power Supplies and Transformers:

1. Power supplies and transformers shall be provided as required for proper distribution of power to the CCTV equipment. The licensed security CONTRACTOR shall be responsible for power supply or transformer connections and cable routing. All equipment shall be designed to operate from an external power source rated 120 Vac. The licensed security CONTRACTOR is responsible for providing all transformers and power supplies needed for other operating voltages.

F. Ethernet Switch:

1. The Ethernet Switch shall be a Cisco WS-C3650-24PS (24port PoE switch). Provide the following accessories:
 - a. Power Supply: Cisco PWR-C2-640WAC (redundant power supply)
 - b. Fiber Optic Modules: four (4) Cisco GLC-SX-MM (multimode fiber optic modules)
 - c. Enterprise IP Services license

G. Communications:

1. Refer to Specification 17515, Communications Interface Equipment.

H. Cable:

1. Cat6 Cable shall be gel filled industrial outdoor rated.
 - a. Manufacturers:
 - (i) Andrew or equal
 - (ii) Essex
 - (iii) Belden

2.02 IP INTERCOM WITH INTEGRATED CAMERA

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Axis

- a. Model: Helios IP Force, Model number 9151101CW
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specific ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- C. Environmental
 1. Operating temperature: -40 to +55° C
 2. Operating humidity: 10 to 95% non-condensing
 3. Storage temperature: -40 to +70° C
- D. Physical
 1. Enclosure rating: NEMA 4X
 2. Power Supply: 12V/8A DC
 3. Dimensions: 16" x 20"; 12" x 14"
 4. LAN interface connector: RJ-45
 5. User physical interface: 1 button, numerical keypad, RFID card reader, IP camera
- E. Functional Performance
 1. LAN signaling interface: 10/100BASE-TX with Auto-MDIX; SIP 2.0 protocol
 2. Audio features: Full duplex; 1W speaker; 10W amplifier; adjustable volume control; 2 microphones
 3. Audio stream: RTP/RTSP protocols; G.711, G.729 codecs
 4. Camera features: ¼" color CMOS; 640 x 480 resolution; 30 frames/sec; 1.9V'lux-sec (650nm) sensitivity; 135° (H), 109° (V) viewing angle; infrared illumination
 5. Video stream: RTP/RTSP/http protocols; H.263+, H.264, MPEG-4, M-JPEG codecs
 6. Relay outputs for operating gate controllers utilizing a DD1FC Direct Door Controller
 7. Compatible with Salient Video Management System.

F. Options and Accessories Required

1. Provide 2N Helios IP Manager Software for managing and configuring the intercom/camera/card reader device.
2. Provide all materials for mounting outdoors in enclosures supported by pedestal at site entrance gates as shown in the Drawings. Enclosure shall be NEMA 4X rated and sized by ISS to house intercom/camera/card reader unit and all required accessory devices, including, but not limited to, power supplies, surge protection devices, and media converters.

G. Spare Assemblies

1. Provide 1 spare intercom/camera/card reader unit

2.03 DOOR CONTROLLER SYSTEM

A. Open Options Intellignet Two Door Controller

1. Model SSP-D2 Two Door Controller
2. Support for additional Reader Sub-controllers (up to 64 doors total)
3. Sub-controller Model # RSC-1 & RSC-2

B. Door Access Readers:

1. HID iClass SE Card Readers:
 - a. Model R40
 - b. HID Proximity
 - c. DESFire/Mifare compatible.
 - d. Provide all manufacturer recommended accessories required for outdoor installation.

C. Door Alarm Switches:

1. Magnetic type switches.
2. Provide input to security system for monitoring of each door.
3. Manufacturer: UTC Fire and Security.

