City of Canton, GA

# Water Pollution Control Plant Expansion to 6 MGD

Contract Documents and Technical Specifications
Bidding Set

## Volume 3 of 3

September 2020

in association with:


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COA: #PEF000902
EXP: 06/30/2022
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# EXPANSION TO 6 MGD
## CITY OF CANTON, GEORGIA

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# Canton Water Pollution Control Plant
# Expansion to 6 MGD
# City of Canton
# Canton, Georgia
# Project Specifications
# Sign and Seal Sheet

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Hector M. Casablanca, P.E.


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# for
# Canton Water Pollution Control Plant
# Expansion to 6 Million Gallons Per Day

## City of Canton
## Canton, Georgia

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| 15550 | Electric Domestic Water Heaters | Clifton John Alford, P.E. |


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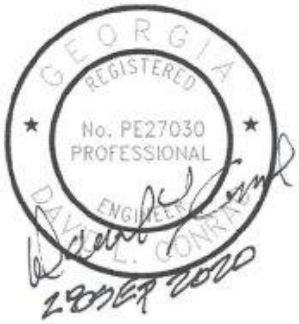

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Jeffrey N. Warmington, AIA, LEED® AP


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# for
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# Expansion to 6 Million Gallons Per Day

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## Canton, Georgia

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Tim Hartwell, P.E.

# SECTION 13121

# PREFABRICATED CONCRETE BUILDINGS

## PART 1: GENERAL

### 1.01 WORK INCLUDED

A. The following Specifications cover all the requirements for providing and installing one pre-engineered, single story, precast concrete building for the Alum Feed Facility and the UVPA Electrical Building.

### 1.02 RELATED SPECIFICATIONS:

A. The following sections of Specifications have scope which is to be provided as part of the fabrication of these buildings:

1. Section 04220, Masonry Units.
2. Section 08100, Doors and Frames.
3. Section 08710, Finish Hardware.
4. Section 09900, Paints and Coatings.

### 1.03 GENERAL

A. Manufacturer to furnish precast, fully assembled, transportable manufactured buildings.

B. The manufacturer needs to coordinate the conduit location of electrical equipment and other pipe entrance location and the size and location of all building cutouts with the General Contractor. The exact size and location of all cutouts shall be determined by the Contractor based on the number and size of conduits entering the building and the scope of all other subcontractors.

### 1.04 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. ACI318-99, “Building Code Requirements for Reinforced Concrete”, American Concrete Institute.
2. ASCE 7-98, “Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers.
3. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):
    a. 90A, Energy Conservation in New Building Design.
    b. Fundamentals Handbook.
4. ASTM International (ASTM):
    a. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.

b. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

c. Cl50, Standard Specification for Portland Cement.

d. C94/C94M, Standard Specification for Ready-Mixed Concrete.

e. C920, Standard Specification for Elastomeric Joint Sealants.

f. E84, Standard Test Method for Surface Burning Characteristics: Building Materials.

5. National Fire Protection Association (NFPA):

a. 10, Portable Fire Extinguishers.

b. 13, Installation of Sprinkler Systems.

c. 70, National Electrical Code.

d. 90A, Standard for Installation of Air Conditioning and Ventilation Systems.

e. 101, Life Safety Code.

1.05 SYSTEM DESCRIPTION

A. Building Names: Alum Feed Facility and UVPA Electrical Building

1. Size: Height and clear interior floor dimension as shown on Drawings and as required to contain equipment.

2. Roof Slope: 1/4 inches vertical to 12 inches horizontal. As shown on Drawings.

3. Include: Liner panels, Doors, frames, door hardware, louvers, lighting and air-conditioning units, interior and exterior finishes, and other equipment as describes herein or as shown on the Project Drawings. equipment and finishes to be corrosion resistant. See Section 08150 Steel Doors and Frame Assemblies and Section 08710, Door Hardware for entrance door assemblies.

B. System: Design, furnish, and install complete building package using manufacturer's standard components.

C. Structure: Pre-engineered, single-story, simple single-span, precast concrete.

D. Design: Coordinate enclosure design with electrical equipment to be enclosed.

E. Control indoor air quality and provide electrical illumination and power.

F. Wall and Roof Insulation:

1. Walls: Minimum R-11.

2. Roof: Minimum R 19.

1.06 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:

a. Manufacturer's Standard Details and Structural Calculations signed and sealed by an Engineer Registered in the State of Georgia. Clearly mark

those portions that apply to specific Project and those parts that do not apply.

b. Manufacturer's Literature and Technical Data: Drawings and Specifications for proposed building system and including all equipment supplied as part of the building.

c. Painting Systems: Specifications including paint manufacturer's name, product trade-name, and preparation for shop and field coats.

d. Structural calculation certified by a licensed Georgia Engineer showing that the structures and calculations will meet design pressures based on criteria established in accordance with the Georgia Building Code and as written in Specifications and on the Structural Drawings.

1) Drawings stamped by Contractor's Engineer Registered in the State of Georgia and prepared specifically for this Project:

2) Materials and Details: Show materials, details of components (including doors and other accessories), finishes, fastenings, methods of joining, sealants, anchor bolt, shear angle, and baseplate details, including all sizes and dimensions, size and location of structural members and bracing, wall structural members, bracing, openings, and structural wind columns as required.

e. Calculations Stamped by Contractor's Engineer Registered in the State of Georgia.

1) Complete structural stress and deflection analysis of structural components and connections; for bolted resistant connections in main frames consider prying off bolts.

2) Heat loss calculations showing conformance with applicable code.

3) Heating and cooling load calculations showing adequate equipment capacity to maintain design indoor conditions.

4) Manufacturer's literature and technical data on lights, starters, and electrical equipment furnished with the building.

2. Samples: Colors of exterior and interiors available.

B. Quality Control Informational Submittals:

1. Experience records of manufacturer and installer.

2. Approval of installer by manufacturer of structure components.

3. Certification that codes and referenced standards have been met.

4. Description and details of electrical continuity and grounding methods.

5. Test reports.

1.07 QUALITY ASSURANCE

1. Designers: Engineers Registered in the State of Georgia.

2. Manufacturer:

a. At least 5 years' experience in work of the type required in this section.

b. Production capacity to provide work required for this Project without delay.

c. Manufacturer must be a member of the National Precast Concrete Association (NCPA) and must be manufactured at a certified plant.

3. Erector/Installer:

a. Not less than 5 years' experience in the erection of prefabricated structures similar to this Project.

b. Approved by manufacturer of building components.

B. Regulatory Requirements: Design building system to meet requirements of:

1. Georgia Building Code.

2. ASHRAE 90A, Energy Conservation in New Building Design.

3. Georgia Plumbing Code.

4. NFPA 101, Life Safety Code.

5. NFPA 70, National Electrical Code.

6. Georgia Fire Prevention Code.

7. Georgia Electrical Code.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver building components in undamaged condition to Site only when ready for installation.

B. Protect products from damage and deterioration.

C. Handle products in accordance with manufacturers' instructions.

1.09 GUARANTEE

A. Conditions: Precast concrete structure, walls, and roof will remain watertight for a period of 20 years. Roofing will remain weathertight for 20 years. Warranty supplied in the County name.

PART 2: PRODUCTS

2.01 BUILDING SYSTEM MANUFACTURERS

A. Easi-Set.

B. Concrete Modular Systems, Inc.

C. Old Castle Precast.

D. Or approved equal.

2.02 SYSTEM PERFORMANCE

A. Structural Loading: Design structure in accordance with ASCE 7-16 and the following:

1. Building: Own dead load.

2. Special Equipment: As located on the Drawings.

3. Floor Live Load: 250 psf.

4. Design Wind Loads: In accordance with applicable building code in the Project area, but not less than 120 mph.

5. Earthquake Load: In accordance with applicable building code requirements for this project site.

6. Roof Live Load: 50 psf.

B. Outside Design Conditions:

1. Temperature: Winter DB, 37; summer DB, 94, WB, 76.

2. Prevailing Wind Direction and Velocity: Winter WNN 9 mph; Summer NNW 8 mph.

2.03 COMPONENTS

A. A. Substructure: Contractor shall be responsible for foundation as detailed on the drawings. Manufacturer shall provide a floor slab that meets the building manufacturer's requirements and is coordinated with the detailed foundation. Manufacturer shall be responsible for coordination of all foundation requirements with the Contractor. The General Contractor is responsible for preparing the site for receipt of the building and its installation.

B. Shell:

1. Provide weathertight structure that has straight, plumb walls with squat comers. The building shall be entirely assembled at the plant, sealed, waterproofed, and sealed and tested for water tightness.

2. Concrete: Steel reinforced, 5,000 psi minimum, 28-day compressive strength, air-entrained (ASTM C260), water reduced normal weight.

3. Reinforcing Steel: ASTM A615, Grade 60, deformed bar unless otherwise indicated.

4. Post-Tensioning Strand: 41K Polystrand CP50, 0.50, 270 ksi, 7-wire strand, greased plastic sheath (ASTM A416). Roof and floor to be post-tensioned by a single, continuous tendon. Said tendon shall form a substantially rectangular configuration having gently curving comers and a comer where the tendon member are anchored. Tendons shall be greased and enclosed within sheathing.

a. If post-tensioning is not used in the roof panel, the following guidelines must be followed to ensure a watertight roof design:

1) The entire precast concrete roof panel surface must be cleaned and primed with a material that prepares the concrete surface for proper adherence to the coating material.

2) The entire precast concrete roof panel surface shall be sealed with 0.045 EPDM continuous membrane cemented to the concrete with a compound designed for this purpose.

5. Caulking: All joints between panels shall be caulked on the exterior and interior surface of the joints. Caulking shall be Sonnebom “Sonolastic NP-1 Limestone sealant, or equal. Exterior caulk joint to be 3/8” x 3/8” deep square so that sides of joints are parallel for correct caulk adhesion. Caulk color and exterior finish color to be selected by Owner.

6. Panel Connections: All panels shall be securely fastened together with 3/8” thick steel brackets. Steel is to be of structural quality, hot-rolled carbon complying with ASTM A36 HR, prime coated after fabrication. All fasteners to be ½” diameter bolts complying with ASTM A307 for low-carbon steel bolts. Cast-in anchors used for panel connections to be Dayton-Superior No. F-63, or equal. All panel connections to be painted as per Section 09900, Painting and Protective Coatings, System No. 4.

7. Concrete exterior walls to be broom finish stained finish. Color to be selected by Owner.

8. Concrete roof, fascia, and soffits to be color as selected by Owner. Roof to receive manufacturer’s 20-year warranty roof, membrane and trim. Warranty to cover wall and roof defects, deterioration, and wall penetration. Warranty to be supplied in the County’s name.

C. Interiors:

1. Floors: Level, easy to clean, nonslip to wet, smooth rubber-sole shoes. Floor to be skid-resistant epoxy with aggregate (one coat, 160 SFPG).

2. Interior walls and ceilings to be Class A rated Kemply FRP Surfaced Paneling or approved equal. FRP panel shall be backed with extruded polystyrene rigid insulation of adequate dimension to meet R-value of R-11 for the walls and R-19 for a ceiling. Panels as manufactured by Crane Kemlite Company, Inc., or approved equal.

   a. Panels to be 12-inch Fine-X Glasbord with Sufaseal Color 85 white.

   b. Substrate is extruded polystyrene foam XEPS-closed cell.

   c. Moldings are PVC (polyvinyl chloride) moldings No. 85 white.

   d. Rivets: No. 85 white.

3. Four-inch rubber base is to be provided as required to finish bottom of wall panels at concrete floor. Base color to match floor color.

4. Flame Spread: ASTM E84 rating of 25 or less.

5. Allowable Inside Ambient Noise Level: 50 dBA from inside sources; 80 dBA from outside sources.

6. For doors and frames and hardware, see Section 08001, Door and Hardware Schedule, Section 08150, Steel Doors and Frame Assemblies, Section 08710, Door Hardware, and Section 08800, Glazing.

D. Special Construction:

1. The precast concrete buildings shall be provided with cutouts located below the equipment, i.e., motor control cabinets, instrumentation, piping, etc., as shown on Plumbing, Electrical, or Process Mechanical Drawings for each building fabricated by building manufacturer for installation of all cables and conduit to the equipment located outside the building.

2. The Contractor shall be responsible for filling this void with grout upon completion of installation to prevent insects, water, dirt, and other from entering the enclosure.

E. Fire Protection: Furnish fire extinguishers as shown on drawings and as specified in Section 10520, Portable Fire and Safety Equipment, and in accordance with NFPA 13.

F. Electrical Systems: Not included as part of scope for prefabricated building manufacturer.

G. Colors: As selected by Owner and coordinated by General Contractor.

2.04 UNIT HEATER, ELECTRIC, SUSPENDED: ALUM FEED FACILITY

A. General

1. Provide one wall mounted unit heater capable of maintaining 55°F inside the building.

2. Factory assembled including casing, heater elements, fan wheel, drive assembly, motor, controls and accessories.

3. UL listed.

4. Meet requirements of National Electrical Code.

5. Three phase heater shall have balanced phases.

6. Provided with wall bracket for installation.

B. Casing:

1. Heavy gage steel casing.

2. Baked enamel finish.

3. Individual adjustable discharge louvers.

4. Protective air inlet louvers or fan guards.

C. Heating Elements shall be one of the following types:

1. Aluminum finned, copper clad, steel sheath.

2. High mass, all steel tubular finned type, copper brazed, in fixed element banks.

3. Nickel chromium wire elements enclosed in powder filled aluminum coated steel tubes with permanently fused fins.

4. Steel tubes with nickel chromium resistance wire embedded in a dielectric with steel fins crimped and brazed to the tube.

5. Corrosion resistant steel fins brazed to tubular heating elements.

D. Design Parameters

1. Temperature Differential: 50°F

2. Provide a minimum air flow of 530 cfm.

3. Heater on and off: Set at the heater or at manufacturer provided thermostat.

E. Fan and Motor:

1. Totally enclosed motor shall be a maximum 0.5 horsepower, 480 V, 3-phase, with disconnect.

2. Direct drive fan.

3. Sealed bearing. Permanently lubricated.

F. Controls:

1. Integral thermostat to automatically maintain 55°F

2. Thermal overload protection with automatic reset.

3. Controls, transformers, and contactors shall be factory assembled.

G. Manufacturers and Products:

1. Qmark; Type MUH

2. Trane; Type UHEC

3. Or equal

2.05 VENTILATION: ALUM FEED FACILITY

A. Propeller Wall Fan

B. General

1. Provide one wall mounted exhaust fan sized to maintain 90°F inside the building.

2. Provide an associated wall mounted back draft damper sized to match air requirements of the wall fan.

3. Factory-assembled wall propeller fan; including housing, propeller, drive assembly, motor and accessories.

C. Housing

1. Material: Metal components constructed from aluminum.
2. Panel:
    a. Minimum 14-gauge sheet metal construction.
    b. Integral formed venturi orifice.
    c. Continuously welded comers.
    d. Bolted to frame.
3. Frame:
    a. Minimum 14-gauge metal construction.
    b. Continuously welded joints.
    c. Reinforced motor baseplate.

D. Propeller:

1. Cast aluminum construction.
2. Hub keyed and mechanically locked to shaft.

E. Shaft, Bearings, Drive:

1. Shaft:
    a. Turned, ground and polished carbon steel.
    b. Keyed for sheave installation.
2. Bearings:
    a. Grease lubricated, precision antifriction ball, self-aligning, sealed pillow block style.
    b. Mounted in cast iron pillow block housing.
    c. Selected for average life (ABMA 9 $L_{50}$) of not less than 200,000 hours operation at maximum cataloged operating speed.

F. Design Parameters

1. Provide a minimum air flow of 12 air changes per hour.
2. Fan on and off: Manually operated through switch at the door.

G. Fan and Motor:

1. Totally enclosed motor shall be a maximum 0.5 horsepower, 480 V, 3-phase, with disconnect.
2. Direct drive fan.
3. Sealed bearing. Permanently lubricated.

H. Back Draft Damper

1. Aluminum, counterbalanced.
2. Suitable for mounting in wall, opposite of the exhaust fan.
3. Counterbalance provided by zinc plated steel weights mechanically attached to blade.
4. Blades shall

I. Motor:

1. General:
   a. Fan motor shall comply with provisions of Section 16220 Electric Motors.
2. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:
   a. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
   b. Winding Thermal Protection: None.
   c. Space Heater: No.
   d. Number of Speeds: Single.
   e. Number of Windings: One.
   f. Motor Efficiency: Premium efficient.
   g. Shaft Type: Solid, carbon steel.
   h. Mounting: As required for fan arrangement.
   i. Service Factor: 1.15.

J. Manufacturers and Products:

1. Aerovent; Macheta.
2. New York Blower; Model NYC.
3. Or equal

2.06 HEATING AND AIR CONDITIONING: UVPA ELECTRICAL BUILDING

A. Furnish heating and air conditioning system to maintain inside temperature between 50 and 85 degrees F and between 50 and 70 percent relative humidity.

B. Self-contained wall mounted air-conditioning unit shall be suitable for outdoor use, specifically designed for electrical enclosure climate control. Unit shall be factory assembled and tested and shall include compressor, indoor and outdoor coils, fans, motors, prewired controls, interconnecting refrigerant tubing, wiring, circuit breaker, and other necessary components mounted in a corrosion resistant cabinet.

C. Unit shall be shipped from the factory with a full operating refrigerant and oil change.

D. Unit shall come with factory applied protective coating.

E. Unit shall be designed for an electrical heat load of 15 kW.

2.07 MATERIALS

A. Concrete: Furnish as specified in Section 03300, Cast-In-Place Concrete.

B. Reinforcing Steel: ASTM A615/A615M, Grade 60 deformed bars.

C. Welded Wire Fabric: ASTM A497/A497M.

D. Concrete Formwork: HDO plywood.

E. Roofing: Manufacturer's standard single-ply EPDM membrane meeting ASTM D4637.

F. Sealant: Single part polyurethane or silicone meeting ASTM C920, Type S, Grade NS, Class 25.

G. Hollow Metal Doors, Frames, and Hardware: See Section 08001, Door and Hardware Schedule, Section 08150, Steel Doors and Frame Assemblies, and Section 08710, Door Hardware.

1. Size: As scheduled on Drawings.

2. Furnish pressed-steel frames and full-flush hollow metal doors meeting Steel Door Institute (SDI) 100, Grade n, Model 1, 18-gauge.

3. Furnish hardware including hinges, cylindrical lock sets keyed into Owner's existing system, automatic closing devices, full weatherstripping, and thresholds, as applicable.

2.08 SOURCE QUALITY CONTROL

A. Inspections: Before shipment, inspect for complete, functional assembly.

B. Tests: Perform manufacturers' standard tests and adjustments on mechanical and electrical equipment and other moving and operating components.

PART 3: EXECUTION

3.01 EXAMINATION

A. Examine Site and access to determine effect on proposed building.

B. Investigate soils conditions and their effect on proposed building.

3.02 SUBGRADE PREPARATION

A. Site shall conform to the requirements of the building manufacturer. The Contractor shall be responsible for preparing the subgrade for the building. Verify site conditions and make necessary field measurements.

B. Perform Site modifications to suit installation of each prefabricated building.

C. Contractor shall be responsible for all excavation, subgrade, preparation, fill and backfill.

3.03 ERECTION

A. Erect structural components in accordance with manufacturer's instructions. Securely anchor to concrete foundation.

B. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of permanent, stable structure.

C. Install materials following manufacturers' instructions and recommendations.

3.04 FIELD FINISHING

A. Doors and Frames: Apply minimum two-coat paint system as specified in Section 09900, Painting and Protective Coatings.

B. Do not paint electrical equipment.

3.05 HEATING AND VENTILATING

A. Install equipment and components following manufacturer's instructions and recommendations.

B. Meet requirements of NFPA 90A and 90B.

C. Adjust for proper operation and control.

3.06 ELECTRICAL SYSTEMS

A. Meet requirements of National Electrical Code, NFPA 70.

B. Install products in accordance with manufacturers' instructions and recommendations.

C. Provide grounding for building by connecting to the plant ground grid.

3.07 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on moving and operating components.

B. Performance Tests: Test and balance HVAC system.

C. Electrical Continuity: Test continuity of completed metal structure and installed equipment to ground.

END OF SECTION

# SECTION 13122

# MODULAR PRECAST CONCRETE STRUCTURES

## PART 1: GENERAL

### 1.01 WORK INCLUDED

A. Contractor to furnish a precast concrete building for the MBR ELECTRICAL BUILDING. The building shall be modular and field assembled by the manufacturer on the cast-in-place foundation as indicated on the Contract Documents.

### 1.02 REFERENCES

A. ACI-318-11: Building Code Requirements for Structural Concrete and Commentary.

B. ASCE/SEI 7-10: Minimum Design Loads for Buildings and Other Structures.

C. IBC 2012: International Building Code.

D. PCI Design Handbook, 7th Edition.

E. Concrete Reinforcing Institute, Manual of Standard Practice.

F. UL-752 (Test Method level 5) for bullet resistance certified by a military approved laboratory.

### 1.03 SYSTEM DESCRIPTION – DESIGN REQUIREMENTS

A. Building Dimensions:

1. Exterior: 24’ x 40’ x 13’-0” (not including floor)

2. Interior: 23’-4” x 39’-4” x 12’ 0”

B. Design Loads:

1. Seismic Design Category ‘D’, Risk Design Category III

2. Roof Live Load (Snow) – 10 PSF

3. Floor Live Load – 250 PSF (if precast floor is provided)

4. Wind Loading* – 120 MPH

*Design loads relate to precast components only, not accessories (i.e., doors, windows, vents, etc.).

C. Roof: Roof panel shall have a minimum of 6” slope from peak to edge. The roof shall extend 4” beyond the wall panel and have a turndown design which extends ½” minimum below the top edge of the wall panels to prevent water migration into the building along top of wall panels. Roof shall also have an integral architectural ribbed edge.

D. Roof Joint Keyway: Grout in keyways shall be a magnesium phosphate material or equal, prepared and placed per the manufacturer's recommendations. Apply a polysulfide, elastomeric joint sealant to the top of the grouted keyway, installed per manufacture's recommendations.

E. Floor panel or contractor supplied cast-in-place slab must have a ½" step-down around the entire perimeter to prevent water migration into the building along the bottom of wall panels.

1.04 SUBMITTALS

A. Engineering calculations that are signed and sealed by a licensed Georgia Professional Engineer shall be submitted for approval. Design shall be based on criteria established in accordance with the Georgia Building Code and as written in Specifications and on the Structural Drawings.

B. Manufacturers' product literature shall be provided for any plumbing, electrical, and miscellaneous installed fixtures demonstrating compliance with these specifications

C. Painting Systems: Specifications including paint manufacturer's name, product trade-name, and preparation for shop and field coats.

D. Structural calculation certified by a licensed Georgia Engineer showing that the structures and calculations will meet design loads based on criteria established in accordance with the Georgia Building Code and as written in Specifications and on the Structural Drawings.

1. Drawings stamped by Contractor's Engineer Registered in the State of Georgia and prepared specifically for this Project:

2. Materials and Details: Show materials, details of components (including doors and other accessories), finishes, fastenings, methods of joining, sealants, anchor bolt, shear angle, and baseplate details, including all sizes and dimensions, size and location of structural members and bracing, wall structural members, bracing, openings, and structural wind columns as required.

E. HVAC Calculations Stamped by Contractor's Engineer Registered in the State of Georgia.

1. Heat loss/gain calculations showing conformance with applicable code.

2. Heating and cooling load calculations showing adequate equipment capacity to maintain design indoor conditions.

3. Manufacturer's literature and technical data on lights, starters, and electrical equipment furnished with the building.

4. Samples: Colors of exterior and interiors available.

F.