D. Door Contact Alarm Integration Controller:

1. Provide UTC model M3000.

2.04 INDUSTRIAL FIBER TO ETHERNET MEDIA CONVERTER (AT PATCH PANEL)

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Axis T8604

2. EtherWan EL2242
 3. B & B Electronics EIR-S-SC
 4. Moxa IMC-21 Series
- B. Contractor to provide all necessary accessories required by manufacturer to convert from fiber optics to Ethernet for camera operation. Accessories to be include but not limited to Midspan units, power supplies, surge protectors, media converter switches, fiber optic cables, cat-6 cables etc.
- C. The listing of specific manufacturers above does not imply acceptance if their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting those specifications in their entirety.
- D. Environmental:
1. Operating Temperature: 32°F to 158°F
 2. Operating Humidity: 20-95% Non-condensing
 3. Storage Temperature: -40°F to 158°F
- E. Physical:
1. Power Supply: 24 VDC
 2. Microprocessor based managed type.
 3. DIN Rail Mountable
- F. Functional Performance:
1. Per port status LED indication.
 2. Wire Speed switching.
 3. 10/100BaseT ports with RJ-45 connectors for Category 6 cabling.
 4. ST or SC type Fiber Optic Connectors for 100BaseFX, 1000BaseSX for Multimode Fiber and 1000Base LX for Single mode Fiber as shown on the drawings.
- G. The listing of specific manufacturers above does not imply acceptance if their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting those specifications in their entirety.
- 2.05 INDUSTRIAL ETHERNET MEDIA CONVERTER (AT SECURITY CABINET)
- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. B & B Electronics EIR-S-SC
 2. Belden / Hirschman Spider 1TX/1FX-mm PD EEC 942 051-002

3. Belden / Hirschman Spider 1TX/1FX-FM 943 891-001?
4. Moxa IMC-21 Series
5. EtherWAN EL900 – Fast Ethernet
6. EtherWAN EL2242 – Gigabit – POE
7. EtherWAN EL9100 – Gigabit
8. EtherWAN EL9020 – Gigabit
9. As approved by the Engineer of Record and SAWS Information Services Department

B. Environmental

1. Operating temperature degrees 10 degrees F to 108 degrees F
2. Operating Humidity: 10 – 95% Non-condensing
3. Minimum storage Temperature: 10 degrees F to 126 degrees F

C. Physical:

1. Power Supply: 24 VDC or 48 VDC as required by the Media Converter
2. Microprocessor based unmanaged type.
3. DIN Rail mountable

D. Functional Performance:

1. Per port status LED indication.
2. Wire Speed switching.
3. 10/100BaseT ports with RJ-45 connectors for Category 6 cabling.
4. ST or SC type Fiber Optics for 100BaseFX, 1000BaseSX for Multimode Fiber and 1000Base LX for Single mode Fiber as shown on the drawings.

2.06 GATE CONTROL SYSTEM COMPONENTS

A. Gate Access Controller Requirements

1. The controller shall have 4 Gate Control Modules.
2. It shall have the following relays: main, alarm shunt, gate ajar, and forced entry.
3. It shall have a door/gate position switch input.
4. The controller shall include a battery back-up power supply and gel-cell battery. The enclosure shall be all steel, environmental NEMA 4 construction suitable for wall mounting,

with a key-lock and tamper switch-protected door. The enclosure shall house the microelectronics, the back-up power battery, and a modem.

5. Manufacturer: Open Options Intellignet Two Door Controller
 - a. Model SSP-D2 Two Door Controller
 - b. Support for additional Reader Sub-controllers (up to 64 doors total)
 - c. Sub-controller Model # RSC-1 & RSC-2

B. Rolling Gate Operator

1. There shall be a Chain Driven Type Slide Gate Operator for the opening/closing of each access gate. 480VAC power will be furnished on-site.
2. It shall be provided with and connected to obstruction loops inserted on both sides of the entrance access gate. The obstruction loops shall be buried 4 inches in the concrete pavement an arranged as per the Contract Drawings.
3. Manufacturer: HySecurity model SlideDrive 50VF2/3 with:
 - a. Plug in Loop Detector Option
 - b. Provide 480V Disconnect Switch adjacent to operator. Mount to rack constructed of 2" galvanized pipe and strut similar to other racks specified for this project.
 - c. Operator shall be mounted on contractor installed concrete slab per the manufacturer. Refer to installation manual for spacing from gate and other requirements.

C. Door Access Readers:

1. HID iClass SE Card Readers:
 - a. Model R40
 - b. HID Proximity
 - c. DESFire/Mifare compatible.
 - d. Provide all manufacturer recommended accessories required for outdoor installation.