G. Manufacturers' product literature shall be provided for any plumbing, electrical, and miscellaneous installed fixtures demonstrating compliance with these specifications.

1.05 QUALITY ASSURANCE

A. The precast concrete building producer shall be a plant-certified member of either the National Precast Concrete Association (NPCA), The Precast/Pre-stressed Concrete Institute (PCI), or equal.

B. The precast concrete building producer shall demonstrate product knowledge and must have a minimum of 5 years experience manufacturing and setting precast concrete.

PART 2: PRODUCTS

2.01 BUILDING SYSTEM MANUFACTURERS

A. Easi-Set.

B. Concrete Modular Systems, Inc.

C. Old Castle Precast.

D. Or approved equal.

2.02 MATERIALS

A. Concrete: Steel-reinforced, 5000 PSI minimum 28-day compressive strength, air-entrained (ASTM C260).

B. Reinforcing Steel: ASTM A615, grade 60 unless otherwise specified.

C. Welded Wire Fabric: ASTM 185, Grade 65.

D. Post-tensioning Strand: Roof sections shall be post-tensioned in the field after grout keyway is filled and has cured to the required PSI strength. Post-tensioning strand shall be 41K Polystrand CP50, ½" 270 KSI Seven-Wire strand, enclosed within a greased plastic sheath (ASTM A416). There will be a minimum of three transverse post-tensioning cables connecting roof and floor (if provided) sections together to provide a watertight joint. To ensure a watertight design, no alternate methods shall be substituted for the post-tensioning.

E. Caulking: All joints between panels shall be caulked on the exterior and interior surface of the joints. Caulking shall be DOW CORNING 790 silicone sealant or equal. Exterior caulk reveal to be 3/8" x 3/4" deep so that sides of joint are parallel for proper caulk adhesion. Back of the joint to be taped with bond breaking tape to ensure adhesion of caulk to parallel sides of joint and not the back.

F. Panel Connections: All panels shall be securely fastened together with 3/8" thick steel brackets. Steel is to be of structural quality, hot-rolled carbon complying with ASTM A36 and hot dipped galvanized after fabrication. All fasteners to be ½" diameter bolts complying with ASTM A325 for carbon steel bolts. Cast-in anchors used for panel connections to be Dayton-Superior F-63 coil inserts, or equal. All inserts for corner connections must be secured directly to form before casting panels. No floating-in of connection inserts shall be allowed. Wall panels shall be connected to cast-in-place floor slab using expansion anchors providing adequate embedment by manufacturer.

2.03 ACCESSORIES

A. Doors and Frames: Shall comply with Section 08100 Doors and Frames.

1. The buildings shall be equipped with:

a. (1) double 3’-0” x 7’-0” x 1-3/4” thick insulated, 18 gauge, FRP doors with 16-gauge frames (to meet wall thickness). Doors to have flush top cap. 12-gauge flat astragals shall be applied to the active leaf to protect against the elements or forced opening.; and

b. (1) 3’-0” X 7’-0” x 1-3/4” thick insulated, 18 gauge, FRP door with 16-gauge frames (to meet wall thickness). Doors to have flush top cap. .

2. Doors and frames shall meet SDI standard Level 2, 1¾” heavy duty.

B. Door Hardware

1. Pull Handle: Shall meet requirements of ANSI A156.2. Shall be thru bolt attached and constructed of a minimum ¾” diameter stainless pull handle sized 8” center to center with a stainless backer plate, minimum 0.053” on both sides.

a. Approved manufacturers: Design Hardware, Don-Jo, or equal

2. Hinges: Shall comply with ANSI A156.1 and be of the ball bearing, non-removable pin type (3 per door minimum). Hinges shall be 4 ½” x 4 ½” US26D (652) brushed chrome finish. Manufacturer shall provide a lifetime limited warranty.

a. Approved manufacturers: Design Hardware, or equal

3. Deadbolt: Commercial Grade Deadbolt conforming to ANSI 156.5 furnished with a 2 ¼” face plate and a 1” projecting deadbolt with hardened steel pins. Dead bolts shall be UL and ADA approved. Finish shall be US26D (626) brushed chrome finish. Manufacturer shall provide a lifetime limited warranty.

a. Approved manufacturers: Design Hardware, Dorma, or equal

4. Surface Bolt: 8” Surface bolt UL listed. Finish US26D (626) brushed chrome finish. (2 per inactive leaf)

a. Approved manufacturers: Don-Jo, Design Hardware, or equal

5. Threshold: Bumper Seal type threshold with a maximum 1” rise to prevent water intrusion. Thresholds shall be approved for UL 10B suitable for use with fire doors rated up to three hours.

a. Approved manufacturers: National Guard Products or equal

6. Overhead Door Holder: Heavy duty surface mounted hold open device with hold open/stop angle of 85 to 110 degrees. Construction shall be stainless steel. Finish US32D (630) satin stainless steel finish.

a. Approved manufacturers: ABH, Rockwood, or equal

7. Drip Cap: Aluminum drip cap with minimum projection of 2 ½” shall be furnished.

a. Approved manufacturers: Design Hardware, National Guard Products, or equal

8. Door Stop: ANSI 156.16 approved wall mounted door stop with keeper constructed of a corrosion resistant cast brass material. Finish US26D (626) brushed chrome finish.

a. Approved manufacturers: Don-Jo, Rockwood, or equal

2.04 HEATING AND AIR CONDITIONING:

A. Furnish heating and air conditioning system to maintain inside temperature between 50 and 85 degrees F and between 50 and 70 percent relative humidity.

B. Self-contained wall mounted air-conditioning unit shall be suitable for outdoor use, specifically designed for electrical enclosure climate control. Unit shall be factory assembled and tested and shall include compressor, indoor and outdoor coils, fans, motors, prewired controls, interconnecting refrigerant tubing, wiring, circuit breaker, and other necessary components mounted in a corrosion resistant cabinet.

C. Unit shall be shipped from the factory with a full operating refrigerant and oil change.

D. Unit shall come with factory applied protective coating.

E. Unit shall be designed for an electrical heat load of 30 KW.

2.05 FINISHES

A. Interior of Building: Smooth form finish on all interior panel surfaces unless exterior finish is produced using a form liner, then smooth hand-troweled.

B. Exterior of Building: (Standard) Architectural precast concrete brick finish: Finish must be imprinted in top face of panel while in form using an open grid impression tool similar to EASI-BRICK®. Finished brick size shall be 2 3/8” x 7 5/8” with vertical steel float or light broom finish. Joints between each brick must be 3/8” wide x 3/8” deep. Back of joint shall be concave to simulate a hand-tooled joint. Each brick face shall be coated with the following water-based acrylic, water repellent penetrating concrete stain: 1) Canyon Tone stain by United Coatings, 2) Sherwin Williams (H&C concrete stain) or equal. Stain shall be applied per manufacturer’s recommendation. Joints shall be kept substantially free of stain to maintain a gray concrete color. Stain color shall be BRICK RED unless specified otherwise.

C. Exterior of Building (Option #1): Washed brown riverstone applied-aggregate finish on all exterior wall surfaces. Aggregate must be seeded into top of panel while in form, chemically retarded, and high-pressure washed to expose the aggregate to a depth of 1/8”.

D. Exterior of Building (Option #2): Additional finishes are available and will vary by local producer.

PART 3: EXECUTION

3.01 SITE PREPARATION RECOMMENDATION (FIELD ASSEMBLED ON CAST-IN-PLACE FLOOR)

A. Work under this section relates to installation of the building by Easi-Set licensed producer on the customer's prepared foundation and site.

B. Slab on grade (designed by others) to be minimum 6" thick and 4,000 psi steel reinforced concrete. Slab to be level within 1/8" in both directions and capable of supporting loads imposed by the structure. Floor slab must have a ½" step-down around the entire perimeter to prevent water migration into the building along the bottom of wall panels.

3.02 SITE ACCESS

A. Contractor must provide a level, unobstructed area large enough for a crane and a tractor-trailer to park adjacent to the pad. Crane must be able to place outriggers within 5'-0" of edge of pad; truck and crane must be able to get side by side under their own power. No overhead lines may be within 75' radius of center of pad. Firm roadbed with turns that allow 65' lowbed tractor-trailer must be provided directly to site. No building shall be placed closer than 2'-0" to an existing structure unless specifically permitted.

END OF SECTION

# SECTION 13204

# POLYETHYLENE STORAGE TANKS

## PART 1: GENERAL

### 1.01 WORK INCLUDED

A. This Section covers the Work necessary to furnish and install two double walled vertical bulk chemical storage tanks for polymer liquid for a belt filter press system and a rotary drum thickener system, and bulk chemical storage tanks for 50% citric acid and 12.5% sodium hypochlorite for the membrane filtration facility.

### 1.02 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American National Standards Institute (ANSI): B16.5, Pipe Flanges and Flanged Fittings.

2. American Society for Testing and Materials (ASTM):

a. D638, Test Method for Tensile Properties of Plastics.

b. D648, Test Method for Deflection Temperature of Plastics Under Flexural Load.

c. D746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.

d. D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

e. D883, Standard Definitions of Terms Relating to Plastics.

f. D1505, Test Method for Density of Plastics by the Density-Gradient Technique.

g. D1525, Test Method for Vicat Softening Temperature of Plastics.

h. D1621, Test Method for Compressive Properties of Rigid Cellular Plastics.

i. D1622, Test Method for Apparent Density of Rigid Cellular Plastics.

j. D1623, Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.

k. D1693, Test Method for Environmental Stress-Cracking of Ethylene Plastics.

l. D1940, Method of Test for Porosity of Rigid Cellular Plastics.

m. D1998, Specification for Polyethylene Upright Storage Tanks.

n. E84, Test Method for Surface Burning Characteristics of Building Materials.

### 1.03 DEFINITIONS

A. HDPE: High density polyethylene

B. RDT: Rotary Drum Thickener

C. BFP: Belt Filter Press

1.04 DESIGN REQIREMENTS

A. Manufacturer shall design dual wall bulk chemical storage tanks, including wall thickness and methods and locations of support and anchorage. Design shall be prepared and sealed by designer meeting requirements of Article Quality Assurance.

B. The minimum required wall thickness of the cylindrical shell at any fluid level shall be determined by the following equation but shall not be less than 0.187-inch thick.

T = P x O.D./2 SD = 0.433 x S.G. x H x O.D./2 SD
T = Wall thickness
SD = Hydrostatic design stress, psi
P = Pressure (0.433 x S.G. x H), psi
H = Fluid head, ft.
S.G. = Specific gravity, $g/cm^3$
O.D. = Outside diameter, in

C. Tank manufacturer must be capable of providing Underwriters Laboratories Listing for Nonmetallic Aboveground Tanks for Chemicals.

1.05 SUBMITTALS

A. All submitted calculations and Drawings shall be prepared, signed, dated, and sealed by a professional engineer registered in the state of Georgia.

B. Shop Drawings:

1. Fabricator’s catalog information, descriptive literature, specifications, and identification of materials of construction. Provide catalog cuts for all off-the-shelf items.

2. Detailed fabrication drawings shall be scale drawings showing the relative size, configuration, location, materials of construction, and details of all equipment and materials to be furnished including the tanks, fittings, gaskets, bolts, access ladders, supports, and tank holddown and support systems. Both plan and elevation views shall be provided. All piping terminal points shall be clearly shown and fully dimensioned.

3. Resin used for each tank and all supporting specifications for resins.

4. Foundation and Anchor Bolt Drawings: Drawings shall be provided that show all data and details required for design of the tank foundations including locations and dimensions for knockouts and embedded items, and the size, type, location, embedment and projection of anchor bolts.

5. Tank data indicating pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, and details of nozzle designs.

6. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.

7. All exceptions and any proposed revisions to the requirements of the Specifications shall be included with the Submittals.

C. Information Submittals:

1. Fabricator's Certificate of Compliance with fabrication requirements.

2. Quality Assurance Inspection:

a. Initial QA Inspection Report.

b. Certification of Factory Testing.

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

4. Fabricator's written/printed installation and tank support instructions.

5. Manufacturer's Certificate of Proper Installation.

6. Operation and Maintenance Manuals.

7. Complete design calculations for tanks, supports and appropriate accessories. Diagrams and calculations shall be provided that indicate all static and dynamic loads. Reactions (uplift, shear, gravity loads, etc.) shall be indicated for each of the applicable loading combinations found in the most recent Georgia Building Code. Calculations for anchor bolt type, size, and location shall be indicated for the controlling load condition.

8. Wall thickness calculations per ASTM D1998, using 600 psi design hoop stress at 100 degrees F.

9. Certified test data on representative samples of standard materials which demonstrate compliance with the physical properties specified herein.

10. Certified copy of all factory test results including gel tests, impact tests, and hydrostatic tests. Provide a listing of procedures used in testing.

11. Installation Instructions: Installation instructions shall be completed, detailed, and sequenced instructions for original installation. Recommended methods for assembly and adjustment including all bolt torques shall be provided along with special precautions and the sequence of work. Rigging and lifting details shall also be included for all factory-fabricated assemblies and individual components weighing over 100 pounds.

1.06 QUALITY ASSURANCE

A. Fabricator's Quality Assurance Supervisor: Minimum of 5 years' experience in the fabrication of polyethylene storage tanks of similar size and usage.

B. Tanks shall be manufactured by a firm with a nationally accepted quality standard (i.e., ISO9001).

C. The interior primary tank shall be made of High Density Linear Polyethylene and have an opaque HDLPE #880046 resin liner; Specific gravity = 1.9.

D. The finished tank shall be free, as commercially practicable, of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, crazing, cracking and delamination that will impair the serviceability of the vessel.

1.07 DELIVERY, STORAGE, AND HANDLING

A. All materials fabricated to this Specification must be packaged, crated or protected in such manner to prevent damage in handling and while in transit. Details of these procedures shall be the responsibility of manufacturer.

B. In addition, prepare and protect the tanks for shipment as follows:

1. Mount tanks on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.

2. Protect all flanged nozzles with wooden blinds bolted to the flange and having a diameter of 2 inches greater than the outside diameter of the flange.

3. Provide either rigid plugs inside the ends to prevent deflection or wooden boxes for all unflanged components. Brace the open ends of tanks with a suitable stiffening member to prevent deflection.

4. Do not ship components or other pieces loose inside the tanks.

5. Load tanks with at least 2 inches of clearance between the tank (including fittings) and the bulkheads or bed of the vehicle.

6. Regardless of the mode of transportation, firmly fasten and pad all components to prevent shifting of the load or flexing of components while in transit.

7. Nozzles or other fittings shall not be used for lifting.

1.08 SPECIAL GUARANTEE

A. Tanks shall have a minimum 3-year full guarantee from the tank manufacturer, covering the complete cost of repair and replacement of the tanks (not including any costs associated with altering, removing, or demolishing the existing facility structure for such removal which shall be borne by Contractor) during the first three years of service, should leakage occur through the tank or the tank fittings, or should the tank or tank fittings show signs of fatigue or failure as determined by Engineer.

B. Manufacturer shall provide an additional standard prorated warranty extending coverage to 5 years.

PART 2: PRODUCTS

2.01 GENERAL

A. All equipment specified herein shall be factory fabricated and assembled to the maximum extent possible requiring a minimum of field assembly. Field installation shall be limited to anchoring the tanks and making external piping connections.

B. All equipment specified herein shall be suitable for contact with the stored chemicals.

C. Like items of materials and equipment shall be the end products of one manufacturer in order to provide standardization for appearance operation, maintenance spare parts, and manufacturer’s service.

2.02 MANUFACTURERS

A. Poly Processing Company

B. Assmann Corporation

C. Or approved equal

2.03 SERVICE CONDITIONS

A. Location: Indoors

B. Ambient Air Temperature Range: 40 to 90 degrees F

C. Relative Humidity: Up to 100 percent

D. Operating Pressure: Atmospheric

E. Stored Materials:

2.04 TANK DESIGN CRITERIA

| Stored Materials | | |
|---|---|---|
| **Equipment** | **Chemical** | **Specific Gravity** |
| RDT Polymer Storage Tank | Emulsion Polymer | 1.02 |
| BFP Polymer Storage Tank | Emulsion Polymer | 1.02 |

A. Special Loads: Design tanks for dead loads from all attached piping.

B. Hydrostatic Load: For specific gravities of stored materials specified herein. Tanks shall be designed to withstand the hydrostatic pressure resulting from a full tank.

C. Dual Wall Construction: Design tanks for double containment of stored chemical.

2.05 TANK CONSTRUCTION

A. The material used shall be virgin polyethylene resin as compounded and certified by the manufacturer. Tank shall be made from linear polyethylene #880046 resin as manufactured by Exxon Chemical, or resin of equal physical and chemical properties.

B. All polyethylene resin material shall contain a minimum of a U.V. 8 stabilizer as compounded by the resin manufacturer. Pigments may be added at the Owner's request but shall not exceed 0.25 percent (dry blended) of the total weight.

C. Tanks shall be fabricated to the dimensions shown on the Drawings and as listed in the Tank Schedule:

| Tank Schedule | | | |
|---|---|---|---|
| **Equipment No.** | **Minimum Capacity** | **Maximum Diameter*** | **Sidewall Height*** |
| RDT Polymer Storage Tank 15-POLY-T-1 | 1,600 gal | 8’ | 5’-3.5” |
| BFP Polymer Storage Tank 15-POLY-T-2 | 2,500 gal | 8’ | 8’-6.5” |
| MBR Citric Acid Storage Tank | 625 gal | 4.5’ | 8’-6” |
| MBR Sodium Hypochlorite Tank | 625 gal | 4.5’ | 8’-6” |
| *Tank sizes are nominal outside diameter sizes | | | |

D. Materials shall Meet or Exceed the Following Properties:

| Parameter | ASTM Test | Requirement |
|---|---|---|
| Density | D1505 | 0.944-0.946 gm/cc |
| Environmental Stress, Cracking Resistance (F50) | D1693 | 1,000 hours |
| Tensile Strength, Ultimate (2” min.) | D638 | 2,600-3,000 psi |
| Elongation at Break (2” min.) | D638 | 400% |
| Vicat Softening Point | D1525 | 240 degrees F |
| Flexural Modulus | D790 | 100,000 psi |
| Brittleness Temperature | D746 | -130 degrees F |
| Heat Distortion Temperature | D648 | 67 degrees C |
| Polyethylene Notch Test (PENT) | F1473 | > 1000 hours |

## 2.06 TANK SUPPORT AND RESTRAINT SYSTEM

A. Each tank and its associated attachments shall be structurally adequate for all tank design criteria specified herein.

B. Provide a minimum of four Type 316 stainless steel holddown lugs, complete with plate, soil anchors, nuts and washers for proper anchoring of the tank. Actual number of holddown lugs shall be calculated with the tank full for seismic load cases and empty for wind load cases.

C. All exposed metal surfaces not constructed of stainless steel shall be painted in accordance with and as specified in Section 09900, PAINTING.

2.07 FITTINGS

A. Tank fittings and openings shall be provided as listed in the Fitting/Opening Schedule and located as shown on the Tank Data Sheet.

| Fitting/Opening Schedule | | |
|---|---|---|
| **Service** | **Type/Location** | **Diameter** |
| Fill | Flanged/Top | 2 inches |
| Vent | Flanged/Top | 4 inches |
| Outlet | Flanged near tank bottom | 2 inches |
| Level Sensor | Flanged/Top | 4 inches |
| Drain | Flanged at tank bottom | 3 inches |
| Overflow | Flanged near top of sidewall | 3 inches |

B. Provide fill pipe drop leg inside tank connecting to fill connection. Pipe drop leg shall extend down into tank interior and shall have a 45-degree elbow installed on its end. Drop leg shall be supported internally by a pipe support. Pipe support shall be a bolted fitting at tank sidewall.

C. Fittings shall be PVDF type, with long shank, deep cut threaded with dual wide nut assembly. End type of fittings for connection to facility piping shall be as shown in the Fitting/Opening Schedule.

D. All flanged fittings shall be gasketed with PVDF Chemline Low Torque Flange Gaskets or approved equal. Viton gaskets will be acceptable for assembly use only.

E. Bolted fittings shall use Hastelloy C bolts with polyethylene-encapsulated heads and PVDF external flanges.

F. All materials used in tank fitting assemblies shall be resistant to the stored chemicals. No wetted fittings or appurtenances shall be of metallic construction.

2.08 ACCESSORIES AND APPURTENANCES

A. All tank accessories and appurtenances shall be chemically compatible with the stored materials and shall be designed to withstand the hydrostatic pressure resulting from a full tank.

B. Ladder:

1. Constructed of fiberglass or stainless steel.

2. Safety cage shall be provided with ladder as required by OSHA standards.

3. Ladder shall be designed to meet OSHA Standards 2206; 1910.27; fixed ladders.

C. Gaskets:

1. PVDF, low torque, full face, ANSI B16.1 dimensions, two concentric, convex, molded rings between center hole and bolt hole circle.

2. Type: 1/4-inch thick, low torque, full face, ANSI B16.1 dimensions.

D. Leak Detector Unit:

1. Tank Attachments-Leak Detector Unit: The leak detector unit shall consist of a proximity sensor, a welded 2-inch fpt connection, a 2-inch bung plug with a 3/4-inch strain relief, and an indicator box. The sensor is placed in the interstitial space between the primary and secondary tanks approximately 1 inch above the tank bottom. The indicator box shall be NEMA 4 rated and factory prewired for 110V ac power. All connections shall be labeled to prevent errors in field installation. The indicator box will show a green light when power is on and the sensor is not detecting a liquid. The light is a push-to-test light allowing the operator to test for power outage or malfunction. If the green light goes out, there are two possibilities. The green light does not come on when the button is pushed. This would indicate a lack of power to the unit or the light bulb is burned out. If the red light comes on when pushed, then a possible leak condition is indicated.

E. Pipe Supports:

1. Provide pipe supports for the fill pipe, overflow pipe, and outlet pipe attached to the tank.

2. Spacing of pipe supports shall be as recommended by the fabricator but shall not be greater than 4 feet on center.

3. Pipe supports shall allow removal of supported pipes.

4. Complete with Hastelloy C bolts, nuts, washers, and other necessary hardware for easy field assembly.

5. Manufacturer to coordinate piping supports with Contractor. Any exceptions must have Engineer’s written approval during the submittal process.

F. Heat Tracing

1. System shall include tank heading pads and a temperature controller.

2. The quantity and type of heating pad shall be determined by the size of the tank.

3. Pads to operate on 120 vac single phase with a maximum power density of 0.5 watts/sq.in.

4. Silicone pad heaters must fully comply with Article 427-23 (v) of the National Electric Code.

5. Temperature controller to be supplied with two electronic thermostats switching the heating system via one solid state relay. Primary thermostat to control desired product temperature and secondary thermostat to provide over temperature protection at 150 degrees.

G. Insulation

1. Insulation shall be polyurethane foam with a density of 2.5 lb/ft^3 with a minimum “R” value of 6.3/in.

2. Foam shall be applied with a nominal thickness of 2” to the external tank surfaces except the tank bottom.

3. Upon completion of application and insulation, 2 full coverage coats of latex mastic coating shall be applied to the surface of the insulation in such manner as to seal the insulation from the outside environment.

H. Lifting Lugs: Provide suitably attached for all tanks weighing over 100 pounds. Lifting lugs shall be bolted fittings in sidewall of tank. Bolted fittings shall be as specified herein. Molded lifting lugs from the same material as the tank are acceptable with written certification of lifting weight.

I. Anchor Bolts: Type 316, stainless steel bolts, sized by fabricator and at least 214-inch in diameter, or as shown and as specified in Section 05500, Metal Fabrications and Castings.

J. Equipment Identification Plates: The tank specified herein shall have a visible label which indicates manufacturer and date, material designed to be handled, maximum specific gravity of stored material, maximum and minimum temperature rating, the resin used to construct the tank, and the equipment identification number as indicated in this Specification. The Identification Plate shall be permanently attached to the tank as recommended by the tank manufacturer.

K. Magnetic Level Indicator: Magnetic float in chamber (material to be chemically resistant to chemical noted) to activate flags in array attached to chamber to indicate liquid level in tank locally.

1. General:

a. Components: Float chamber, magnetic float, flag array.

b. Performance:

1) Range: Nozzles to be placed as close to bottom of tank and top of sidewall as possible.

2) Accuracy: Plus or minus 2 inches.

3) Chemical Resistance: All wetted parts to be chemically resistant to chemical noted.

4) Float Failure: Automatic indication of float sinking.

2. Float Chamber:

a. Type: Nonmagnetic material to be chemically resistant to chemical noted.

b. Float Maintenance: Removable lower cover that allows the float to be removed and replaced.

c. Length: To provide indication of tank level as noted on the Tank Data Sheet.

d. Mounting: 1-inch ANSI 150 flanges.

e. Drain and Vent Connections: 0.5-inch API, normally plugged.

f. Isolation: Isolation ball valves, material to be chemically resistant to chemical noted.

3. Magnetic Float:
    a. Material: Material to be chemically resistant to chemical noted.
    b. Length: Suitable for specific gravity of chemical.
4. Flag Array:
    a. Type: Magnetic flags, two-color, supported from corrosion free low-friction bearings.
    b. Mounting: On float chamber, rotatable through 200 degrees for optimum viewing angle.
    c. Flat Failure: Separate area of array to show float has sunk.
    d. Calibrated in gallons, coordinated to individual tank.
5. Manufacturers:
    a. Gems Sensors, Inc.
    b. ISE Magtech.

2.09 SOURCE QUALITY CONTROL

A. General: The tank fabricators shall have a quality control procedure adequate to ensure that all fabrication complies with these Specifications.

B. Factory Tests:

1. Impact Tests: A representative sample from each tank shall undergo a factory impact test. Impact test must meet the requirements of ASTMD1998.
    a. For low temperature impact test, specimens shall be conditioned at minus 40 degrees F for a minimum of 2 hours.
2. Hydrostatic Leak Tests:
    a. Perform on each tank.
    b. Fill to overflow nozzle; allow to stand for 24 hours with no visible leakage.
3. Wall Thickness: Each tank shall have an actual wall thickness measurement taken at every 90 degrees, at each one foot elevation, up to three feet from the bottom of the tank.
4. Reports: Certify, by signature, the results of the factory testing.

PART 3: EXECUTION

3.01 INSTALLATION

A. In accordance with the manufacturer’s written instructions.

B. Contractor shall provide all supervision, labor, tools, construction equipment incidental materials, and the necessary services required to complete the installation and testing of the equipment.

C. Accurately place anchor bolts using templates furnished by the or as otherwise recommended by manufacturer and as specified in Section 05500, Metal Fabrications and Castings.

D. Tanks shall be installed in such a manner that no stresses shall be applied to flanged outlet as per manufacturer's installation instructions.

E. Bolt torques on gaskets shall be as recommended by the equipment manufacturer.

3.02 FIELD QUALITY CONTROL

A. Field Tests:

1. Hydrostatic Test: Storage tanks shall be filled with clean water to the overflow level after all connections have been made. There shall be no leakage, no signs of weeping, and no signs of capillary action over a period of 48 hours.

2. Quality control shall include a final inspection by Contractor and a written record of this final inspection.

3. After testing, the tanks shall be thoroughly cleaned and dried.

3.03 MANUFACTURER'S SERVICES

A. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by Owner for the minimum person-days listed for the services hereunder, travel time excluded:

1. 1 person-day for inspection and certification of the installations

2. 1 person-day for field testing of leak detectors

B. Manufacturer shall certify in writing:

1. Equipment has been provided in accordance with this Specification.

2. Equipment has been installed in accordance with the manufacturer's recommendations and inspected by a manufacturer's authorized representative.

3. Proper mechanical connections have been made.

4. Equipment is ready for startup and operation.

3.04 CHEMICALS SUPPLIED BY CONTRACTOR

A. Coordinate with Owner for the delivery of polymers to ensure delivered polymer solutions adhere to Owner's specifications for the chemicals.

B. Fill storage tank with 5,000 gallons of emulsion polymer solutions for both the RDT polymer system and BFP polymer system, prior to functional and performance testing.

C. Coordinate with Owner to provide full tanks of chemical prior to Contract Closeout.

3.05 SUPPLEMENTS

A. The supplement listed below, following “END OF SECTION,” is part of this Specification.

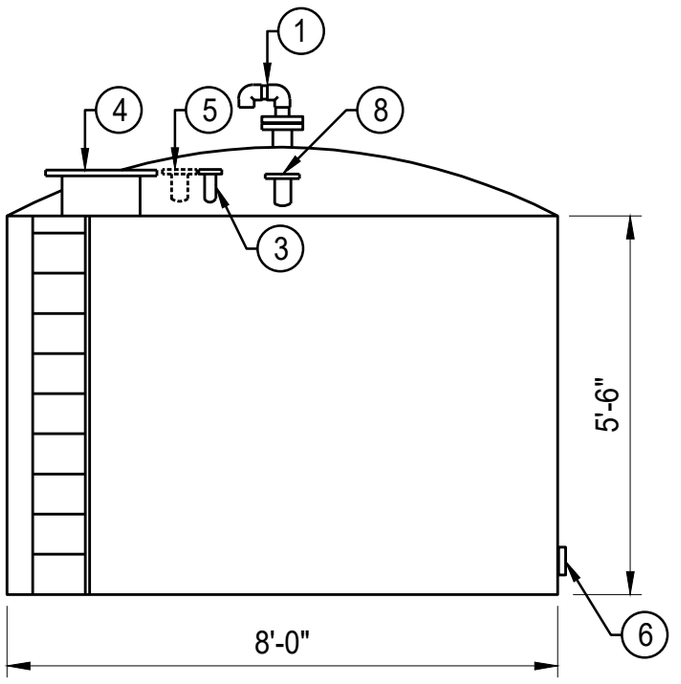
1. Tank Data Sheet: RDT Polymer Storage Tank.
2. Tank Data Sheet: BFP Polymer Storage Tank.
3. Tank Data Sheet: MBR Citric Storage Tank
4. Tank Data Sheet: MBR Sodium Hypochlorite Storage Tank

END OF SECTION

| DOUBLE CONTAINMENT HDPE TANK DATA SHEET | | | | | |
|---|---|---|---|---|---|
| TANK NAME | : | RDT POLYMER TANK | | | |
| TAG NUMBER | : | 15-POLY-T-1 | | | |
| QUANTITY | : | 1 | | | |
| SERVICE | : | EMULSION POLYMER | SPECIFIC GRAVITY | : | 1.02 |
| pH RANGE | : | | TEMP. RANGE (°F) | : | 50-100 |
| DIAMETER | : | 8' | STRAIGHT SHELL HEIGHT | : | 5'-6" |
| CAPACITY | : | 1,600 Gallons | STRAIGHT SKIRT HEIGHT | : | N/A |

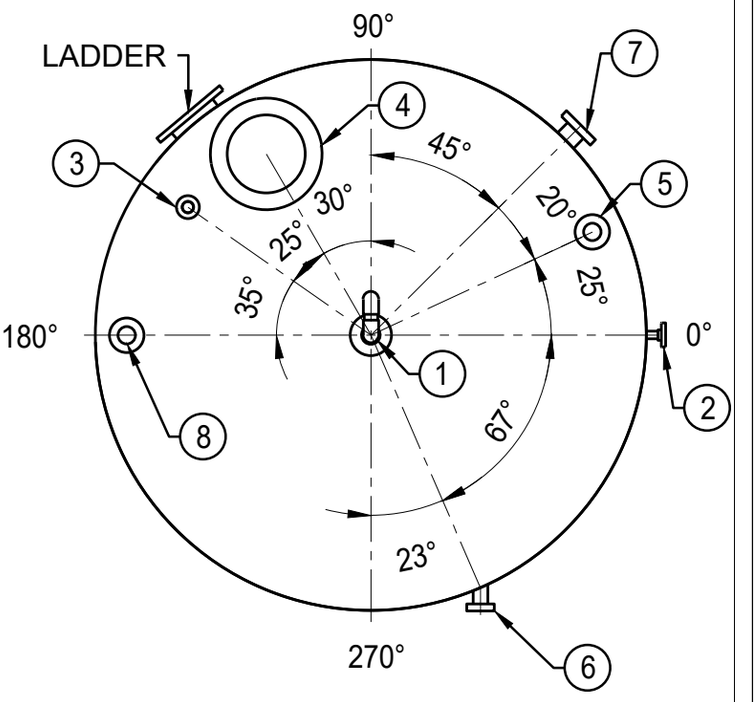
NOTES:

1. PROVIDE INTERNAL DOWN PIPE FOR FILL FROM DOME OF TANK TO 3 FEET ABOVE FLOOR OF TANK.
2. PROVIDE A MINIMUM OF 4 LIFTING LUGS AND 8 HOLD DOWN LUGS OF TYPE 316 SST.
3. ALL CONNECTIONS SHALL BE PVC FITTINGS, EPDM GASKETS, AND HASTELLOY BOLTS.
4. PROVIDE LEAK DETECTION SYSTEM.
5. PROVIDE HEATING PAD AND INSULATION.




## COMPOSITE SECTION

SCALE: NTS




## PLAN

SCALE: NTS

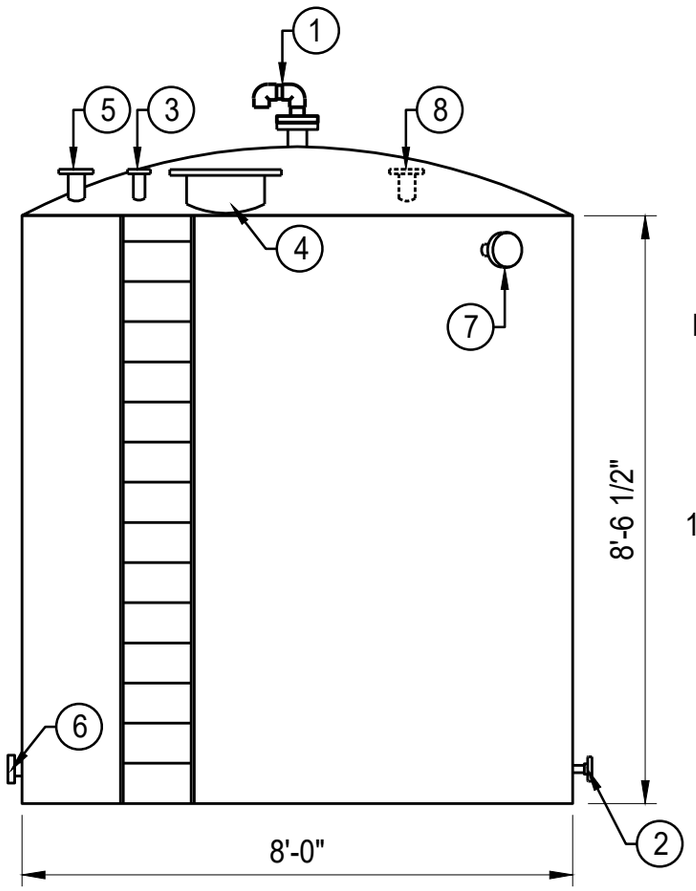
| NOZZLES | MARK | QTY | SIZE | NOTES |
|---|---|---|---|---|
| FILL | 5 | 1 | 2" | |
| OUTLET | 2 | 1 | 2" | |
| OVERFLOW | 7 | 1 | 3" | |
| LEVEL CONN | 3 | 1 | 8" | |
| VENT | 1 | 1 | 6" | |
| MANWAY | 4 | 1 | 24" | |
| TO RECIRC. PUMP | 6 | 1 | 2" | |
| FROM RECIRC. PUMP | 8 | 1 | 2" | |

| DESIGN DATA | |
|---|---|
| TANK LOCATION | : INDOOR |
| WIND OR SNOW LOADS | : N/A |
| TYPE OF TOP HEAD | : DOMED |
| TYPE OF TOP BOTTOM | : FLAT |
| LADDER REQUIRED | : YES |
| PIPE SUPPORTS FOR INTERIOR PIPING: YES | |
| PIPE SUPPORTS FOR EXTERIOR PIPING: YES | |
| GRADUATED STANDPIPE | : NO |
| HEAT TRACING AND INSULATION: YES | |
| HANDRAILS | : N/A |
| | |
| TIE DOWN SYSTEM: ANCHOR BOLTS | |
| LATERAL RESTRAINT: N/A | |
| N/A = NOT APPLICABLE | |

| DOUBLE CONTAINMENT HDPE TANK DATA SHEET | | | | | |
|---|---|---|---|---|---|
| TANK NAME | : | BFP POLYMER TANK | | | |
| TAG NUMBER | : | 15-POLY-T-2 | | | |
| QUANTITY | : | 1 | | | |
| SERVICE | : | EMULSION POLYMER | SPECIFIC GRAVITY | : | 1.02 |
| pH RANGE | : | | TEMP. RANGE (°F) | : | 50-100 |
| DIAMETER | : | 8' | STRAIGHT SHELL HEIGHT | : | 8'-6.5" |
| CAPACITY | : | 2,500 Gallons | STRAIGHT SKIRT HEIGHT | : | N/A |

NOTES:

1. PROVIDE INTERNAL DOWN PIPE FOR FILL FROM DOME OF TANK TO 3 FEET ABOVE FLOOR OF TANK.
2. PROVIDE A MINIMUM OF 4 LIFTING LUGS AND 8 HOLD DOWN LUGS OF TYPE 316 SST.
3. ALL CONNECTIONS SHALL BE PVC FITTINGS, EPDM GASKETS, AND HASTELLOY BOLTS.
4. PROVIDE LEAK DETECTION SYSTEM.
5. PROVIDE HEATING PAD AND INSULATION.




## COMPOSITE SECTION

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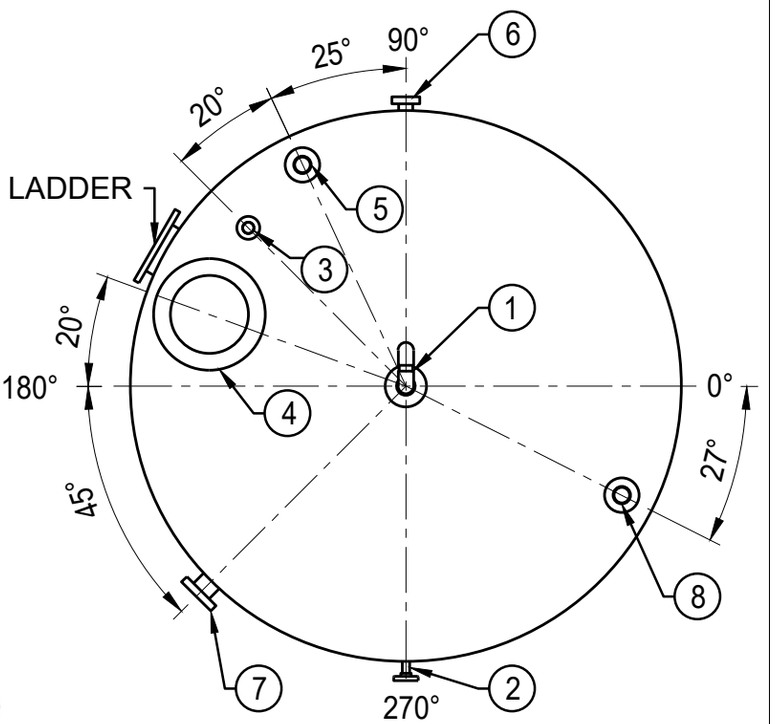



## PLAN

SCALE: NTS

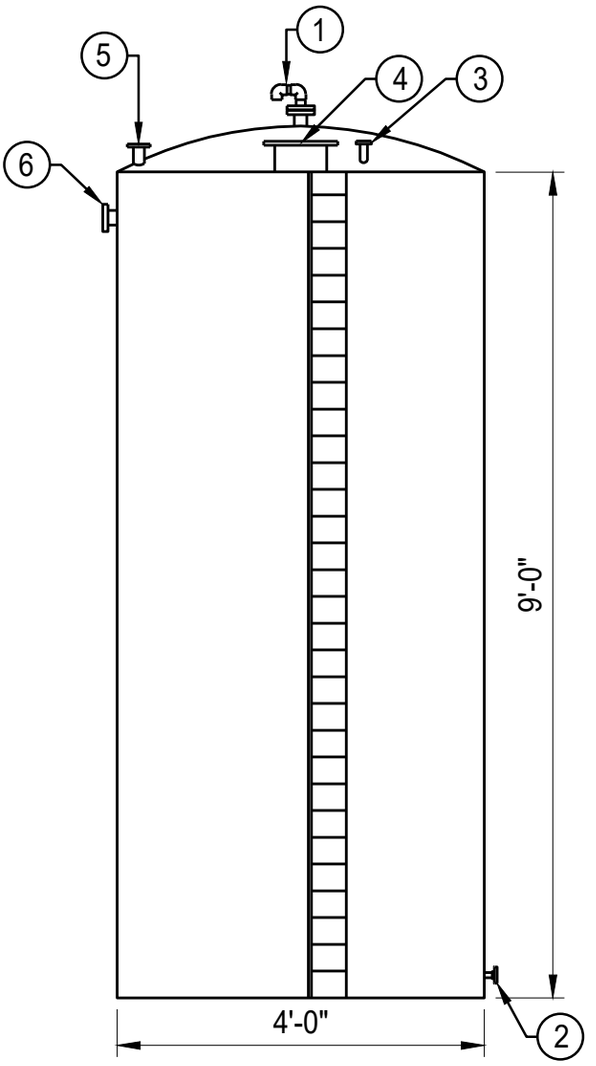
| NOZZLES | MARK | QTY | SIZE | NOTES |
|---|---|---|---|---|
| FILL | 5 | 1 | 2" | |
| OUTLET | 2 | 1 | 2" | |
| OVERFLOW | 7 | 1 | 3" | |
| LEVEL CONN | 3 | 1 | 8" | |
| VENT | 1 | 1 | 6" | |
| MANWAY | 4 | 1 | 24" | |
| TO RECIRC. PUMP | 6 | 1 | 2" | |
| FROM RECIRC. PUMP | 8 | 1 | 2" | |

| DESIGN DATA |
|---|
| TANK LOCATION : INDOOR |
| WIND OR SNOW LOADS : N/A |
| TYPE OF TOP HEAD : DOMED |
| TYPE OF TOP BOTTOM : FLAT |
| LADDER REQUIRED : YES |
| PIPE SUPPORTS FOR INTERIOR PIPING: YES |
| PIPE SUPPORTS FOR EXTERIOR PIPING: YES |
| GRADUATED STANDPIPE : NO |
| HEAT TRACING AND INSULATION: YES |
| HANDRAILS : N/A |
| |
| TIE DOWN SYSTEM: ANCHOR BOLTS |
| LATERAL RESTRAINT: N/A |
| N/A = NOT APPLICABLE |

| DOUBLE CONTAINMENT HDPE TANK DATA SHEET | | | | | |
|---|---|---|---|---|---|
| TANK NAME | : | CHEMICAL STORAGE ACID TANK | | | |
| TAG NUMBER | : | ACID TK | | | |
| QUANTITY | : | 1 | | | |
| SERVICE | : | CITRIC ACID | SPECIFIC GRAVITY | : | 1.3 - 1.5 |
| pH RANGE | : | 2 - 3 | TEMP. RANGE (°F) | : | 50 - 100 |
| DIAMETER | : | 4' | STRAIGHT SHELL HEIGHT | : | 9'-0" |
| CAPACITY | : | 625 Gallons | STRAIGHT SKIRT HEIGHT | : | |

NOTES:

1. PROVIDE INTERNAL DOWN PIPE FOR FILL FROM DOME OF TANK TO 3 FEET ABOVE FLOOR OF TANK.
2. PROVIDE A MINIMUM OF 4 LIFTING LUGS AND 8 HOLD DOWN LUGS OF TYPE 316 SST.
3. ALL CONNECTIONS SHALL BE PVC FITTINGS, EPDM GASKETS, AND HASTELLOY BOLTS.
4. PROVIDE LEAK DETECTION SYSTEM.




COMPOSITE SECTION

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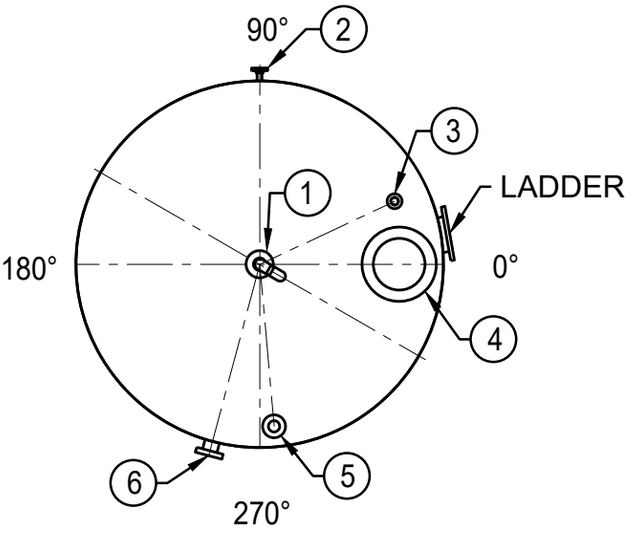



PLAN

SCALE: NTS

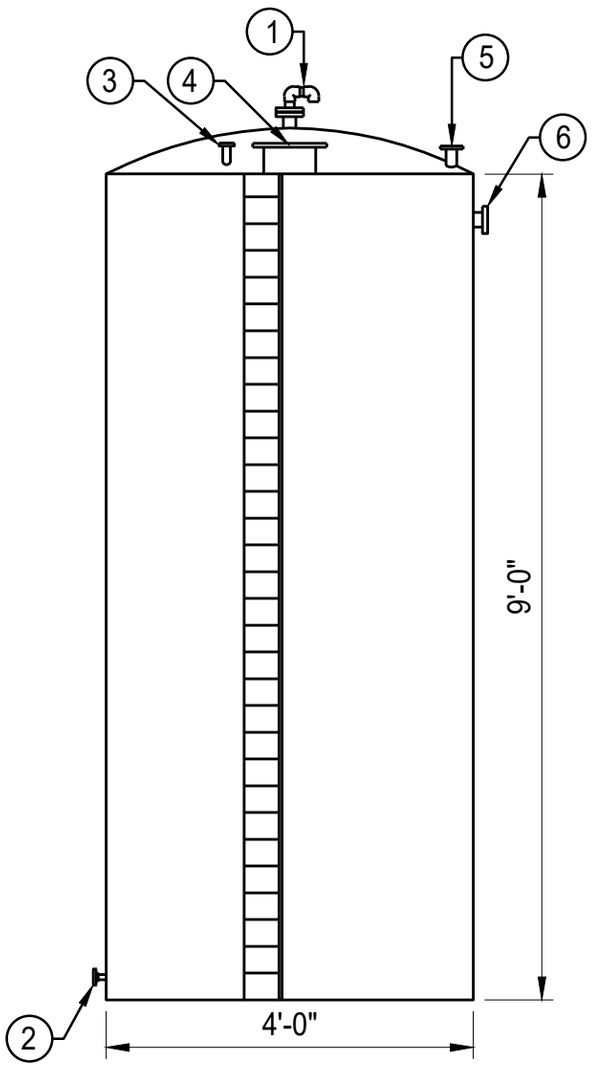
| NOZZLES | MARK | QTY | SIZE | NOTES |
|---|---|---|---|---|
| FILL | 5 | 1 | 2" | |
| OUTLET | 2 | 1 | 2" | |
| OVERFLOW | 6 | 1 | 3" | |
| LEVEL CONN | 3 | 1 | 2" | |
| VENT | 1 | 1 | 6" | |
| MANWAY | 4 | 1 | 24" | |
| | | | | |
| | | | | |

| DESIGN DATA | |
|---|---|
| TANK LOCATION | : INDOOR |
| WIND OR SNOW LOADS | : N/A |
| TYPE OF TOP HEAD | : DOMED |
| TYPE OF TOP BOTTOM | : FLAT |
| LADDER REQUIRED | : YES |
| PIPE SUPPORTS FOR INTERIOR PIPING: YES | |
| PIPE SUPPORTS FOR EXTERIOR PIPING: YES | |
| GRADUATED STANDPIPE | : NO |
| HEAT TRACING AND INSULATION: NO | |
| HANDRAILS | : N/A |
| | |
| TIE DOWN SYSTEM: ANCHOR BOLTS | |
| LATERAL RESTRAINT: N/A | |
| N/A = NOT APPLICABLE | |

| DOUBLE CONTAINMENT HDPE TANK DATA SHEET | | | | | |
|---|---|---|---|---|---|
| TANK NAME | : | CHEMICAL STORAGE NaOCl TANK | | | |
| TAG NUMBER | : | NaOCl TK | | | |
| QUANTITY | : | 1 | | | |
| SERVICE | : | SODIUM HYPOCHLORITE | SPECIFIC GRAVITY | : | 1.02 - 1.24 |
| pH RANGE | : | 10 - 14 | TEMP. RANGE (°F) | : | 50 - 100 |
| DIAMETER | : | 4' | STRAIGHT SHELL HEIGHT | : | 9'-0" |
| CAPACITY | : | 625 Gallons | STRAIGHT SKIRT HEIGHT | : | |

NOTES:

1. PROVIDE INTERNAL DOWN PIPE FOR FILL FROM DOME OF TANK TO 3 FEET ABOVE FLOOR OF TANK.
2. PROVIDE A MINIMUM OF 4 LIFTING LUGS AND 8 HOLD DOWN LUGS OF TYPE 316 SST.
3. ALL CONNECTIONS SHALL BE PVC FITTINGS, EPDM GASKETS, AND HASTELLOY BOLTS.
4. PROVIDE LEAK DETECTION SYSTEM.




COMPOSITE SECTION

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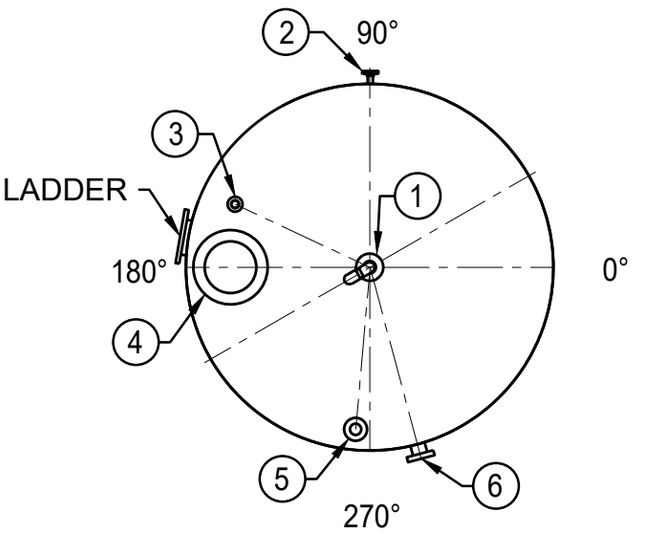


PLAN

SCALE: NTS

| NOZZLES | MARK | QTY | SIZE | NOTES |
|---|---|---|---|---|
| FILL | 5 | 1 | 2" | |
| OUTLET | 2 | 1 | 2" | |
| OVERFLOW | 6 | 1 | 3" | |
| LEVEL CONN | 3 | 1 | 2" | |
| VENT | 1 | 1 | 6" | |
| MANWAY | 4 | 1 | 24" | |
| | | | | |
| | | | | |

| DESIGN DATA | |
|---|---|
| TANK LOCATION | : INDOOR |
| WIND OR SNOW LOADS | : N/A |
| TYPE OF TOP HEAD | : DOMED |
| TYPE OF TOP BOTTOM | : FLAT |
| LADDER REQUIRED | : YES |
| PIPE SUPPORTS FOR INTERIOR PIPING: YES | |
| PIPE SUPPORTS FOR EXTERIOR PIPING: YES | |
| GRADUATED STANDPIPE | : NO |
| HEAT TRACING AND INSULATION: NO | |
| HANDRAILS | : N/A |
| | |
| TIE DOWN SYSTEM: ANCHOR BOLTS | |
| LATERAL RESTRAINT: N/A | |
| N/A = NOT APPLICABLE | |

# SECTION 13205

# FIBERGLASS REINFORCED PLASTIC TANKS

## PART 1: GENERAL

### 1.01 WORK INCLUDED

A. This Section covers the work necessary to furnish and install, complete, the double wall filament-wound fiberglass reinforced plastic (FRP) tanks for the aboveground storage of aluminum sulfate. Contractor shall furnish and install all PVC and/or CPVC piping, valves, and quick connect fill fittings.

### 1.02 REFERNCES

A. The following is a list of standards which may be referenced in this Section:

1. American Society for Testing and Materials (ASTM):

a. C582, Standard Specification for Contact Molded Reinforced Thermo-setting Plastic (RTP) Laminates for Corrosion Resistant Equipment.

b. D2563, Standard Practice for Classifying Visual Defects in Glass Reinforced Plastic Laminate Parts.

c. D2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impresser.

d. D2584, Standard Test Method for Ignition Loss of Cured Reinforced Resins.

e. D3299, Standard Specification for Filament Wound Glass Fiber Reinforced Thermoset Resin Chemical Resistant Tanks.

f. El067, Recommended Practice for Acoustic Emission Testing of Fiberglass Reinforced (FRP) Tanks/Vessels.

### 1.03 GENERAL

A. See Conditions of the Contract which contain information and requirements that apply to the work specified herein and which are mandatory for this Project.

### 1.04 SUBMITTALS

A. The following Specific Information shall be Provided:

1. Detailed design calculations for tanks, supports, and fabrication drawings shall be submitted prior to fabrication.

2. The tank diameters, wall thickness, protective coating details, straight shell lengths, overall lengths, pressure rating, corrosion barrier thickness, details of nozzle design and ladders, fittings, gaskets, and bolt material on all tanks shall be finished.

3. Description of interior protective coating application procedures.

4. Copies of fabrication, quality control, and testing records shall be furnished upon completion of tank construction.

5. Fabricators detailed requirements for tank foundations.

6. Recommended bolt torques for all FRP connections

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 Fabricators Quality Assurance Supervisor.

3. Copy of the fabricator s Quality Assurance Program.

4. Quality Assurance Inspection.

a. Initial QA Inspection Report.

b. Certification of Factory Testing.

5. Certification that the access nozzles have been coordinated with the actual equipment being furnished.

6. Special shipping, storage and protecting and handling instructions.

7. Fabricator’s written/printed installation and tank support instructions.

8. Manufacturer’s Certificate of Proper Installation.

9. Installation list for proof of a minimum of five installations with at least 5 years of service without failure.

1.05 QUALITY ASSURANCE

A. Manufacturer shall be RTP-1 certified FRP tank manufacturer. The tank shall be RTP-1 certified.

B. Fabricator’s Quality Assurance Supervisor: Minimum of 5 years’ experience in the fabrication of fiberglass structures.

C. Designer: Registered professional engineer licensed in the State of Georgia.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare and Protect the Tanks for Shipment as Follows:

1. Mount tanks on padded cradles if shipped horizontally or on a suitable kid if shipped vertically.

2. Protect all flanged nozzles with wooden blinds bolted to the flange and having a diameter of 2 inches greater than the outside diameter of the flange.

3. Provide either rigid plugs inside the ends to prevent deflection or wooden boxes for all unflanged components. Brace the open ends of tanks with a suitable stiffening member to prevent deflection.

4. Do not ship components or other pieces loose inside the tanks.

5. Load tanks with at least 2 inches clearance between the tank (including

6. fittings) and the bulkheads or bed of the vehicle.

7. Regardless of the mode of transportation, firmly fasten and pad all components to prevent shifting of the load or flexing of components while in transit.

1.07 SEQUENCING AND SHCEDULING

A. Tanks/Vessels shall not be shipped from factory until Engineer's review of Certification of Factory Testing is completed.

1.08 OPERATION AND MAINTENANCE MANUALS

A. Provide manufacturer's Operation and Maintenance Manual(s) (O&M).

1.09 WARRANTY

A. Provide manufacturer's certificate(s) of warranty for 10-year term.

1.10 SPARE PARTS AND SPECIAL TOOLS

A. Provide the following spare parts and special tools for each chemical tank specified herein:

| Quantity | Item |
|---|---|
| 2 | Sets of gaskets for each size provided on the storage tanks |

PART 2: PRODUCTS

2.01 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the General Conditions.

2.02 MANUFACTURERS

A. Augusta Fiberglass.

B. ECS

C. Or equal.

2.03 SERVICE CONDITIONS

A. Liquid Store: 100 percent concentration aluminum sulfate

B. Specific Gravity of Aluminum Sulfate: 1.33

C. Ambient Temperature: 0 to 100 degrees Fahrenheit.

D. Pressure: Atmospheric.

E. Design Wind Loads: 120 mph

F. External Load: 50psf plus live load and dead load.

2.04 DESIGN CONDITIONS

A. Tank Description:

1. Provide one double wall vertical aluminum sulfate storage tank. Each tank shall have a minimum capacity of 20,000 gallons. The tanks shall have dimensions shown on the Tank Data Sheet.

B. Configuration: Storage tanks shall be installed in the vertical position and located as shown on the Drawings. Tanks will be cylindrical, flat bottom, dished top, filament wound FRP construction. All metal shall be specified on the Tank Data Sheet.

C. Closed Top: Head knuckle radius minimum 1.5 inches.

D. Flat Bottom:

1. Bottom Knuckle Radius: Minimum 2 inches.

2. Extend reinforcement of the knuckle-radius area up the vertical wall a minimum of 8 inches on tanks up to 4 feet diameter and 12 inches for tanks over 4 feet diameter.

E. The tanks shall be vented.

F. Tanks shall be chemically inert to stored products at the listed temperatures.

2.05 DESIGN REQUIREMENTS

A. The fabricator shall be responsible for the basic design of the FRP tanks, based on these Specifications, including resin selection, wall thickness, methods and locations of support, and stiffener requirements. This is subject to review and approval by the Engineer.

B. Tanks shall be filament wound FRP construction and shall be constructed in accordance with ASTM D3299, Type 1 tanks; ASTM C581, and ASTM C582. Previous tests will be acceptable for conformance with ASTM C581, provided all laminates used are representative.

C. All flanged nozzles on the tanks shall be rated at 150 psi with dimensions appropriate for pressure rating.

D. The back face of all flanges shall be spot-faced, flat, and parallel to the flange face of sufficient diameter to accept a SAE metal washer under the bolt head or nut.

E. All flanges shall be of hand lay-up construction. Press molded flanges will not be allowed.

F. Tanks shall be of vertical cylindrical construction with flat bottom suitable for installation on a concrete pad.

G. All tank nozzles shall be gusseted with conical type gussets in preference to plate type gussets.

H. The fabricator shall be responsible for providing all information details and requirements for installation and support of the tank in the configuration shown on the Drawings.

I. The fabricator shall provide detailed requirements for foundations for the flat-bottomed vertical tanks.

J. Nozzles shall have a 6-inch projection as measured form the face of the flange to the closest point on the to the closest point on the outside of the tank. See attached Tank Data Sheet for nozzle orientation and location. The final locations of the nozzles will be determined during Shop Drawings review.

K. Shell nozzles shall be mounted radially, perpendicular to the side shell. The suction and drain nozzles shall be side bottom type as appropriate for a dual wall tank. Top nozzles shall be mounted parallel to the vertical axis of the tank with bolt holes straddling this principle axis. Nozzles shall be finished flush with the inside wall surface of the tank. Provide two gaskets for each nozzle. Gasket material for all flanged nozzles, manway covers, and tank covers shall be 1/4-inch thick full-face elastomeric material having a hardness of Shore A60 plus or minus 5 and shall be supplied by the fabricator. Gasket material shall be suitable for exposure to the liquid contained within the tank.

L. Each tank shall be labeled for appropriate service on two sides with 6-inch high letters.

M. Pipe supports shall be FRP complete with necessary bolts, nuts, and washers Provide pipe supports for all tank overflow pipes and loading pipes. Pipe support shall allow for removal of the pipe and spacing of supports shall be as recommended by fabricator but shall not be greater than 4 feet on center.

N. Tank manway shall be manufacturer's standard vapor-tight flanged manway.

O. All tank shells, bottoms, and dishes shall be shop fabricated in a controlled environment with no vertical seams allowed.

2.06 EQUIPMENT

A. Provide anchor bolts, nuts, and anchor bolt templates for each piece of equipment furnished or specified herein. Anchor bolts shall be Type 316 stainless steel and designed to withstand all load conditions including seismic. Details of anchors shall be shown on the Drawings.

B. Anchor Bolts: Anchor bolts, furnished by the Contractor, shall be Type 316 stainless steel and at least 1/2 inch in diameter. Coordinate required size with final Shop Drawings.

C. Insect Screen: Provide an insect screen on the vents of the storage tanks. Screen material shall be compatible with the chemical stored in the tank.

D. Pipe Supports: Provide pipe supports on the chemical storage tanks for fill an overflow piping. Pipe supports shall be integral to the tank and laminated to the structural laminate.

E. Lifting lugs shall be provided for all vessels weighing more than 100 pounds. Lifting lugs shall be of Type 316 stainless steel and a minimum of three shall be provided. The lifting lugs shall be incorporated into the filament winding system.

F. Equipment Identification Plates: The tank specified herein shall have an embedded, visible label which indicates manufacturer and date, material designed to be handled, maximum specific gravity of stored material, maximum and minimum temperature rating, the resin used to construct the tank, and the equipment identification number as indicated in this Specification. Marking shall be permanent. Decals, labels, etc., shall be sealed into the laminate exterior with clear resin.

G. The Contractor shall coordinate the size and configuration of the equipment pad for the tanks with the tank manufacturer.

H. Magnetic Level Indicator: Magnetic float in chamber (material to be chemically resistant to chemical noted) to activate flags in array attached to chamber to indicate liquid level in tank locally.

1. General:
    a. Components: Float chamber, magnetic float, flag array
    b. Performance:
        1) Range: Nozzles to be placed as close to bottom of tank and top of sidewall as possible.
        2) Accuracy: Plus or minus 2 inches.
        3) Chemical Resistance: All wetted parts to be chemically-resistant to chemical noted.
        4) Float Failure: Automatic indication of float sinking.
2. Float Chamber:
    a. Type: Nonmagnetic material to be chemically-resistant to chemical noted.
    b. Chamber Size: 1-Inch by 2-inch by 1-inch reducer mounted to 2-inch flanges.
    c. Float Maintenance: Removable lower cover that allows the float to be removed and replaced.
    d. Length: To provide indication of tank level as noted on the Tank Data Sheet.
    e. Mounting: 2 inch ANSI 150 flanges.
    f. Drain and Vent Connections: 0.5-inch API, normally plugged.
    g. Isolation: Isolation ball valves, material to be chemically resistant to chemical noted.
3. Magnetic Float:
    a. Material: Material to be chemically resistant to chemical noted.
    b. Length: Suitable for specific gravity of chemical.

4. Flag Array:
    a. Type: Magnetic flags, two-color, supported from corrosion free low-friction bearings.
    b. Mounting: On float chamber, rotatable through 200 degrees for optimum viewing angle.
    c. Flat Failure: Separate area of array to show float has sunk.
    d. Calibrated in gallons, coordinated to individual tank.
5. Manufacturers:
    a. Gems Sensors, Inc.
    b. ISE Magtech.

I. Ladder

1. Constructed of fiberglass or stainless steel.
2. Safety cage shall be provided with ladder as required by OSHA standards.
3. Ladder shall be designed to meet OSHA Standards 2206; 1910.27; fixed ladders.

J. Heat Tracing

1. System shall include tank heading pads and a temperature controller.
2. The quantity and type of heating pad shall be determined by the size of the tank.
3. Pads to operate on 120 vac single phase with a maximum power density of 0.5 watts/sq.in.
4. Silicone pad heaters must fully comply with Article 427-23 (v) of the National Electric Code.
5. Temperature controller to be supplied with two electronic thermostats switching the heating system via one solid state relay. Primary thermostat to control desired product temperature and secondary thermostat to provide over temperature protection at 150 degrees.

K. Insulation

1. Insulation shall be polyurethane foam with a density of 2.5 $lb/ft^3$ with a minimum “R” value of 6.3/in.
2. Foam shall be applied with a nominal thickness of 2” to the external tank surfaces except the tank bottom.
3. Upon completion of application and insulation, 2 full coverage coats of latex mastic coating shall be applied to the surface of the insulation in such manner as to seal the insulation from the outside environment.

## 2.07 COMPONENTS

A. Resins

1. Resin System: Selected by the Fabricator, subject to approval by the Engineer, and suitable for the intended service.
2. Liner Resin: Premium grade and corrosion-resistant; shall meet or exceed resistance to corrosion, similar to Dera Kane 411 or ATLAC 382.
3. The same corrosion-resistant resin shall be used throughout the laminate construction of the tank. Dual laminate systems shall not be used.
4. Add ultraviolet absorbers to the surfacing resin to improve weather resistance.
5. Include 5-mil external pigmented UV protective coating on each tank, color as selected by the Owner and approved by the Engineer from the color charts submitted by the tank manufacturer.
6. The resin shall not contain fillers or thixotropic agents unless specified.
7. Use Manufacturer's currently recommended cure system, unless otherwise agreed upon by the Fabricator and Engineer.

B. Reinforcement

1. Veil: Chemical surfacing mat, polyester fabric, two plies, with a finish and a binder compatible with the lay-up resin.
2. Corrosion Barrier: Resin-rich interior surface of nominal 100 to 120 mils using chopped strand glass backing the veil. Use no additive in the corrosion barrier.
3. Chopped Strand Mat: Type E glass, minimum 1-1/2 ounces per square foot, with silane finish and styrene soluble binder.
4. Continuous roving used in chopper gun for spray-up shall be Type E glass.
5. Woven roving shall be Type E glass, nominal 24 ounces per square yard, 4 by 5 weave, with silane type finish.
6. Continuous roving used for filament winding shall be Type E glass with a silane type finish, with a nominal yield of at least 110 strand yards per pound.

C. Laminate

1. Laminate shall consist of an inner surface (corrosion barrier), an interior layer, and an exterior layer.
2. Laminate Quality: Meet requirements of the visual acceptance criteria in ASTM C582 including, but not limited to, the following:
    a. Appearance.
    b. Defects.
    c. Cut edges.
    d. Construction joints.

3. Reinforce inner surface with a resin-rich surfacing veil of 10 to 20 mils thick.

4. The resin content of inner surface shall be minimum of 80 percent by weight.

5. Construct interior layer of resin reinforced with at least the equivalent of two plies of chopped strand mat. Thickness of interior layer shall be at least 100 mils.

6. Glass content of combined inner surface and interior layer shall be 27 percent plus or minus 5 percent.

7. Exterior or structural layer shall be filament wound. Filament winding shall be with continuous strand roving to provide a glass content of 50 to 80 percent.

8. Marking:

   a. Identify each tank with fabricator's name, capacity in gallons, maximum temperature, design pressure/vacuum, specific gravity, pH, resin, minimum thickness, vessel number, vessel name, and date of manufacture.

   b. Provide permanent marking. Seal decals, labels, etc., into laminate exterior with clear resin.

2.08 SOURCE QUALITY CONTROL

A. Identify and retain all cutouts. Engineer may select certain cutouts for testing for physical properties of the laminate.

B. Factory Test Reports: Certify, by signature, results of the following:

1. Inspections.

2. Results of hydrostatic testing.

3. Test reports of physical properties of standard laminates.

PART 3: EXECUTION

3.01 RESIN

A. Cure all products to a minimum of 90 percent of the minimum Barcol hardness specified by resin manufacturer.

B. Barcol hardness shall be measured according to ASTM D2583.

3.02 LAMINATE

A. Reinforce inner surface with a resin-rich polyester surfacing veil of 10 to 20 mils thick.

B. The resin content of the inner surface shall be a minimum of 80 percent by weight.

C. Construct interior layer of resin reinforced with at least the equivalent of two plies of chopped strand mat. Thickness of interior layer shall be at least 100 mils.

D. Glass content of combined inner surface and interior layer shall be 25 percent plus or minus 5 percent (70 to 80 percent resin by weight).

E. The exterior or structural layer shall be filament wound. Filament winding shall be with continuous strand roving to provide a glass content of 50 to 80 percent.

3.03 SHIPPING, HANDLING, STORAGE, PROTECTION REQUIREMENTS

A. The equipment provided under this Section shall be shipped, handled, stored, and protected in accordance with the manufacturers' written instructions.

3.04 INSTALLATION

A. The tanks shall be installed as shown on the Drawings and in strict accordant with the manufacturer's written instructions.

B. The installed tanks shall be thoroughly cleaned and disinfected before being put into service.

3.05 PAINTING

A. All non-stainless steel metal components shall be prepared primed and finished in the field in accordance with Section 09900, Painting.

3.06 FIELD QUALITY CONTROL

A. Field Testing/Inspection: Prior to final installation the tanks shall be hydrostatically tested with clean water to detect any damage during shipment and inspected for proper alignment, connection, function, and verification of complete compliance with Drawings and Specifications. There shall be no visible leakage in 48 hours. Any evidence of leakage shall be cause for rejection of the tank.

3.07 MANUFACTURERS’ SERVICES

A. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Owner and at such times as requested by the Owner for the minimum person-days listed for the services hereunder, travel times excluded:

1. 1-1/2 person-days for installation assistance.

2. 1 person-day for inspection, functional testing, certification of the installation, and training.

3.08 CHEMICALS SUPPLIED BY CONTRACTOR

A. Coordinate with Owner for the delivery of chemical to ensure delivered chemical adhere to Owner’s specifications for the chemical.

B. Fill storage tank with 10,000 gallons of aluminum sulfate, prior to functional and performance testing.

C. Coordinate with Owner to provide full tank of chemical prior to Contract Closeout.

3.09 SUPPLEMENTS

A. The Supplements listed below, following “END OF SECTION,” are part of this Specification.

1. Tank Data Sheet, 16-AL-T-1 Aluminum Sulfate Storage Tank.

2. Tank Data Sheet, 16-AL-T-2 Aluminum Sulfate Storage Tank.

END OF SECTION

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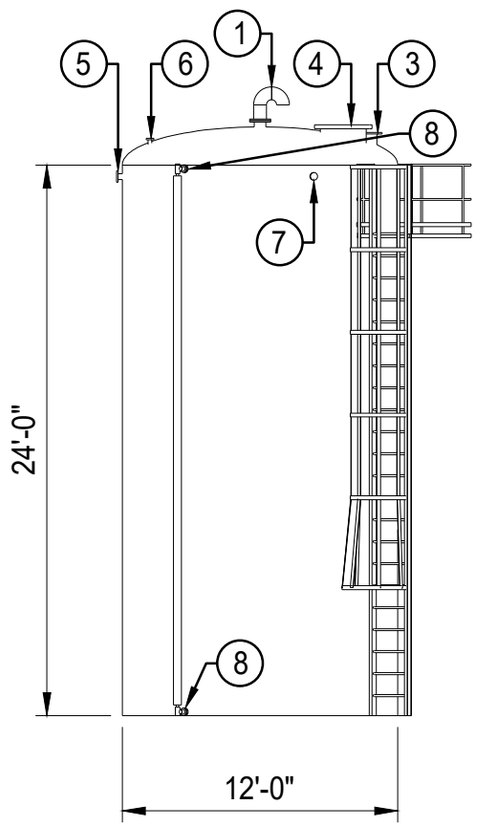
| DOUBLE CONTAINMENT FRP TANK DATA SHEET | | | | | |
|---|---|---|---|---|---|
| TANK NAME | : | ALUM TANK 1 | | | |
| TAG NUMBER | : | 17-AL-T-1 | | | |
| QUANTITY | : | 1 | | | |
| SERVICE | : | ALUMINUM SULFATE | SPECIFIC GRAVITY | : | 1.33 |
| pH RANGE | : | 3.0 - 4.0 | TEMP. RANGE (°F) | : | 0-100 |
| DIAMETER | : | 12' | STRAIGHT SHELL HEIGHT | : | 24' |
| CAPACITY | : | 20,000 Gallons | STRAIGHT SKIRT HEIGHT | : | N/A |

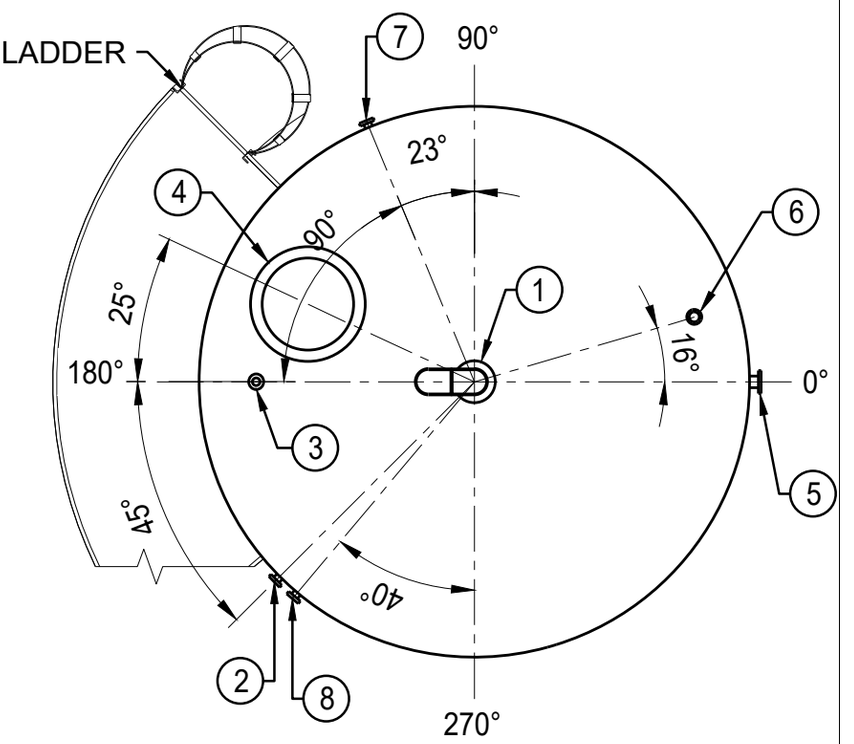
NOTES:

1. PROVIDE INTERNAL DOWN PIPE FOR FILL FROM DOME OF TANK TO 3 FEET ABOVE FLOOR OF TANK.
2. PROVIDE A MINIMUM OF 4 LIFTING LUGS AND 8 HOLD DOWN LUGS OF TYPE 316 SST.
3. ALL CONNECTIONS SHALL BE PVC FITTINGS, EPDM GASKETS, AND HASTELLOY BOLTS.
4. PROVIDE LEAK DETECTION SYSTEM.
5. PROVIDE HEATING PAD AND INSULATION.




## COMPOSITE SECTION

SCALE: NTS




## PLAN

SCALE: NTS

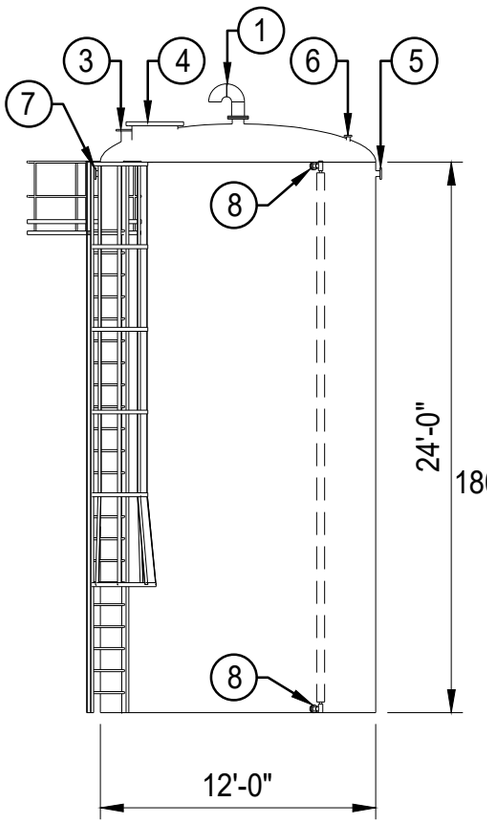
| NOZZLES | MARK | QTY | SIZE | NOTES |
|---|---|---|---|---|
| FILL | 5 | 1 | 2" | |
| OUTLET | 2 | 1 | 2" | |
| OVERFLOW | 7 | 1 | 3" | |
| LEVEL CONN | 3 | 1 | 2" | |
| VENT | 1 | 1 | 6" | |
| MANWAY | 4 | 1 | 24" | |
| BYPASS | 6 | 1 | 2" | |
| MAG LEVEL | 8 | 2 | 2" | |

| DESIGN DATA | |
|---|---|
| TANK LOCATION | : OUTDOOR |
| WIND OR SNOW LOADS | : 12MPH |
| TYPE OF TOP HEAD | : DOMED |
| TYPE OF TOP BOTTOM | : FLAT |
| LADDER REQUIRED | : YES |
| PIPE SUPPORTS FOR INTERIOR PIPING: YES | |
| PIPE SUPPORTS FOR EXTERIOR PIPING: YES | |
| GRADUATED STANDPIPE | : NO |
| HEAT TRACING AND INSULATION: YES | |
| HANDRAILS | : YES |
| PLATFORM: YES | |
| TIE DOWN SYSTEM: YES | |
| LATERAL RESTRAINT: N/A | |
| N/A = NOT APPLICABLE | |

| DOUBLE CONTAINMENT FRP TANK DATA SHEET | | | | | |
|---|---|---|---|---|---|
| TANK NAME | : | ALUM TANK 2 | | | |
| TAG NUMBER | : | 17-AL-T-2 | | | |
| QUANTITY | : | 1 | | | |
| SERVICE | : | ALUMINUM SULFATE | SPECIFIC GRAVITY | : | 1.33 |
| pH RANGE | : | 3.0 - 4.0 | TEMP. RANGE (°F) | : | 0-100 |
| DIAMETER | : | 12' | STRAIGHT SHELL HEIGHT | : | 24' |
| CAPACITY | : | 20,000 Gallons | STRAIGHT SKIRT HEIGHT | : | N/A |

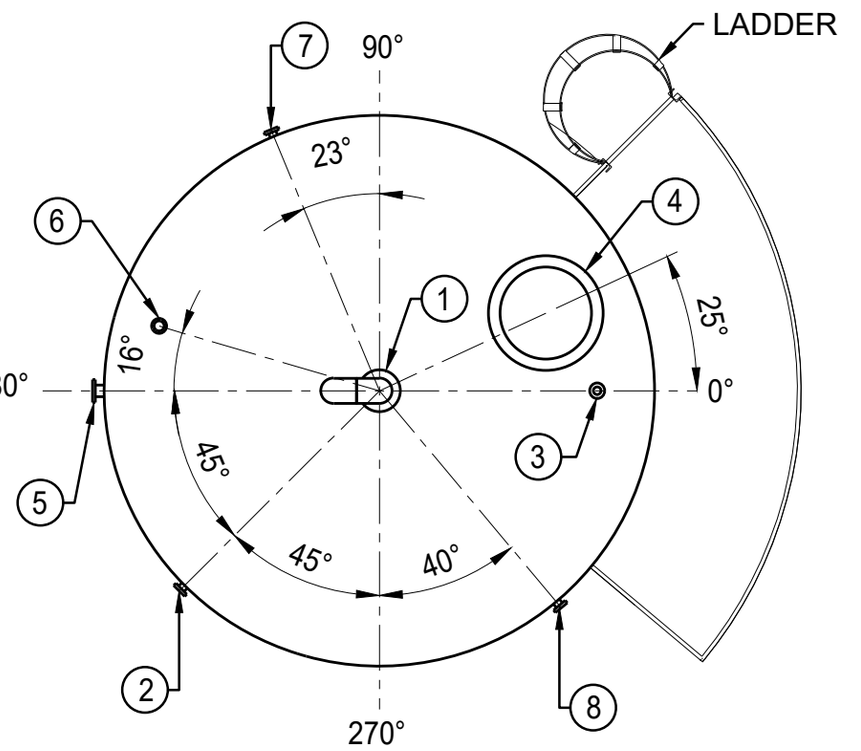
NOTES:

1. PROVIDE INTERNAL DOWN PIPE FOR FILL FROM DOME OF TANK TO 3 FEET ABOVE FLOOR OF TANK.
2. PROVIDE A MINIMUM OF 4 LIFTING LUGS AND 8 HOLD DOWN LUGS OF TYPE 316 SST.
3. ALL CONNECTIONS SHALL BE PVC FITTINGS, EPDM GASKETS, AND HASTELLOY BOLTS.
4. PROVIDE LEAK DETECTION SYSTEM.
5. PROVIDE HEATING PAD AND INSULATION.




## COMPOSITE SECTION

SCALE: NTS




## PLAN

SCALE: NTS

| NOZZLES | MARK | QTY | SIZE | NOTES |
|---|---|---|---|---|
| FILL | 5 | 1 | 2" | |
| OUTLET | 2 | 1 | 2" | |
| OVERFLOW | 7 | 1 | 3" | |
| LEVEL CONN | 3 | 1 | 2" | |
| VENT | 1 | 1 | 6" | |
| MANWAY | 4 | 1 | 24" | |
| BYPASS | 6 | 1 | 2" | |
| MAG LEVEL | 8 | 2 | 2" | |

| DESIGN DATA | |
|---|---|
| TANK LOCATION | : OUTDOOR |
| WIND OR SNOW LOADS | : 12MPH |
| TYPE OF TOP HEAD | : DOMED |
| TYPE OF TOP BOTTOM | : FLAT |
| LADDER REQUIRED | : YES |
| PIPE SUPPORTS FOR INTERIOR PIPING: YES | |
| PIPE SUPPORTS FOR EXTERIOR PIPING: YES | |
| GRADUATED STANDPIPE | : NO |
| HEAT TRACING AND INSULATION: YES | |
| HANDRAILS | : YES |
| PLATFORM: YES | |
| TIE DOWN SYSTEM: YES | |
| LATERAL RESTRAINT: N/A | |
| N/A = NOT APPLICABLE | |

# SECTION 15041

# DISINFECTION OF POTABLE WATER LINES

## PART 1: GENERAL

### 1.01 DESCRIPTION

A. The work covered by this section includes furnishing all labor, equipment, materials, and chemicals required to disinfect all potable water lines in accordance with the procedures specified herein.

### 1.02 STANDARDS

A. Procedures for disinfecting potable water lines, unless other wise modified herein, shall conform to the requirements of AWWA C651 (Disinfecting Water Mains), C653 (Disinfection of Water Treatment Plants), B300 (Sodium Hypochlorite), and B301 (Liquid Chlorine).

### 1.03 SUBMITTALS

A. Information Submittals:

1. Plan describing and illustrating conformance to appropriate AWWA standards and this specification.

2. Procedure and plan for cleaning system.

3. Procedures and plans for disinfection and testing.

4. Proposed locations within system where samples will be taken

5. Type of disinfecting solution and method of preparation.

6. Method of disposal for highly chlorinated disinfecting water.

7. Independent Testing Agency: Certification that testing agency is qualified to perform bacteriological testing.

### 1.04 QUALITY ASSURANCE

A. Independent Testing Agency: Certified in the state of Georgia. Agency shall use calibrated testing instruments and equipment and documented standard procedures for performing specified testing.

### 1.05 SEQUENCING

A. Commence disinfection after completion of following:

1. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.

PART 2: PRODUCT

2.01 DISINFECTION AGENT

A. The disinfection agent shall be chlorine or chlorine compound. The method of application and type of disinfecting agent shall both be acceptable to the Engineer.

B. Owner will supply potable quality water.

PART 3: EXECUTION

3.01 GENERAL

A. Conform to AWWA C651 for pipes and pipelines, except as modified in these specifications.

B. Contractor's Equipment: Furnish chemicals and equipment such as hoses, to accomplish disinfection.

C. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

D. Disinfect new pipeline that connects to existing pipelines up to point of connection.

E. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

3.02 DISINFECTION PROCEDURE

A. Prior to disinfection, all surfaces shall be thoroughly flushed with clear, uncontaminated, and potable water to clean foreign matter from pipe in accordance with AWWA C651.

B. Disinfection Procedure: In accordance with AWWA C651, unless herein modified.

C. Disinfection shall be accomplished be the application of clear water containing a minimum of 50 ppm of available chlorine. The chlorine bearing water shall remain in contact with surfaces for a period of not less than 24 hours. At the end of the contact period the chlorine residual in all units and at extremities of pipelines and other representative points shall be at least 25 ppm.

D. In the process of chlorinating newly installed pipe, all valves or other appurtenances shall be operated at least 5 times while the pipelines are filled with chlorinating agent.

E. Upon completion of the disinfection procedure, all piping shall be flushed with potable water until the chlorine residual remaining is 1.0 ppm or less and the replacement water throughout the units, upon suitable bacteriological tests, has proved to be of acceptable quality and in conformance with Georgia Department

of Natural Resources standards for municipal water supplies. This satisfactory quality of water shall continue for 2 full days as determined by laboratory examination of two samples taken for a tap located and installed in such a way as to prevent outside contamination. Coordinate with Owner for laboratory testing services. Sampling points shall be representative and accepted by Engineer.

F. No portion of new work shall be placed in service until the Contractor has completed disinfection. Should the initial treatment fail to result in disinfection, the chlorination procedure shall be repeated until satisfactory results are obtained.

G. If two consecutive tests fail, Owner may require Contractor to utilize outside services at no additional cost to the Owner. Outside testing services shall be provided by a laboratory certified by the State of Georgia and approved by the Owner. Contractor shall collect two sets of samples per AWWA C651, Section 5.1, deliver the samples to the approved laboratory within six hours of obtaining the samples, and obtain a bacteriological quality test to demonstrate the absence of coliform organisms.

3.03 DISPOSAL OF CHLORINATED WATER

A. Do not allow flow into a waterway without neutralizing disinfectant residual. See appendix of AWWA C651 for acceptable neutralization methods.

3.04 TESTING

A. Collection of Samples:

1. Coordinate activities to allow samples to be taken in accordance with this specification.

2. Provide valves at sampling points.

3. Provide access to sampling points.

B. Test Equipment:

1. Clean containers and equipment used in sampling and make sure they are free of contamination.

2. Obtain sampling bottles with instructions for handling from Owner’s an independent testing laboratory.

C. Chlorine Concentration Sampling and Analysis:

1. Collect and analyze Samples in accordance with AWWA.

2. Sampling Frequency for Disinfecting Solution: Three samples per section of pipe.

3. Residual Free Chlorine Samples: Three samples per section of pipe.

4. Sampling Locations: A Minimum of 100 feet of potable water piping.

5. Analysis to be performed by an independent test laboratory. Samples will be analyzed using amperometric titration method for free Chlorine as described in latest edition of Standard Methods for Examination of Water and Wastewater.

D. Turbidity Sampling and Analysis:

1. After pipelines have been cleaned, disinfected, and refilled with potable water, and independent laboratory will take water samples and have them analyzed for conformance to turbidity limitations for public drinking water supplies. Turbidity shall not exceed 0.3 NTU.

2. If turbidity is in excess of the limit, dispose of the water in accordance with this Specification and applicable regulations, take action to remove source of turbidity, refill system, and retest.

E. If minimum Samples required above are bacterially positive, disinfecting procedures and bacteriological testing shall be repeated until bacterial limits are met.

END OF SECTION

SECTION 15094

PIPE SUPPORTS AND HANGERS

PART 1: GENERAL

1.01 REFERENCE

A. The following is a list of standards which may be referenced in this Section:

1. ASTM International (ASTM): E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

2. International Code Council (ICC):

a. International Building Code (IBC).

b. International Mechanical Code (IMC).

c. International Plumbing Code (IPC).

3. Manufacturers' Standardization Society (MSS):

a. SP 58, Pipe Hangers and Supports: Materials, Design and Manufacture.

b. SP 69, Pipe Hangers and Supports: Selection and Application.

c. SP 89, Pipe Hangers and Supports: Fabrication and Installation.

1.02 DEFINITIONS

A. Ferrous Metal: Iron, steel, stainless steel, and alloys with iron as principal component.

B. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Drawings of each piping support system to scale shown, locating each support, brace, hanger, guide, component and anchor. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.

2. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

3. Product Data: For the following:

a. Steel pipe hangers and supports.

b. Trapeze pipe hangers

B. Informational Submittals: Maintenance information on piping support system.

1.04 QUALIFICATIONS

A. Piping support systems shall be designed, and Shop Drawings prepared and sealed by a registered professional engineer in the State of Georgia.

1.05 DESIGN REQUIREMENTS

A. General:

1. Pipe Support Systems shall be designed for:

a. Gravity loads imposed by weight of pipes including the weight of fluid in pipes and insulation.

b. Seismic loads in accordance with governing codes.

c. Wind loads in accordance with governing codes.

2. Design, size, and locate piping support systems throughout facility, whether shown or not.

3. Meet requirements of MSS SP 58, MSS SP 69, MSS SP 89, and IBC.

4. Piping Smaller Than 30 Inches:

a. Supports are shown only where specific types and locations are required; Additional pipe supports may be required.

B. Pipe Support Systems:

1. Pipe support systems shall be designed for gravity and thrust loads imposed by weight of pipes or internal pressures, including weight of fluid in pipes and insulation.

2. Outdoor exposed piping shall be designed for wind loads per the applicable codes.

3. Maximum support spacing and minimum rod size shall be in accordance with MSS SP-69 and the table below.

a. For ductile iron pipe spanning more than 10 feet, Toruseal gaskets are required.

4. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

a. NPS 1-1/2 and NPS 2 : 60 inches with 3/8-inch rod.

b. NPS 3 : 60 inches with 1/2-inch rod.

c. NPS 4 : 60 inches with 5/8-inch rod.

5. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

a. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.

b. NPS 1 and NPS 1-1/4 : 72 inches with 3/8-inch rod.

c. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

d. NPS 2-1/2: 108 inches with 1/2-inch rod.

e. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

6. Plastic pipe: As recommended by the manufacturer for the flow temperature in the pipe.

| Pipe Size | Maximum Support/Hanger Spacing | Minimum Rod Size Single Rod Hangers |
|---|---|---|
| 1" & smaller | 4 feet | 1/4" |
| 1-1/2" through 2-1/2" | 5 feet | 1/4" |
| 3" & 4" | 6 feet | 3/8" |
| 6" | 12 feet | 3/8" |
| 8" | 12 feet | 1/2" |
| 10" & 12" | 14 feet | 5/8" |
| 14" | 16 feet | 3/4" |
| 16" & 18" | 16 feet | 7/8" |
| 20" | 18 feet | 1" |
| 24" | 18 feet | 1-1/4" |
| 30" & larger | As shown on Drawings | As shown on Drawings |

C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

E. Bracing: Provide vertical sway bracing on 10-foot maximum centers or where Shown.

F. Pipe Anchors:

1. Provide on straight runs without provisions for piping expansion.

2. Maximum Spacing: The maximum straight run of piping smaller than

3. 3 inches not bound by anchors shall be as follows:

| Pipe Type (Service Temperature) | Anchor Spacing (ft) |
|---|---|
| Steel (81 - 212 degrees F) | 100 |
| Steel (33 - 80 degrees F) | 120 |
| Stainless steel (81 - 212 degrees F) | 80 |
| Stainless steel (33 - 80 degrees F) | 100 |
| PVC or CPVC (81 degrees F and higher) | 60 |

| | |
|---|---|
| PVC or CPVC (33 - 80 degrees F) | 100 |

4. Direction of design load shall be either perpendicular or parallel to support, or parallel to pipe, whichever produces greatest stress in anchor. Design load shall be as follows:

| Pipe Size (inches) | Design Load (Pounds) |
|---|---|
| 1/4 | 150 |
| 1/2 | 150 |
| 3/4 | 150 |
| 1 | 150 |
| 1-1/4 | 200 |
| 1-1/2 | 300 |
| 2 | 500 |
| 2-1/2 | 800 |

G. Building Structural Attachments:

1. Minimum Design load for Attachments shall be the following:

| Pipe Size | Load (Pounds) |
|---|---|
| 1-1/4" and smaller | 150 |
| 1-1/2" and 2" | 150 |
| 2-1/2" | 170 |
| 3" | 210 |
| 4" | 260 |
| 6" | 530 |
| 8" | 760 |
| 10" | 1,120 |
| 12" through 18" | 1,200 |

2. Rating shall be based on an allowable stress of 1/5 of the minimum tensile strength of the material at service temperature. Castings shall include a casting quality factor of 0.80 of the allowable stress specified.

3. Verify that the concrete used is of sufficient strength to hold concrete inserts at the design load rating specified.

PART 2: PRODUCT

2.01 GENERAL

A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.

B. All pipe supports shall be field primed and painted with the specified painting system for the application in accordance with requirements of Section 09900 Painting of these Specifications.

C. Special support and hanger details may be required for cases where standard catalog supports are inapplicable.

D. Materials: In accordance with the table below.

| Exposure Condition | Support Material |
|---|---|
| General | Coated or galvanized steel |
| Wetted or submerged | 316 Stainless Steel or FRP |
| Chemical Facilities | FRP |
| High Humidity | 316 Stainless Steel or FRP |
| Dewatering Facility | 316 Stainless Steel or FRP |

2.02 MANUFACTURERS

A. Anvil.

B. Uni-Strut.

C. Eaton B-Line Series

D. Or Equal.

2.03 NONMETALLIC CHANNEL FRAMING SYSTEM

A. Glass Fiber Reinforced Composites and Plastic Products: Flame spread rating of 25 or less when tested per ASTM E84.

B. Channel Framing: Glass reinforced plastic manufactured by pultrusion or extrusion to provide proper balance to longitudinal and transverse strength.

C. Vinyl Ester: Premium grade, at least equal to Krup-Koppers 9300, corrosion resistance, and nexus polyester surfacing.

D. Minimum Pull-Out Strength: 1,000 pounds when load is applied to head grooves over a 3/8-inch long section of channel.

E. Pipe Clamps and Hangers: Polyamide 12 nylon.

2.04 COMPONENTS

A. Nonmetallic Pipe Clamps and Hangers:

1. Pipe Size: 1/8 inch through 4 inches.

2. Type: Two-piece, automatic locking, corrosion resistant.

3. Features:

a. Clamping segments anchor to base by nylon hinges at base.

b. Fastening via centrally located oval mounting holes.

4. Structural Attachments:

a. Furnish required factory-fabricated accessories

B. Intermediate Pipe Guides:

1. Piping 6 Inches and Smaller:

a. Type: Pipe clamp with oversized pipe sleeve to provide minimum 1/8-inch clearance.

b. Manufacturers and Products:

1) Kin-Line, Inc.; Figure 417.

2) Anvil Power Strut; Figure P5932.

2. Piping 8 Inches and Larger:

a. Type: Specially formed U-bolts with double nuts to provide

b. 1/4-inch minimum clearance around pipe.

c. U-Bolt Stock Size:

1) 8-Inch Pipe: 5/8 inch.

2) 10-Inch Pipe: 3/4 inch.

3) 12 Through 16-Inch Pipe: 7/8 inch.

4) 18 Through 30-Inch Pipe: 1 inch.

C. Pipe Alignment Guides:

1. Type:

a. Piping 8 Inches and Smaller: Spider or sleeve type.

b. Piping 10 Inches and Larger: Roller type.

2. Manufacturers:

a. Flexonics.

b. Kin-Line.

D. Pipe Anchors:

1. Type: Anchor chair with U-bolt or bar strap.

2. Manufacturers and Products:

a. Anvil; Figure 198.

b. B-Line; Figure B3147A or B3147B

2.05 DIELECTRIC BARRIERS

A. Plastic coated hangers, isolation cushion, or tape.

B. Manufacturer and Products:

1. B-Line; B1999 Vibra Cushion

2. B-Line: Iso Pipe, Isolation Tape

2.06 FASTENERS

A. Anchor Bolt Material: Wetted or submerged use Type 316 stainless steel.

B. Nonmetallic Channel Framing Connections: Vinyl ester glass fiber or

C. polyurethane base composite nuts and bolts.

2.07 FABRICATION

A. Shop Assembly: In accordance with MSS SP 89.

B. Shop Finishing:

1. In accordance with MSS SP 85.

2. Coat ungalvanized steel components with rust inhibitive primer as

3. specified in Section 09900, Painting.

2.08 SOURCE QUALITY CONTROL

A. Shop Tests: In accordance with MSS SP 89.

PART 3: EXECUTION

3.01 INSTALLATION

A. GENERAL

1. Install all pipe supports and hangers in accordance with Manufacturers Standardization Society (MSS) SP-58, and MSS SP 89 Pipe Hangers and Supports, and as specified herein.

2. Hangers shall permit a minimum of 1 ½ inch vertical adjustment after installation.

3. Cast iron or ductile iron piping shall be supported as recommended by the manufacturer, and at all valves and fittings larger than 4 inches in size as shown on the Drawings. At least one support shall be provided per pipe section or at every other joint, whichever is closer. Supports shall be located next to hubs or bells.

4. Pipe ends of pipe columns used for support shall be completely covered with a ¼ - inch-thick plate or angle leg welded in place.

5. All threaded connections installed loose, such as hanger rods and U-bolts, shall have a double nut installation.

6. Pipes passing through non-load bearing walls and partitions shall not bear on building construction. Pipes shall not be supported from roof decking, bar joists, or ceiling suspension systems unless approved by the Engineer.

7. On insulation finished with an aluminum jacket, a 1/32-inch thick sheet of neoprene shall be provided between the jacket and the shield.

8. Hangers shall be selected to fit around insulation.

9. Unless otherwise shown, piping shall not be fastened to a support in such a manner than would prevent axial movement due to thermal expansion and contraction.
10. No pipe supports shall be anchored to or supported from floor grating.
11. Unless otherwise noted, piping dimensions shown on the Drawings are for reference only and shall be verified in the field by the Contractor. The Contractor shall size supports and hangers using actual field dimensions.
12. Support piping connections to equipment by pipe support and not by the equipment.
13. Support no pipe from the pipe above it.
14. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
15. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
16. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.
17. Install lateral supports for seismic loads at all changes in direction.
18. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
19. Repair mounting surfaces to original condition after attachments are made.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
    a. Single Pipes: Adjustable swivel-ring, splint-ring or clevis hangers.
    b. Grouped Pipes: Trapeze hanger systems.
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 are also acceptable.
    b. Stacked Piping:
        1) Wall-mounted framing system and clips acceptable for piping smaller than 3-inch minimal diameter.
        2) Piping clamps that resist axial movement of pipe through the support are not acceptable.
3. Horizontal Piping Supported From Floors:
    a. Stanchion Type:
        1) Pedestal type; adjustable with stanchion, saddle, and anchoring flange.
        2) Use yoked 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.

4) Provide minimum 1-1/2-inch grout beneath baseplate.

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. Insulated Pipe:

a. Pipe hanger and support shall be on outside of the insulation and shall not be enclosed within the insulation.

b. Provide precut 120-degree sections of rigid insulation (minimum length same as the shield), galvanized steel shields and oversized hangers or insulated saddle system. Anvil; Figure 260 (ISS).

c. Wall mounted piping clips not acceptable for insulated piping.

5. Vertical Pipe: Support with wall bracket and base elbow or riser clamp on floor penetrations.

6. Standard Attachments:

a. To Concrete Ceilings: U-channel concrete inserts, U-channel to concrete attachment plaster.

b. To Steel Beams: I-beam clamp or welded attachments.

c. To Concrete Walls: Concrete inserts or brackets or clip angels with anchor bolts.

d. To Concrete Beams: U-channel concrete inserts, or if inserts are not used to attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

C. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides (or pipe supports that provide the same function) at all expansion joints and loops.

2. Guide piping on each side of an expansion joint or loop at 4 and 14 pipe diameters from each joint or loop.

3. Install intermediate guides on metal framing support systems not carrying a pipe anchor or alignment guide.

D. Accessories:

1. Insulation Shield: Install on insulated piping. Oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe. Oversize rollers and supports.
3. Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.
4. Dielectric Barrier:
    a. Provide plastic coated hangers, or isolation tape between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and non-stainless steel ferrous metal piping.
    b. Install 1/4-inch by 3-inch neoprene rubber wrap between submerged metal pipe and oversized clamps.

END OF SECTION

# SECTION 15100

# VALVES, HYDRANTS, AND OPERATORS

## PART 1: GENERAL

### 1.01 SCOPE

A. Work covered by this section includes furnishing all labor, equipment, and materials required to furnish and install all valves, including operators, electric actuators, boxes, and accessories, as specified herein, shown on the Drawings, or required for proper completion of the work under these Contract Documents.

B. Contractor shall coordinate butterfly valves for air service with the limit switch requirements as specified in Section 16920 Instrumentation.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Shop Drawings, product Data and Samples – Section 01340 Shop Drawings, Product Data and Samples.

B. Storage and Protection – Section 01600 Delivery, Storage and Handling.

C. Operating and Maintenance Data – Section 01730 Operating and Maintenance Manual.

D. Warranties and Bonds – Section 01740 Warranties and Bonds.

E. Painting – Section 09900 Painting.

F. Fiberglass (FRP) ductwork valves and accessories – Section 15201 Fiberglass Reinforced Plastic Ductwork

G. Instrumentation-Division 16.

### 1.03 SHOP DRAWINGS AND ENGINEERING DATA

A. Submittals including more than two valves and/or operators shall contain a Table of Contents, tabbed sections, page numbers, ant the valve type listed in the upper right hand corner of each associated data sheet. Submittals meeting these requirements shall be rejected without review if the submittal is not properly formatted.

B. Action Submittals:

1. Shop Drawings:

a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.

b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

c. Factory applied paint systems

d. Certification for compliance to NSF 61 for valves used for drinking water service.

e. Power and control wiring diagrams, including terminals and numbers.

f. For each power actuator provided, manufacturer's standard data sheet, with application specific features and options clearly identified.

g. Sizing calculations for open-close/throttle and modulating valves.

C. Complete shop drawings and engineering data on all piping and accessories shall be submitted to the Engineer in accordance with requirements of the Section 01300 Submittals.

1.04 STORAGE AND PROTECTION

A. Valves and accessories shall be stored and protected in accordance with requirements of Section 01600 Delivery, Storage and Handling of these Specifications.

B. Valves shall be completely drained prior to shipment. Ends of flanged and mechanical joint valves shall be protected with full size wooden baffles securely bolted to the valve ends. Size of baffles shall be at least equal to outside diameter of flange. Valves 24-inches in size and larger shall be secured to a wooden skid to facilitate handling and storage.

1.05 PAINTING

A. Unless otherwise specified, all interior and exterior nonmachined, nonbearing ferrous surfaces on iron body valves, and accessories for buried or submerged service shall be blast-cleaned and painted at the factory with 2 coats of asphaltic varnish conforming to Federal Specification TT-C-494A.

B. Exterior nonmachined, nonbearing ferrous surfaces on valve operators and on exposed valves shall be blast-cleaned and painted at the factory with 1 coat of zinc chromate primer conforming to Federal Specification TT-P-645A.

C. The valve supplier, subject to the Engineer's approval, may propose other paint systems.

D. All exposed valves shall be field primed and painted in accordance with Section 09900 PAINTING.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit complete operation and maintenance data on the valves in accordance with requirements of SECTION 01730 Operating and Maintenance Manual.

1.07 QUALITY ASSURANCE

A. The valve manufacturers shall furnish a written certification to the Engineer that all valves and operators furnished comply with all applicable requirements of the governing AWWA standards specified herein.

1.08 GUARANTEE

A. Provide a guarantee against defective equipment and workmanship in accordance with requirements of Section 01740 Warranties and Bonds of these Specifications.

1.09 WARRANTY

A. Each actuator shall be warranted for a minimum of 24 months of operation up to a maximum of 36 months from shipment.

## PART 2: PRODUCTS

### 2.01 GENERAL

A. All castings, regardless of material, shall be free from surface defects, swells, lumps, blisters, sand holes, or other imperfections.

B. All valves shall have the name of the manufacturer, rated working pressure, and size of the valve cast upon the body or bonnet in raised letters. Alternately, the name of the valve manufacturer, rated working pressure, and size may be stamped on a stainless steel identification plate permanently attached to the valve body or bonnet.

C. Valves and operating mechanisms shall be of the proper size and dimensions to fit the pipe connections thereto and shall be installed in the position and within the space shown on the Drawings.

D. Unless otherwise specified, the direction of rotation of the operator to open the valve shall be to the left (counterclockwise). Each valve body or operator shall have cast thereon the word OPEN and an arrow indicating the direction to open.

E. A union or coupling shall be provided within 2 feet on each side of a threaded end valve unless the valve can be otherwise easily removed from the piping. This shall not apply to soldered end valves in copper plumbing.

F. All exposed bolts and nuts on buried or submerged valves and operators shall be brass or stainless steel for corrosion resistance. Exposed bolts and nuts on exposed valves and operators shall be of corrosion-resistant materials or shall be zinc plated.

G. Valves and operators shall be of the proper size to fit the pipe connections and shall fit in the position and space as shown on the Drawings.

H. Valve operators shall be of sufficient size and capacity to seat, unseat, and operate the valve under the maximum specified differential pressure. Where no maximum differential pressure is specified, the operator shall be designed for a differential pressure equal to the maximum working pressure of the valve. Additional allowances shall be made for the lubricating and/or scale forming tendencies of the fluid.

I. Valves and operators designed for buried service shall be provided in all underground applications.

### 2.02 PAINTING

A. All exposed valves shall be field primed and painted in accordance with Section 09900 PAINTING.

2.03 FACTORY FINISHING

A. General

1. Interior coating for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.

2. Exterior coating for valves and hydrants shall be in accordance with Section 09900 Painting.

3. Material in contact with potable water shall conform to NSF 61.

4. Exposed safety isolation valves and lockout valves with handles, handwheels or chain wheels shall be safety yellow.

B. Where epoxy lining and coating are specified, factory finishing shall be in accordance with AWWA C550.

2.04 ANGLE TYPE HOSE VALVE

A. 3/4-inch NPT female inlet, 3/4-inch male hose thread outlet, heavy rough brass body rated 125 psi, lockshield bonnet, removable handle, atmospheric vacuum breaker conforming to ASSE 1011 and IAPMO code.

B. Manufacturers and Products:

1. Acorn 8126, surface pipe mount valve, bent nose without flange

2. Acorn 8121, surface mount through wall valve, bent nose, with flange

3. Acorn 8131, pipe and pedestal mounted above 6 inches, straight nose

4. Acorn 8131, pipe and pedestal mounted above 6 inches, inverted nose

2.05 BALL VALVES

A. Ball valves shall be of the quarter-turn type with full pipe size opening through the valve. Ball valves shall be suitable for a differential working pressure in either direction of not less than 400 psi.

B. Ball valves less than 4-inches shall have brass body, self-aligning brass ball, blowout-proof brass stem, reinforced Teflon seats and seals, plastic-coated plated steel handle, and flanged ends per ANSI B2.1. Ball valves shall have a 3-piece, bolted body designed to allow the interior portion of the valve to be removed without disturbing adjacent piping. Ball valves shall be Apollo Model 82-100, Nibco S-595-Y, or equal.

C. Ball valves, 4-inches to 6-inches, shall have cast iron body with stainless steel ball and stem, PTFE Teflon seats and seals, plastic-coated plated steel handle, and flanged ends. Ball valves shall be Apollo Model 6PLT Series or equal.

D. Ball valves on domestic water systems shall be lead free, full port and 2-piece construction is acceptable.

E. Ball valves shall be available with Type 316 stainless steel construction when connecting to stainless steel piping.

F. Ball valves for chemical service shall be as specified in Paragraph 2.14 VALVES FOR CHEMICAL SERVICES.

2.06 BUTTERFLY VALVES

A. Unless otherwise shown or specified, butterfly valves shall be of the resilient seated, tight-closing type and shall conform in all respects to the applicable material and dimensional requirements of AWWA C504. Wafer-type butterfly valves in sizes 24 inches and larger shall conform to all general requirements of AWWA C504 except laying length. Butterfly valves shall operate from fully open to fully closed with a 90-degree rotation of the valve stem.

B. Butterfly valves shall be suitable for intended use.

C. Wafer-type valves shall have a pressure rating of not less than 150 psi. Valves shall be drip-tight and bubble-tight at rated pressure differential across the valve in both directions

D. Valve body shall be 1-piece, constructed of cast iron conforming to ASTM A126, Class B. Diameter of the opening shall be not less than the diameter of the corresponding pipe size. Unless otherwise specified, valve body shall be of the short-body style in accordance with Table 3 of AWWA C504. This requirement shall not apply to wafer-type valves. No part of the valve internals shall extend beyond the valve ends when the valve is in the closed position. Short-body valves shall have 125-pound flanged ends per ANSI B16.1. Wafer-style valves shall be designed to fit between 125-pound flanges per ANSI B16.1.

E. Disc shall be cast bronze conforming to ASTM B 143, Alloy 1A, cast iron conforming to ASTM A48, Class 40, Ni-resist ductile iron conforming to ASTM A 439, Type D2. When used in wastewater or raw water, disc shall be streamlined with no exterior ribbing or openings.

F. Shafts shall be polished stainless steel conforming to ASTM A276, Type 304 or Type 316. All keys and pins used in securing valve disc to shafts shall be stainless steel or Monel.

G. Valve seat shall be of 1-piece, molded synthetic rubber, Buna-N (Hycar) for wastewater and Buna-N or neoprene for air. Where temperatures exceed 180 degrees F, EPDM or Viton seats shall be used. Retaining rings, if used, shall be stainless steel. The method of mounting valve seat shall conform to applicable requirements of AWWA C504, Section 3.5. Valve seats in sizes 24 inches and larger shall be field replaceable without necessity of shipping, burning, or cutting. Seats secured with retaining rings shall be fully adjustable. Metal seat mating surfaces shall be smoothly contoured and polished 18-8 stainless steel or Monel. Alloy cast iron will not be acceptable as a seat-mating surface. Sprayed or plated seat mating surfaces will not be acceptable.

H. Shaft seals shall be O-ring or self-adjusting chevron packing of Buna-N or neoprene. Shaft seals shall conform to the requirements of AWWA C504, Section 3.7, and shall be of a design that allows replacement of the seal without removing the valve shaft. Alternately, pull-down packing is acceptable if the packing is adjustable and replaceable without removing valve operator.

I. Valve bearings shall be self-lubricating, sleeve-type bearings of corrosion resistant materials. Bearing load shall not exceed 2,500 psi. Valves 24 inches in size and larger shall be provided with an adjustable, 2-way thrust bearing to center the disc in the valve and allow the valve to be installed with the valve stem vertical. Bearing shall be easily accessible for adjustment.

J. Where the valve is installed, adjacent to a fitting, flow meter, another valve, or similar items, a spool piece or adaptor coupling shall be furnished as a spacer so that valve disc does not interfere with operation of the adjacent meter or valve or contact cement linings on pipe or fittings.

K. Valve shall be furnished with a lever operator, rotary manual operator, electric motor operator, or pneumatic cylinder operator as shown on the Drawings. Unless otherwise shown of specified, a lever operator shall be furnished on valves 6 inches and smaller, and a rotary manual operator shall be furnished on valves 8 inches and larger. Extension stem and floorstand shall be furnished, where shown or required.

L. Butterfly valves shall be as manufactured by DeZurik, Pratt, or equal.

2.07 GATE VALVES

A. Unless otherwise specified, all gate valves shall be of the single disc, double-seated, solid tapered resilient wedge type. Valves shall have non-rising stems and shall be capable of being repacked under pressure when valve is fully open. Iron body gate valves for potable water lines shall be provided in all underground applications.

B. Gate valves 2 ½ inches in size and smaller shall be bronze body, bronze-fitted valves, and shall have 150-pound, cast bronze body, union bonnet, Teflon-impregnated asbestos packing, and threaded ends per ANSI B2.1. Bronze shall conform to ASTM B 62. Brass for nuts and gland shall conform to ASTM B 16. Valve discs shall be reversible. Bronze gate valves shall be Nibco Fig. T-136, or equal. For use in copper plumbing, gate valves shall be furnished with solder ends per ANSI B16.18.

C. Gate valves 2 inches in size and larger shall be iron body, bronze mounted valves conforming in all respects to the applicable material and dimensional requirements of AWWA C509. Minimum working pressures shall be 200 psi for valves 12 inches in size and smaller and 150 psi for valves 16 inches and larger. Gate valves shall have a triple O-ring stem seal. Two rings are located above and one O-ring below the thrust collar, O-rings set in a cartridge shall not be allowed and 125-pound flanged ends per ANSI B16.1, except for valves to be buried underground, which shall have mechanical joint ends per ANSI A21.11 (AWWA C111). Body seat rings shall be ASTM B 62 bronze and shall be screwed into the body so as to be field replaceable. Wedge shall be constructed of ductile iron and encapsulated in rubber. Cast iron for body and bonnet shall conform to ASTM A 126, Grade B. Iron body gate valves with solid resilient wedge discs shall be Clow, Mueller, American Flow Control, or engineer approved equal.

D. Gate valves shall be furnished with nut, wrench, chain, or handwheel operators as shown on the Drawings. Unless otherwise shown or specified, valves shall have operators as specified herein. Extension stems, floor stands, and valve boxes and covers shall be furnished where shown or required.

E. Gate valves on domestic water systems shall be lead free.

2.08 KNIFE GATE VALVES – 24” AND SMALLER

A. Solid cast iron body (ASTM 126-b) dual flange, ANSI 150# flange bolt patter.

B. Type 304 stainless steel gate.

C. Nitrile body seat seal mechanically retained to prevent “pull-out” and installed flush with bottom body bore for self-cleaning of seat area.

D. Nitrile top transverse seal with TFE packing (repackable while in service or under pressure) complete with glass-filled phenolic scraper blades to wipe gate clean during opening stroke to protect and prolong life of transverse seal.

E. Extra heavy-duty steel yoke.

F. Heavy-duty grease filled bevel gear actuator with thrust bearing and seals furnished complete with 2-inch square operating nut.

G. Heavy-duty rising stem with rigid gate connector for full stroke support of gate.

H. Bi-directional bubble-tight shutoff from 150 psi to -28 Hg vacuum.

I. Reduced chest cavity to ensure gate closure in high concentrations of solids backup.

J. Contoured body bore for self-flushing/cleaning.

K. Gate guided for full length of stroke with internal body gate guides.

L. Gate supported in body with close clearance chest area machining to allow valve to installed on its side.

M. Manufacturers: Wey Model NA1.

2.09 PLUG VALVES - TWO-WAY

A. Unless otherwise shown or specified, 2-way plug valves shall be of the eccentric, non-lubricated type with resilient, neoprene or nitrile-faced plugs providing drip-tight shut-off at rated pressure. Port area shall not be less than 80 percent of the corresponding full pipe area in sizes 16 inches and smaller and 100 percent of the corresponding full pipe area in valves 20 inches and larger. Two-way valves shall operate from fully open to fully closed with a 90-degree rotation of the valve stem.

B. Valves shall be designed for a working pressure of not less than 175 psi in sizes through 16 inches and 150 psi in sizes 18 inches and larger. Valves shall be drip-tight at rated pressure differential in both directions.

C. Valves shall have bodies of ASTM A 126, Grade B or ASTM A 48, Grade 40 cast iron. Valves 4 inches and larger in size shall have bolted bonnet.

D. Body seats for resilient-faced plugs shall be welded in and shall contain a minimum of 90 percent nickel. Welded-in seats shall conform to applicable requirements of AWWA C507, Section 7.2 and AWWA C504, Section 9.4. Plugs shall have a field replaceable, full-circle rubber seat securely attached to the plug.

E. As an equal to Paragraph D above, the nickel seat ring shall be fused into the plug and the field replaceable, full-circle rubber seat shall be located in the body.

F. Shaft seal shall be of the self-adjusting or split-V type of Buna-N and shall comply with applicable requirements of AWWA C504, Section 11 and AWWA C507, Section 10. Seals requiring adjustment shall be adjustable and replaceable without bonnet or shaft removal.

G. Bearings shall be supplied in both the upper and lower journals. Bearings shall be permanently lubricated and replaceable with stainless steel, bronze, or corrosion-resistant sleeves and bushings. Bearings shall conform to the applicable requirements of AWWA C504, Section 9 and AWWA C507, Section 8.

H. Valves sized 2½ inches and smaller shall have threaded ends per ANSI B2.1. End connections for valves sized 3 inches and larger shall be 125-pound flanged per ANSI B16, except for valves to be buried underground, which shall have mechanical joint ends per ANSI A21.11 (AWWA C111). Flanged end valves in sizes 12 inches and smaller shall have a laying length equal to that of an AWWA gate valve of the same size.

I. Valves intended for buried or submerged service shall be sealed against the entrance of water and dirt.

J. Valves shall be furnished with a lever operator, rotary manual operator, or electric motor operator as shown on the Drawings. Unless otherwise shown or specified, a lever operator shall be furnished on valves 8 inches and smaller, and a rotary manual operator with handwheel shall be furnished on valves 10 inches and larger. Extension stem, floorstand, and valve box shall be furnished where shown or required.

K. Two-way plug valves shall be manufactured by DeZurik, Pratt or equal.

2.10 PLUG VALVES - THREE-WAY

A. Three-way, nonlubricated, taper plug valves shall be cast iron with Buna-N coated plug. Vale shall have stainless steel bearings, nickel or epoxy coated seat and be rated for 125 psi minimum. Valve shall be flanged ends that meet ASME B16.1.

B. Valve operator shall be gear type, totally enclosed and lubricated.

C. Valve shall be DeZurik, Milliken or equal.

2.11 VALVES FOR CHEMICAL SERVICES

A. Isolation valves shall be PVC ball valves rated 150 psi at 73 degrees F, with ASTM D1784, Type 1, Grade 1 polyvinyl chloride body, ball and stem. Valves shall be double union design, solvent weld socket ends, elastomeric seat, Teflon O-ring seals.

1. Manufacturers:

a. Nibco Chemtrol Tru-Bloc

b. ASAHI/America Duo-Bloc

c. Or equal

B. Ball check valves shall be PVC body with Viton seat and seal. Valve shall have dual union socket welded ends, rated 150 psi at 73 degrees F.

1. Manufacturers:

a. Nibco Chemtrol Tru-Bloc

b. ASAHI/America True Union

c. Or equal

C. Backpressure sustaining valve for chemical services shall be installed at the injection points and sized to match connecting pipe. Valves shall be CPVC body with PTFE/EDPM diaphragm, 316 SST bolts, and NTP threaded connections. Backpressure shall be field adjustable.

1. Manufacturers:

a. Hayward PBV Series

b. Plastomatic Series RVDT

c. Or equal

D. Pressure relief valves for chemical services shall be CPVC and hand adjustable from 5-75 psi.

1. Manufacturers:

a. Hayward RV Series

b. Plastomatic Series RVD

c. Or equal

2.12 CHECK VALVES

A. Unless otherwise shown or specified, check valves shall be of the swing type suitable for use in either horizontal or vertical piping. Disc shall swing entirely clear of the path of flow when in the open position. All internal parts shall be readily accessible and easily replaced in the field.

B. Check valves on domestic water systems shall be lead free.

C. Check valves in sizes 2 ½ inches and smaller shall be Y-pattern, regrinding, bronze-body, bronze-mounted valves. Valves shall have 200-pound, cast bronze body, renewable bronze disc, screwed cap, and threaded ends per ANSI B2.1. Bronze for body and cap shall conform to ASTM B16. Valves shall have a hinge bumper capable of preventing the valve from sticking in the open position and an arrow cast on the valve body to indicate direction of flow. Bronze check valves shall be Apco Model 6000, Nibco Fig. T453-B, or equal.

D. Check valves in sized 3 inches and larger shall be iron body, bronze-mounted valves conforming to AWWA C508. Valves shall have 125-pound cast iron body, bolted and gasketed cover, stainless steel or brass hinge pin, renewable bronze seats and disc, outside lever and adjustable weight, and 125-pound flanged ends per ANSI B16.1. The lever arm and weight(s) shall be designed to meet the requirements of this Contract. Cast iron for body and cap shall conform to ASTM A 126, Grade B. Bronze for disc and seats shall conform to ASTM B 62. Iron body check valves shall be Apco Model 6000, Nibco Fig. F-918-BL&W, or equal.

E. Oil Controlled Closing Swing Check Valve for Reclaimed Water Pumps

1. The valve shall have a heavy duty body of high-strength cast iron conforming to ASTM A126 Class B with integral flanges, faced and drilled per ANSI B16.1 Class 125 for horizontal installation.

2. Disc arm shall be fabricated of high strength steel and be suspended from and keyed to an 18-8 stainless steel shaft completely above the waterway and supported at each end by heavy bronze bushings. Shaft shall rotate freely without the need for external lubrication. Valve disc shall be faced with a renewable, resilient seat ring held in place by a follower ring and stainless steel screws and shall seal tightly against a bronze replaceable body seat.

3. Shaft shall be sealed where it passes through the body by means of low friction pressure activated TFE v-rings or adjustable pack. Simple O-ring type shaft seals

are not acceptable. A single external lever with adjustable counterweight shall be keyed to the shaft.

4. Valve design shall provide for two speed closure. Rapid initial closure shall be affected by the outside counterweight. Final closure shall be controlled under full differential pressure across the open valve disc by means of a single, external side-mounted hydraulic cylinder. Final closure speed shall be easily adjusted by a needle type valve controlling the flow of hydraulic oil to and from an unpressurized reservoir. The point of transition from rapid initial to controlled final closure also shall be adjustable. The hydraulic cylinder shall be rigidly mounted to the valve body on machined pads using dowel pins or shoulder bolts to prevent fretting. Dual, bottom-mounted or pivoting hydraulic cylinders or pre-charged air chambers are not acceptable.

5. The valve shall swing open smoothly at pump start and provide two-stage closing upon pump shutdown. Valve shall close quickly through the initial portion of closure and at a controlled rate of speed for the final pre-determined portion of its closing stroke to minimize surges associated with pump shut down by allowing a nominal amount of backflow through the valve during closing.

6. Manufactures shall be Apco Model 6000 or engineer approved equal.

F. Check Valves for Air Lines

1. Check Valves in air piping sized 3 inches and larger shall be of the globe style silent check valves with cast iron body, 316 stainless steel plug, stainless steel hinge pin and springs, and EPDM seats. Check valves shall be suitable for mounting between two 125-pound ANSI B16.1 flanges. Check valves shall be rated for a working pressure of not less than 150 psi. Valves shall be capable of operating in the horizontal or vertical position.

2. Valves shall be Apco CSC Style 600A or equal.

G. Check valves for chemical service shall be as specified in Paragraph 2.14 VALVES FOR CHEMICAL SERVICES.

## 2.13 REDUCED PRESSURE BACKFLOW PREVENTION ASSEMBLY

A. Two resilient seated check valves with an independent relief valves between the valves, two nonrising stem resilient seated isolation valves, test cocks, in accordance with AWWA C511, rated 175 psi maximum working pressure.

1. For valves up to 2-inch, assemblies shall be Apollo RPLF 4A, Wilkins 975XL, or equal.

2. For valves larger than 2-inch, assemblies shall be Apollo RPLF 4A, Wilkins 375, or equal.

## 2.14 POTABLE WATER FIRE HYDRANTS

A. All fire hydrants shall be dry barrel type, designed and manufactured to comply with the latest specifications of the AWWA. The hydrants shall be designed for 150 pounds working pressure, of simple design, easy to operate, effectively and positively drained and protected from damage by freezing, and convenient for repairing and replacing parts.

B. Each hydrant shall be equipped with a 6-inch isolation gate valve as specified in Paragraph 2.04 GATE VALVES.

C. All connections between the main and the fire hydrant isolation valves shall be mechanical joint with ductile iron retainer glands.

D. Hydrants shall be equipped with one 4-1/2" pumper nozzle and two 2-1/2" diameter hose connections, which shall have threads meeting the latest requirements of the State Fire Insurance Commission. Hydrants shall have a safety flange on the barrel and stem in case of traffic accident.

E. The connection at the base of the hydrant shall be mechanical joint with ductile iron retainer gland, for Class 150, centrifugally cast, 6" cast iron pipe. The valve opening shall meet the requirements of the AWWA Specifications for 4-1/2" hydrant. The valve, valve seat and inner working parts shall be easily accessible. The depth from the surface of the ground to the bottom of the connecting pipe shall be 36". The distance from the ground to the hose nozzle shall be not less than 24". Each hydrant shall be neatly painted with a red reflecting paint.

F. Hydrants shall have a safety flange on the barrel and stem in case of traffic accident.

G. Hydrants shall be equal to Mueller Company's Super Centurian 350, or American Darling Mark 73-5.

2.15 YARD HYDRANTS

A. Yard hydrants shall be non-freeze type constructed of galvanized steel pipe with solid brass 1” NPTF brass inlet and 1” NPT brass hose adaptor outlet.

B. Hydrants shall have a heavy-duty cast iron head with stainless steel operating rod and one-piece plunger. The inlet and plunger shall be designed such that the hydrant riser will drain when flow is shut off.

C. Variable flow shall be controlled by CAM-type operating lever, lever shall be the same material as the hydrant head.

D. Top of hydrant head shall be 33” above the ground or solid mounting surface with a minimum bury depth of 2’. Where site grade varies at certain locations, bury depth up to 6’ may be required.

E. Yard hydrants shall be as manufactured by Josam 71450 Series or equal.

2.16 SLOW CLOSING SOLENOID VALVES

A. Slow closing solenoid valves shall be packless piston type direct acting for sizes less than 1-in and internal pilot operated for sizes 1-in and larger, 2-way or 3-way, valves and shall be Red Hat Series 221 as manufactured by Automatic Switch Co., or equal for air and water service.

B. Valves shall be energized to open, except for valves on water seal lines to pumps which shall be energize to close slowly to avoid water hammer.

C. Valves shall have forged brass bodies, NPT end connections of the connected piping Type 316 series stainless steel internal parts, and Buna-N or Ethylene Propylene valve seats. Valves shall have a minimum 150 psig safe working pressure and zero minimum operating pressure differential. Connections shall be threaded.

1. Except as otherwise specified herein, valves shall be as noted in PART 1 of this Specification.

D. Solenoid valves on bypass piping shall be installed whether shown or not.

E. Solenoid valves shall be suitable for operation on a 120-volt, single phase, 60 Hertz power supply unless otherwise shown on the Drawings. Valves shall be provided in a Type 4X stainless steel, watertight enclosure. NEMA 7 enclosures shall be provided for hazardous locations.

2.17 AIR RELEASE VALVES

A. Air release valves shall have cast iron body, stainless steel float, and stainless steel or bronze trim. Valves shall automatically exhaust small amounts of entrained air that accumulates in a system.

B. Valve shall be designed for a working pressure of 0 to 150 psi and shall be equipped with an orifice appropriate to the venting needs of the pipeline.

C. Air release valves for potable water applications shall have NPT threaded inlet and outlet to match sizes as shown on the Construction Drawings. Valves shall be built and tested to AWWA C512 standards.

D. Air release valves for non-potable water applications shall be equipped with an elongated body, a 2-inch NPT inlet connection, and a ½-inch NPT outlet connection and shall be provided with 2-inch inlet shut-off valve, 1-inch blow-off valve, and ½-inch back-flush valve with quick-disconnect coupling and flushing hose with quick-disconnect connections.

E. Air release valves shall be manufactured by Apco or Val-Matic.

2.18 COMBINATION AIR RELEASE/AIR VACUUM VALVE

A. Combination air valves shall be of the single-housing style that combines the operation features of both an air vacuum and air release valve. Valves shall be suitable for the service application as shown on the Construction Drawings.

B. The air/vacuum portion shall automatically exhaust large quantities of air during the filling of the pipeline and automatically allow air to re-enter the pipeline during draining or when negative pressure occurs. Valves for clean water applications shall be built and tested to AWWA C512 standards.

C. The air release portion shall automatically release small pockets of air from the pipeline while the pipeline is in operation and under pressure.

D. Combination air release valves shall be sized as shown on the Drawings. They shall be a maximum working pressure of 300 psi unless noted otherwise.

E. Valves shall be manufactured by Apco or Val-Matic.

2.19 SURGE RELIEF ANGLE VALVE

A. Surge Relief Angle Valves 2” to 16” shall have pressure relief ratings up to 200 psi. The valve shall be normally closed against the system pressure by external spring(s) in compression and shall open quickly to relieve pressure when the system pressure exceeds the pressure relief setting. The pressure relief setting shall be

factory set and field adjustable by adjusting the spring compression. The valve will begin to close when the system pressure subsides below the pressure relief setting. The closing speed shall be adjustable to suit the application by means of infinitely adjustable, lockable flow control valve.

B. Body shall be a 90-degree elbow design conforming to the center-to-face dimension for long-radius elbows per ASME B16.1 and ASME B16.42. Valve shall be a compact design to fit in tight installation spaces.

C. Body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron. Body Seat shall be 316 stainless steel. Flanges shall be flat faced and conform to ASME B16.42 Class 150. Valve shall be proof-of-design tested to 5,000 cycles.

D. A self-contained, sealed hydraulic system shall provide closing speed control. The valve cover shall provide an air gap between the line fluid and the hydraulic oil that will indicate seal wear and prevent contamination of line fluid or hydraulic oil. The valve shall be capable of being mounted in any position without modification or customization of the hydraulic system components. A mechanical stroke counter with manual reset shall provide local indication of total valve cycles.

E. External spring(s) located on the valve cover in a protective steel enclosure shall provide closing force. Springs shall be sized to optimally match customer-specified relief pressure setting to minimize pressure rise above the set-point in order to fully open valve. A single adjustment screw shall be provided for field adjustment of relief pressure setting.

F. Valve Disc shall have a replaceable seat ring of Acrylonitrile-Butadiene (NBR); Terpolymer of Ethylene, Propylene and A Diene (EPDM) or Fluoro Rubber (FKM) for tight shutoff.

G. Valves shall be APCO model SRA-3000A Surge Relief Angle Valves as manufactured by DeZURIK or approved equal.

2.20 MANUAL VALVE OPERATORS

A. Unless otherwise shown or specified, all valves shall be furnished with manual operators as follows:

| **Valve** | | **Operator** |
|---|---|---|
| Gate Valves | Buried | Extension stem and valve box with standard operating nut |
| Gate Valves | Submerged or Located in Deep Vault | Extension stem with floor stand and handwheel operator |
| | Exposed Less than 7’ above working surface | Handwheel operator |
| | Exposed More than 7’ feet above working surface | Chainwheel operator |
| Globe Valves | All | Handwheel Operator |
| Butterfly and Plug Valves | Buried | Standard operating nut with extension stem and valve box (8 inches and smaller); or rotary manual operator with extension stem and valve box and |

| | | |
|---|---|---|
| | | standard operating nut (larger than 8 inches) |
| | Submerged or Located in Deep Vault | Rotary manual operator with extension stem and floor stand with handwheel (all sizes) |
| | Exposed Less than 7' above working surface | Lever operator (8 inches and smaller) or rotary manual operator and handwheel (larger than 8 inches) |
| | Exposed More than 7' above working surface | Rotary manual operator and chainwheel (all sizes) |

B. Operating nuts for buried or submerged valves shall be standard 2-inch square nuts and shall conform to AWWA C500, Section 19. Extension stems, valve boxes, and stem guides shall be furnished where shown, specified, or required for proper operation.

C. Hand lever operators shall have heavy-duty, cast iron bracket, cast iron latching lever, and self-lubricating bushings and shall be capable of securing the valve at the fully open and fully closed position and a minimum of 5 intermediate positions. Lever operators shall be installed so that the lever is parallel with the axis of the pipe in which the valve is installed when the valve is fully open.

D. Rotary manual operators for aboveground service shall be of the worm and worm gear or of the traveling nut type. Rotary operators shall have a heavy-duty, weatherproof cast iron or steel housing with gasketed, removable cover and shall be equipped with a mechanical dial or slot type position indicator and a suitable handwheel. Manual operators shall be totally enclosed and sealed to prevent the entrance of rain, dirt, and corrosive atmospheres. Traveling nut operators shall have a grease-lubricated alloy steel screw stem, brass nut, and self-lubricating bronze bushings. Worm gear operators shall have hardened, grease-lubricated alloy steel worms and bronze worm gears. All exterior bolts and fasteners shall be bronze or stainless steel for corrosion resistance. The valve shall open with counterclockwise rotation of the handwheel.

E. Manual rotary operators for buried or submerged service shall conform with the requirements of Item D above except the operator shall be totally enclosed and completely sealed to prevent the entrance of water and dirt. Buried or submerged operators shall be finished on the outside with a bituminous or other approved coating. Rotary operators for buried or submerged service shall be capable of withstanding 300-foot/pounds of torque on the operating nut or handwheel. A corrosion resistant, dial-type valve position indicator shall be provided at the operating nut on the extension stem of buried operators to provide a remote indication of valve position.

F. Chain wheel operators shall be of heavy cast iron construction and shall be equipped with chain guide and looped, flexible, operating chain. Chain shall be heavily galvanized or cadmium plated and shall extend to within 60 inches of floor.

G. All manual rotary and lever operators shall be capable of seating or unseating the valve disc under the most adverse conditions in the particular application with not more than an 80-pound pull on the handwheel or lever. Valve operators shall be capable of holding the valve in any position between fully open and fully closed without creeping or fluttering. Operators shall be provided with adjustable, mechanical, stop-limiting devises to prevent over-travel of the valve disc in the open and closed positions. Manual rotary and lever operators shall comply with all applicable requirements of AWWA C504.

2.21 EXTENSION STEMS

A. Extension stems shall be solid steel not smaller than the stem of the valve or galvanized steel pipe having an inside diameter not smaller than the outside diameter of the valve or valve operator stem. Extension stems shall connect to the valve by a flexible socket coupling. All couplings shall be pinned, keyed, or socket type.

B. Each extension stem for buried valves shall extend to within 6 inches of the top of the valve box and shall be provided with spacers, which will center the stem in the valve box. A standard wrench nut shall be provided on the top of the extension stem. Extension stems for rising stem valves shall be stainless steel or carbon steel with bronze or stainless steel sleeves. Sleeves shall be of sufficient length and location to extend through each stem guide throughout the full vertical stem travel. Extension stems for submerged service shall be stainless steel or bronze.

C. Stem guides shall be bronze-bushed, cast iron construction adjustable in 2 directions. Stem guides shall be installed so the unsupported length of the extension stem does not exceed 10 feet or an L/r or 200.

D. Bevel gear extension stems shall be furnished where it is impractical to locate the floorstand directly over the valve. Such stems shall include a sufficient number of bearings to permit easy operation of the valves.

2.22 VALVE BOXES

A. Unless shown or noted otherwise, all buried valves shall be provided with 3-piece, cast iron, extension sleeve type, valve boxes suitable for the depth of cover as shown on the Drawings.

B. Valve boxes shall not be less than 5 inches in diameter, shall have a minimum thickness of 3/16-inch at any point, and shall be provided with suitable cast iron bases and covers. Covers shall have cast thereon an appropriate name designating the service for which the valve is intended (“W” for water, “S” for drain or waste lines). Covers in roadways shall be of the deep locking type.

C. All parts of valve boxes, bases, and covers shall be heavily coated with a suitable bituminous finish.

D. Valves and boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves with the top of the box flush with the finished grade.

2.23 T-HANDLE OPERATING WRENCH

A. The Contractor shall furnish 4 (four) T-handle, steel valve operating wrenches with sockets compatible with standard 2-inch square valve operating nuts.

B. The operating wrenches shall be at least 36 inches in length.

2.24 ELECTRIC VALVE ACTUATORS - NON-INTRUSIVE TYPE

A. General

1. The electric actuators for the motor operated valves shall be of Non-Intrusive design with the capability for remote two-wire digital control interface. No substitution, or exception to the following specification will be accepted. The

actuators shall be suitable for use on a nominal 460 Volt, 3 Phase, and 60-Hertz power supply.

2. The actuators shall be self-contained unit consisting of electric motor, 15-bit, optical, absolute position encoder, electronic torque sensor, integral reversing starter, electronic control, protection, and monitoring package, manual override hand wheel, valve interface bushing, 32-character LCD display, and local control switches all contained in a sealed watertight enclosure suitable for NEMA 4, 4X, 6, IP68 and explosion proof as required. Actuator shall be suitable for automatic valve positioning and modulation control when utilized in a rate of flow control operation. Signal shall be a 4-20mA analog input to the valve unless otherwise noted.

3. All calibration shall be possible without removing any covers and without the use of any special tools. Answering simple “YES” or “NO” questions displayed on the 32-character LCD display shall perform all calibration. All local displays shall be expressed in multilingual text, no symbols on the LCD will be allowed.

4. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator.

B. Actuator Sizing

1. The actuator shall be sized to guarantee valve closure and opening at the specified differential pressure and valve opening. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. The operating speed shall be such as to give valve closing and opening at approximately 10-12 inches per minute unless otherwise specifically stated in the valve specification and/or valve data sheets.

C. Ambient Temperature

1. The actuator shall be capable of functioning in an ambient temperature ranging from minus 22°F (-30°C) to + 158°F (+70°C). Actual operating environment for specific valve application is as shown in the associated valve specification and/or data sheets.

D. Motor

1. The motor shall be 3-phase, 60-cycle, 460-volt with class F insulation, and a thermistor embedded within the motor windings to prevent damage due to overload. The motor shall be easily removed through the use of a plug-in connector and shaft coupling. Motor shall have the capability of removal without the need of draining oil from the actuator gearbox.

E. Power Transmission

1. The power transmission shall be completely bearing – supported, and consist of a hardened alloy steel worm and bronze worm gear, oil-bath lubricated using synthetic oil designed specifically for extreme pressure gear transmission service. Where the actuator operates gate valves or large diameter ball or plug valves, the drive shall incorporate a lost-motion hammer-blow feature. For rising spindle valves, the output shaft shall be hollow to accept a rising stem and incorporate

thrust bearings of the ball or roller type at the base of the actuator, and the design should be such as to permit the gear case to be opened for inspection or disassembled without releasing the stem thrust or taking the valve out of service.

F. Hand Operation

1. A hand wheel and a de-clutch (hand/auto selection) lever shall be provided for manual operation. The hand wheel drive must be mechanically independent of the motor drive, and any gearing should be such as to permit emergency manual operation in a reasonable time. The hand wheel shall not rotate during electric operation nor can a seized motor prevent manual operation. Hand wheel is engaged when the motor is declutched by a lever or similar means. Energizing the motor shall restore the actuator automatically to motor operation. The de-clutch (hand/auto selection) lever shall be padlockable. Lost motion “hammer blow” effect shall be provided with both direct and independently geared hand wheels.

2. Clockwise operation of the hand wheel shall give closing movement of the valve unless otherwise stated in the job specification.

G. Drive Bushing

1. The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. Normally the drive bushing shall be positioned in a detachable base of the actuator. Thrust bearings, when housed in a separate thrust base, should be of the sealed-for-life type.

H. Position & Torque Sensing

1. A 15 – bit optical absolute position encoder, shall sense valve position. Position setting range shall be: 2 to 100,000 turns, with a maximum angular resolution of 7.5° degrees of actuator drive sleeve output position at the valve stem. Open and closed positions shall be stored in permanent, non-volatile memory. The encoder shall measure valve position at all times, including both motor and hand wheel operation, with or without 3 – phase power, and without use of a battery. Use of batteries in the actuators shall not be acceptable.

2. An electronic torque sensor shall be included. The torque limit may be adjusted from 40% to 100% of rating in 1% increments. The motor shall be de-energized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating, and a “Jammed Valve” protection feature, with automatic retry sequence shall be incorporated to de-energize the motor if no movement occurs.

3. No mechanical torque sensing system using springs, or washers will be accepted.

I. Remote Valve Position / Actuator Status Indication

1. Four latched contacts rated 250 Vac / 30 Vdc, 5 amps shall be provided for remote indication of valve position, configured as 1-N/O and 1-N/C for both the open and closed positions. The remaining contacts shall be configured to represent any other actuator status; mid-travel position, switched to local, over torque, motor over temperature, manual operation, switched to remote, switch to stop, valve moving, close torque switch trip, open torque switch trip, hardware failure, ESD active, or valve jammed.

2. Monitor Relay

    a. A monitor relay shall be included and shall trip when the actuator is not available for remote operation. Both N/O and N/C contacts shall be included, rated 250 Vac / 30 Vdc, 5 amps. The yellow LED shall blink when the monitor relay is active. The relay must de-energize if any of the following events occur:

        1) Loss of one or more of the 3-Phase incoming power supply.

        2) Loss of internal control power supply.

        3) Jammed valve detected.

        4) Motor over temperature is active, unless thermostat is configured to OFF.

        5) Selector switch is in the “LOCAL” mode.

        6) Selector switch is in the “STOP” mode.

    b. The actuator must also include monitoring capability for the following parameters:

        1) Valve over-torque

        2) Inhibit signal active

        3) ESD signal active

    c. Provision shall be made in the design for the addition of a contact less transmitter to give a 4-20mA analog signal corresponding to valve travel for remote indication for all modulating valves.

3. Local Position Indication

    a. A 32-character, Liquid Crystal Display (LCD) for ease of viewing shall be included to display valve position as a percent of open, 0 – 100%, and current actuator status. “STATUS OK” shall be displayed for an operable actuator. If the actuator is not operable, the appropriate alarm shall be displayed in easy to understand English text (symbols are not acceptable for local indication). the appropriate alarm shall be displayed. The alarm shall be continuously displayed until the actuator is operable. Red, green, and yellow LED’s shall be included for local open, close, stopped, and moving indication.

4. Integral Starter and Transformer

    a. The reversing contactor shall be mechanically interlocked to prevent simultaneous energizing of the open and close coils. The control module shall also include an auto reversal delay to inhibit high current surges caused by rapid motor reversals. The reversing contactor, as standard shall be rated for 150 motor starts per hour. Optional solid state reversing contactor shall be available for high rate modulating service up to 1200 motor starts per hour.

    b. The control transformer shall include vacuum-impregnated coils and dual primary fuses. A phase correction circuit shall be included to correct motor rotation faults caused by incorrect site wiring. The phase correction circuit

shall also detect the loss of a phase and disable operation to prevent motor damage.

5. Integral Local Control Switches

   a. A padlockable LOCAL-STOP-REMOTE switch and an OPEN-CLOSE switch shall be included for local valve actuator control. The control switches shall not penetrate the controls cover and shall be designed to electrically isolate the actuator's internal components from the external environment.

   b. It shall be possible to select maintained or non-maintained local control. The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.

6. Remote Control Facilities

   a. Actuator must have configurable remote control as 2, 3, or 4 wires for open-stop-close control. Terminals must also be provided for ESD (Emergency Shutdown) and inhibit Movement commands. The ESD signal shall override any existing signal (except LOCAL, STOP, and INHIBIT) and send the valve to it's configured emergency position. The actuator configuration shall be capable of overriding LOCAL, STOP, and/or INHIBIT.

   b. The actuator must be capable of receiving remote control commands powered by external power source of 24, to 125 volts ac, or dc. Automatic switching.

   c. The actuator must be capable of powering remote control function loops of 24Vdc, or 120 Vac.

7. Wiring and Terminals

   a. All field terminations shall be located in a termination chamber that is separately sealed from all other actuator components. Site wiring shall not expose actuator components to the environment. The internal sealing within the termination chamber is suitable for NEMA 4, 6, and IP68. The chamber shall include screw-type terminals, 3 - power and 50 - control, for site connections.

   b. Three conduit entries, available as: (2) – 1.25" NPT and (1) – 1.5" NPT shall be supplied.

8. Paint Coating

   a. The actuator shall be coated with a high-solids epoxy E-coat primer, and then finished-coated with a National Blue Color, polymer powder coat. The coating system shall be suitable for an ASTM B117 salt spray test of 1500 hours.

9. Startup Kit

   a. Each actuator shall be supplied with a startup kit comprising installation instruction, electrical wiring diagram, and sufficient spare cover screws and seals to make good any site losses during the commissioning period.

10. Performance Test Certificate

    a. A report confirming successful completion of testing shall be included with actuator.

b. The actuator designs shall have been tested to demonstrate electromagnetic compatibility with the following:

1) EFT Immunity; EN 50082-2

2) Conducted Immunity; EN 50082-2

3) Conducted Immunity; Mains (power) Harmonic Distortion per MIL-STD-461 Method conducted Emissions; EN 55011

4) Radiated Emissions; EN 55011

5) ESD Immunity; EN 50082-2

6) Radiated Immunity; EN 50082-2

7) Radiated Immunity; 1 – 2 Ghz Per IEC 801-3

8) CS01 & CS02

9) Surge Immunity; IEC 1000-4-5 & ANSI / IEEE C62.41 to 4 KV

10) Magnetic Field Immunity; IEC 1000-4-8

11) Vibration and seismic capability shall be in accordance with MIL-STD-167

12) IEEE-344-1975, and IEC68-2-6.

11. Warranty

a. Each actuator shall be warranted for a minimum of 24 months of operation up to a maximum of 36 months from shipment.

## PART 3: EXECUTION

### 3.01 FACTORY TESTS

A. All valves shall be tested at the point of manufacture for proper and unobstructed operation and for leakage and adequacy of design.

B. Iron body gate valves shall be tested in accordance with AWWA C500.

C. Butterfly and plug valves shall be tested in accordance with AWWA C504.

D. Iron body check valves shall be tested in accordance with AWWA C508.

E. Electric operators shall be tested in accordance with AWWA C540.

F. All other valves shall be given an operation test, a leakage test at rated pressure differential, and a hydrostatic test at 2 times rated pressure. During the hydrostatic test, there shall be no leakage through the metal, the end joints, or the shaft or stem seal, nor shall any part be permanently deformed. During the leakage test, leakage shall not exceed that permitted by ANSI B16.104, Class IV, for metal seated valves and Class VI for resiliently seated valves.

### 3.02 INSTALLATION

A. All valves shall be installed in strict conformance with the Drawings and approved ship drawings and manufacturer’s instructions.

B. Unless otherwise shown or specified, butterfly valves shall be installed with stems in the horizontal position.

C. Double plate, clapper type check valves in horizontal piping shall be installed with the stem in the vertical position.

D. Swing check valves shall be installed only in a horizontal position. Lever shall be free to operate without obstruction.

E. All underground valves shall be installed using a valve box as specified herein.

F. Four-way solenoid valves shall exhibit no leakage in either position.

G. Valves shall be installed in such a way that operators and packing are easily accessible. Valves with field replaceable seats shall be installed with sufficient clearance to permit removal of valve bonnet and stem without removing valve from the line.

3.03 FIRE HYDRANTS

A. Fire hydrants shall be placed at the points shown on the plans and as directed by the Engineers.

B. Care shall be exercised that set screws and retainer glands are tightened sufficiently to secure the hydrants before pressure is put on the main.

C. Not less than four cubic feet of coarse, broken stone shall be placed around the base of the hydrants.

D. Prior to testing, the stuffing boxes shall be tightened and the hydrant valve opened and closed to see that all parts are in working condition.

E. All hydrant openings shall be kept capped, except when hydrant is being worked on.

F. Hydrant Testing:

1. Each hydrant shall be tested to 150 psi. The test shall be made with the valve open but all nozzles closed. While this test is being carried on, the hydrant shall be subjected to a hammer test.

2. Any hydrant showing defects by leakage, sweating, or otherwise shall be rejected. The barrel and all parts shall withstand these tests. These tests shall be made in the field after the hydrants are installed.

3.04 FIELD TESTING

A. Following installation, all valves shall be tested by the Contractor under the anticipated operating conditions. The ability of the valves to operate properly without leakage, binding, sticking, fluttering, or excessive operating torque shall be demonstrated to the satisfaction of the Engineer. The Contractor shall at his own expense adjust and/or replace any valve as necessary to assure satisfactory operation.

B. Following installation and testing, all ferrous and non-machined surfaces of exposed valves, operators, floorstands, and stem guides shall be field primed and painted with a finish suitable for the intended service in accordance with requirements of the section entitled “Painting” of these Specifications.

C. Actuated valves shall be set up and field tested by the manufacturer's technical representative with the support of the Contractor. Manufacturer's Certificate of Proper Installation shall be provided by the manufacturer's technical representative.

3.05 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site for minimum person-days listed below, travel time excluded:

1. 6 person days over 3 site visits for installation assistance and inspection

2. 6 person days over 3 site visits for functional testing and completion of Manufacturer's Certificate of Proper Installation

END OF SECTION

Attachments

Manually Operated Valve Schedule

Power Operated Valve Schedule

## CANTON WPCP EXPANSION TO 6 MGD
## MANUALLY OPERATED VALVE SCHEDULE

| VALVE TYPE | VALVE SIZE RANGE (IN) | FITTINGS | RATING | MATERIAL | SERVICE (FLUID) | REMARKS |
|---|---|---|---|---|---|---|
| ANGLE-HOSE | 1 - 2 | THREADED | 175WOG | BRONZE | PW | |
| BALL | 1/4 - 2 | THREADED | 150SWP | 316 SST | CA | |
| BALL | 1/4 - 2 | SCREWED | 250WOG | BRONZE | CD, REC ,S | |
| BALL | 1/4 - 2 | THREADED | 150SWP | 316 SST | CA | |
| BALL | 1/4 - 3 | SOLVENT WELD | 150 PSI @ 105F | BRASS | PW | |
| BALL | 4 - 6 | FLANGED | 150 PSI @ 105F | CAST IRON | PW | |
| BUTTERFLY | >= 4 | MECH. JNT | 150W | CAST IRON | ALP, PW | |
| BUTTERFLY | >=4 | FLANGED | 50W | CAST IRON | ALP, PW | |
| GATE | 2.5 - 48 | FLANGED | 125SWP/200WOG | IRON BODY/BRONZE MOUNTED | PW, PER, EFF, REW, TOS, TOR | |
| GATE | 2.5 - 48 | MECH. JOINT | 150-WOG | IRON BODY/BRONZE MOUNTED | PW, PER, EFF, REW, TOS, TOR | |
| KNIFE GATE | 4 - 12 | FLANGED | 150-WOG | 304 SST | DSL | |
| PLUG | 4 - 24 | FLANGED | 150WOG | CAST IRON | BNR-E, BNR-I, FM, IR, RAS, RS, SS, SCUM, TWAS, WAS | |
| PLUG | 4 - 24 | MECH. JNT | 150WOG | CAST IRON | BNR-E, BNR-I, FM, IR, RAS, RS, SS, SCUM, TWAS, WAS | |
| PLUG, 3-WAY | 3 - 6 | FLANGED | 125CWP | CAST IRON | DSL | AT BELT FILTER PRESSES |
| VALVES FOR CHEMICAL SERVICE | 1/2 - 3 | THREADED | 150SWP | BRONZE | ALUM, ACID, MgOH, PO, NaOCL | |
| CHECK | < 2 | THREADED | 200WOG | BRONZE | DR, PW | |
| CHECK | 2 .5 - 12 | FLANGED | 125 SWP/200WOG | CAST IRON | TWAS, WAS, REC,SCUM, PW | LEVER & SPRING |
| CHECK | 4 | SOCKET/FLANGED | 150W | CPVC | REC, PW | |
| REDUCED PRESSURE BACKFLOW | 3/4 - 10 | FLANGED | 175W | CAST IRON | PW | BACKFLOW PREVENTER |
| FIRE HYDRANT | 4 - 6 | FLANGED | 150W | CAST IRON | PW | FIRE HYDRANTS. |
| SOLENOID | < 2.5 | THREADED | 125W | BRASS/316 SST | PW | |

# CANTON WPCP EXPANSION TO 6 MGD
# POWER OPERATED VALVE SCHEDULE

**FAILURE MODE LEGEND:**
**FLP = FAIL LAST POSTION**
**FC = FAIL CLOSED**
**FO = FAIL OPEN**

**SERVICE LEGEND:**
**O/C = OPEN OR CLOSED**
**M = MODULATING**

| VALVE TYPE | VALVE TAG No. | VALVE SIZE (IN) | LOCATION | FLOW STREAM | FAILURE MODE | SERVICE | P&ID SHEET | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| Butterfly | 5-AT1-V-1 | 6 | BNR Basin 1 | Air Low Pressure | FLP | M | 5-I-1 | DO Control |
| Butterfly | 5-AT1-V-2 | 6 | BNR Basin 1 | Air Low Pressure | FLP | M | 5-I-1 | DO Control |
| Butterfly | 5-AT1-V-3 | 6 | BNR Basin 1 | Air Low Pressure | FLP | M | 5-I-1 | DO Control |
| Butterfly | 5-AT1-V-4 | 6 | BNR Basin 1 | Air Low Pressure | FLP | M | 5-I-1 | DO Control |
| Butterfly | 5-AT2-V-1 | 6 | BNR Basin 2 | Air Low Pressure | FLP | M | 5-I-1 | DO Control |
| Butterfly | 5-AT2-V-2 | 6 | BNR Basin 2 | Air Low Pressure | FLP | M | 5-I-1 | DO Control |
| Butterfly | 5-AT2-V-3 | 6 | BNR Basin 2 | Air Low Pressure | FLP | M | 5-I-1 | DO Control |
| Butterfly | 5-AT2-V-4 | 6 | BNR Basin 2 | Air Low Pressure | FLP | M | 5-I-1 | DO Control |
| Butterfly | 5-AT3-V-1 | 6 | BNR Basin 3 | Air Low Pressure | FLP | M | 5-I-1 | DO Control |
| Butterfly | 5-AT3-V-2 | 6 | BNR Basin 3 | Air Low Pressure | FLP | M | 5-I-1 | DO Control |
| Butterfly | 5-AT3-V-3 | 6 | BNR Basin 3 | Air Low Pressure | FLP | M | 5-I-1 | DO Control |
| Butterfly | 5-AT3-V-4 | 6 | BNR Basin 3 | Air Low Pressure | FLP | M | 5-I-1 | DO Control |
| Ball Valve | 5-SCUM-V-1 | 4 | Scum Collection | Potable Water | FLP | O/C | 5-I-4 | Spray Header Valve |
| Butterfly | 6-AT4-V-1 | 6 | BNR Basin 4 | Air Low Pressure | FLP | M | 6-I-1 | DO Control |
| Butterfly | 6-AT4-V-2 | 6 | BNR Basin 4 | Air Low Pressure | FLP | M | 6-I-1 | DO Control |
| Butterfly | 6-AT4-V-3 | 6 | BNR Basin 4 | Air Low Pressure | FLP | M | 6-I-1 | DO Control |
| Butterfly | 6-AT4-V-4 | 6 | BNR Basin 4 | Air Low Pressure | FLP | M | 6-I-1 | DO Control |
| Butterfly | 10-A-V-5 | 6 | UVPA Facility | Air Low Pressure | FLP | M | 10-I-2 | DO Control |
| Butterfly | 10-A-V-6 | 6 | UVPA Facility | Air Low Pressure | FLP | M | 10-I-3 | DO Control |
| Butterfly | 12-AD-FV-1 | 6 | Aerobic Digester 1 | Air Low Pressure | FLP | M | 12-I-1 | DO Control |
| Butterfly | 12-AD-FV-2 | 6 | Aerobic Digester 1 | Air Low Pressure | FLP | M | 12-I-1 | DO Control |
| Butterfly | 12-AD-FV-3 | 6 | Aerobic Digester 2 | Air Low Pressure | FLP | M | 12-I-1 | DO Control |
| Butterfly | 12-AD-FV-4 | 6 | Aerobic Digester 2 | Air Low Pressure | FLP | M | 12-I-1 | DO Control |
| 3-Way Plug | 15-BFP-V-1 | 4 | Belt Filter Press | Thickened WAS | FLP | O/C | 15-I-4 | At Belt Filter Press 1 |
| 3-Way Plug | 15-BFP-V-2 | 4 | Belt Filter Press | Thickened WAS | FLP | O/C | 15-I-4 | At Belt Filter Press 2 |
| Ball Valve | 15-BFP-V-3 | 2 | Belt Filter Press | Potable Water | FLP | O/C | 15-I-4 | Controlled by BFP 1 |
| Ball Valve | 15-BFP-V-4 | 2 | Belt Filter Press | Potable Water | FLP | O/C | 15-I-4 | Controlled by BFP 2 |
| Ball Valve | 15-DS-V-1 | 2 | Dewatered Sludge Pump 1 | Compressed Air | FC | O/C | 15-I-9 | Solenoid |
| Ball Valve | 15-DS-V-2 | 2 | Dewatered Sludge Pump 2 | Compressed Air | FC | O/C | 15-I-9 | Solenoid |
| Ball Valve | 15-DS-V-3 | 2 | Sludge Hopper | Potable Water | FLP | O/C | 15-I-9 | Spray Header Valve |

SECTION 15120

PIPE SPECIALTIES

PART 1: GENERAL

1.01 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's data on materials, construction, end connections, dimensions, ratings, coatings, overall lengths, and live lengths (as applicable).

2. Manufacturer's data on chemical resistance and chemical compatibility for all products intended for use in chemical processes or in chemical areas.

B. Action Submittals:

1. Drawings to scale of each thermal expansion systems for low pressure air piping systems and for thermal oil systems, locating each expansion, brace, and/or pipe anchor. Identify type of expansion joint or bellow by catalog/model number and Shop Drawing detail number.

2. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

3. Product Data: For the following:

a. Expansion joints

b. Connectors

c. Braided flexible expansion loops

C. Informational Submittals

1. Coupling Harness:

a. Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.

b. Weld procedure requirements and qualifications.

c. Load proof-testing report of prototype restrain for any size coupling.

2. Basket Strainers:

a. Manufacturer's written/printed installation instructions.

b. Manufacturer's Certificate of Proper Installation

3. Operations and Maintenance Manuals.

PART 2: PRODUCTS

2.01 GENERAL

A. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded pipe joints are not.

2.02 CONNECTORS

A. Teflon Bellows Connector:

1. Type: Two convolutions unless otherwise shown, with metal reinforcing bands.

2. Flanges: Ductile iron, drilled 150 psi ANSI B16.5 standard.

3. Working Pressure Rating: 140 psi, minimum, at 120 degrees F.

4. Thrust Restraint: Limit bolts to restrain the force developed by the specified test pressure.

5. Manufacturers:

a. Garlock; Style 214.

b. Resistoflex; No. R6904.

B. Elastomer Bellows Connector:

1. Type: Fabricated spool, with single filled arch.

2. Materials: Nitrile tube and wrap-applied neoprene cover.

3. End Connections: Flanged, drilled 125-pound ANSI B16.1 standard, with full elastomer face and steel retaining rings.

4. Working Pressure Rating: 140 psig, minimum, at 180 degrees F for sizes 12 inches and smaller.

5. Thrust Restraint: Control rods to limit travel of elongation and compression.

6. Manufacturers and Products:

a. Goodall Rubber Co.; Specification E-1462.

b. Garlock; Style 204.

C. Metal Bellows Connector:

1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.

2. Material: Type 316 stainless steel.

3. End Connections: ANSI 150-pound carbon steel flanges.

4. Minimum Design Working Pressure: 150 psig at 750 degrees F.

5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.

6. Manufacturers:

a. Hyspan Precision Products, Inc.; Series 1500

b. Pathway Bellows, Inc.; Style CT.

D. Flexible Metal Hose Connector:

1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Bronze
3. End Connections: Female copper solder joint.
4. Minimum Burst Pressure: 500 psig at 70 degree F.
5. Length: Minimum manufacturer recommendation for vibration isolation.
6. Manufacturers:
    a. Senior Flexonics.
    b. Anamet Industrial, Inc.
    c. Unisource Manufacturing, Inc.
    d. Proco Products, Inc.

2.03 EXPANSION JOINTS FOR DUCTILE IRON

A. Expansion joints shall be installed in the locations indicated on the drawings and shall be manufactured of ductile iron conforming to the material properties of ANSI/AWWA C153/A21.53.

B. All expansion joints shall be capable of expanding or contracting to no less than 4-inches total axial movement. Separation beyond the maximum extension of the expansion joint shall be prevented without the use of external tie rods.

C. Each expansion joint shall be pressure tested against its own restraint to a minimum of 350 psi (250 psi 24 inch and greater).

D. All expansion joints shall be EX-TEND 200, as manufactured by EBAA Iron, Inc., or approved equal.

2.04 BRAIDED FLEXIBLE EXPANSION LOOPS

A. Braided flexible expansion loops for the thermal oil system shall consist of two parallel sections of braided metal hose, a 180 degree return bend, with inlet and outlet 90 degree elbow connections. The loops shall be engineered to move in all three planes and shall impart no thrust loads to system anchors.

B. Materials of construction of the braided metal hoses are to be a type 321 stainless steel with a type 304 stainless steel braid. End fittings shall be consistent with pipe material and connection fittings.

C. Loops shall be designed to meet the following criteria:

1. Locations: Two thermal oil supply lines and two thermal oil return lines between the Thermal Oil Room and the Sludge Dryer in the Solids Handling Facility.
2. Piping: 6-inch carbon steel
3. Fittings: Welded
4. Fluid: Thermal Oil

5. Temperature range: 70 – 750°F

6. Design Pressure: 65 psi

7. Movement Required: 4 inches

D. Loops shall be capable of accommodating piping system and equipment movements and vibration as needed.

E. Loops shall be furnished with factory supplied hanger / support lug located at the bottom of the 180 degree return. Also provided at the bottom return will be a plugged FPT to be used for a drain or air release vent.

F. Loops shall be furnished with a 0.5” plugged FTP at the top of the loops for high point air release.

G. Braided flexible expansion loops shall be Flexicraft Industries, ML Loop or equal.

2.05 QUICK CONNECT COUPLINGS FOR CHEMICAL SERVICES:

A. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.

B. Materials: Glass-filled polypropylene or PVDF with EPDM, Viton-A or Teflon gaskets as recommended for the service by the manufacturer.

C. End Connections: NPT threaded or flanged to match piping connections. Hose shank for chemical installations.

D. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.

E. Pressure Rating: 125 psi minimum at 70 degrees F.

F. Manufacturers:

1. OPW Kamlock.

2. Ryan Herco, 1300 Series.

2.06 COUPLINGS

A. Flexible Couplings: Manufacturers and Products:

1. Steel Pipe:

a. Dresser; Style 38.

b. Smith-Blair; Style 411.

2. Ductile Iron Pipe:

a. Dresser; Style 153.

b. Smith-Blair; Style 411.

B. Transition Couplings:

1. Manufacturers:

a. Dresser; Style 162.

b. Smith Blair; Style 413.

C. Flanged Coupling Adapters: Manufacturers and Products:

1. Steel Pipe:
   a. Smith-Blair; Series 913.
   b. Dresser Industries, Inc.; Style 128.
2. Ductile Iron Pipe:
   a. Smith-Blair; Series 912.
   b. Dresser Industries, Inc.; Style 127.
3. Stainless Steel:
   a. Depend-O-Lok with O-ring material to match pipe flange gaskets

2.07 EXPANSION JOINTS

A. Elastomer Bellows:

1. Type: Reinforced, molded wide-arch.
2. End Connections: Flanged, drilled 125-pound ANSI B16.1 standard with split galvanized steel retaining rings.
3. Washers: Over the retaining rings to help provide a leakproof joint under test pressure.
4. Thrust Protection: Control rods to protect the bellows from overextension.
5. Bellows Arch Lining: Buna-N, nitrile, or butyl.
6. Rated Temperature: 250 degrees F.
7. Rated Deflection and Pressure:
   a. Lateral Deflection: ¾ inch minimum.
   b. Burst Pressure: Four times the working pressure.
   c. Compression deflection and minimum working pressure follows:

| Size (inch) | Deflection (inch) | Pressure (psig) |
|---|---|---|
| 2-1/2 to 12 | 1.06 | 150 |
| 14 | 1.65 | 130 |
| 16 to 20 | 1.65 | 110 |

8. Manufacturers:
   a. General Rubber Corp.; Style 1015 Maxijoint.
   b. Mercer; Flexmore Style 450.
   c. Goodall Rubber Co.; Specification E-711.

d. Unisource Manufacturing, Inc.; Series 1500.

e. Proco Products, Inc.; Series 251.

B. Teflon Bellows:

1. Type: Three convolutions, with metal reinforcing bands.

2. Flanges: Ductile iron, drilled 150 psi ANSI B16.5 standard.

3. Working Pressure Rating: 100 psig, minimum, at 120 degrees F.

4. Thrust Restraint: Limit bolts to restrain the force developed by the specified test pressure.

5. Manufacturers:

a. Garlock; Style 215.

b. Resistoflex; No. R6905

c. Unisource Manufacturing, Inc.; Style 113.

d. Proco Products, Inc.; Series 443.

C. Metal Bellows:

1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.

2. Material: Type 316 stainless steel.

3. End Connections: ANSI 150-pound carbon steel flanges.

4. Minimum Design Working Pressure: 150 psig at 750 degrees F.

5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.

6. Manufacturers:

a. Hyspan Precision Products, Inc.; Series 1500.

b. Pathway Bellows, Inc.; Style CT.

D. Expansion