D. Fire Department Emergency Access Lock Box

1. Subject to compliance with the Contract Documents, the following manufacturer is acceptable:
 - a. DoorKing
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. The manufacturer listed above is not relieved from meeting these specifications in their entirety.
3. There shall be a Fire Department Emergency Access Lock Box installed on the gate access panel.
4. Type: DoorKing DKS Model 1401
 - a. The lock box type is for reference only. The Contractor shall provide a lock box from the approved manufacturers which meet the following features.
 - b. 14-gauge steel cabinet painted black. Faceplate is painted bright red.
 - c. Accepts Knox KS-2 key switch (not supplied).
 - d. Blank label inside for written instructions
 - e. Gate/door opens when the key switch is activated by Fire Department personnel.
 - f. Dimensions: 5.38"H x 4.5"W x 5.38"D

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. All CCTV and security system components, including mounting hardware, shall be provided and installed by the licensed security CONTRACTOR. The licensed security CONTRACTOR shall be responsible for providing, installing, and terminating all wiring to the CCTV and security system equipment, including the NVR setup and 120 Vac power wiring. Conduits and wiring shall be provided by the licensed security CONTRACTOR unless noted otherwise.
- B. The licensed security CONTRACTOR shall be responsible for installation of control and signal wiring.
- C. Miscellaneous:
 - 1. Any signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, or isolation requirements shall be furnished as required to make the equipment perform properly.
 - 2. All components shall be securely mounted and all cabling shall be neatly organized and tied.
- D. Training:
 - 1. Training shall be provided by an experienced, competent, and authorized representative of the equipment manufacturer. The training shall be conducted onsite in the OWNER's facilities and shall cover equipment setup, operation, maintenance, and features. One eight-hour session shall be provided for the CCTV system. One eight-hour training session shall be provided for the security system. All costs for these services shall be included in the Contract Price.

3.02 SUBMITTALS:

- A. Complete electrical wiring diagrams, assembly drawings, detailed specifications, and data covering the materials used and the parts, devices and other accessories forming a part of the equipment furnished shall be submitted. The equipment submittals shall include the following:
 - 1. A complete description of all system components including certification of UL and FM listings.
 - 2. Complete sequence of operation for all functions of the system.
 - 3. Complete system wiring diagram for all components.
 - 4. A listing of the manufacturer's representatives responsible for service.
- B. Operation and Maintenance Manuals. Adequate operation and maintenance information shall be supplied for all equipment requiring maintenance or other attention. The licensed security CONTRACTOR shall prepare an operation and maintenance manual for each type of equipment indicated in the individual equipment sections or the equipment schedule.
- C. Operation and maintenance manuals shall include the following:
 - 1. Equipment function, normal operating characteristics, and limiting conditions.

2. Assembly, installation, alignment, adjustment, and checking instructions.
 3. Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.
 4. Maintenance instructions.
 5. Guide to troubleshooting.
 6. Parts lists and predicted life of parts subject to wear.
 7. Outline, cross section, and assembly drawings; engineering data; and wiring diagrams.
- D. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.
- E. Preliminary copies of operation and maintenance manuals shall be submitted to the OWNER before shipment of the equipment. Preliminary copies shall be in hardcopy format. The quantity of copies shall be as required.
- F. After review by OWNER, final copies of operation and maintenance manuals shall be delivered to OWNER no later than 30 days prior to placing the equipment in operation. Final copies shall include the number of hard copies and electronic copies as required.
- G. Hardcopies for final manuals shall be temporarily bound in heavy paper covers bearing suitable identification. All manuals and other data shall be printed on heavy, first quality 8-1/2 x 11 inch paper, with standard three-hole punching. Drawings and diagrams shall be reduced to 8-1/2 x 11 inches or 11 x 17 inches. Where reductions are not practicable, larger drawings shall be folded separately and placed in envelopes, which are bound into the manuals. Each envelope shall be suitably identified on the outside. Each volume containing data for three or more items of equipment shall include a table of contents and index tabs. The final hardcopy of each manual shall be prepared and delivered in substantial, permanent, three-ring or three-post binders with a table of contents and suitable index tabs.
- H. Each electronic copy shall be delivered on a unique CD-ROM in Adobe Acrobat's Portable Document Format (PDF). The PDF files(s) shall be fully indexed using the Table of Contents, searchable with thumbnails generated.
- I. All material shall be marked with project identification, and inapplicable information shall be marked out or deleted.
- J. Shipment of equipment will not be considered complete until all required manuals and data have been received.
- 3.03 WARRANTIES AND GUARANTEES:
- A. All equipment shall be covered by manufacturer's normal written guarantee and/or warranty (minimum one year) with respect to parts, workmanship, and performance of the product. CONTRACTOR shall warranty labor and installation for a minimum of 2 years. The equipment guarantee and/or warranty will become effective on the date of acceptance of the completed system by the OWNER.

END OF SECTION

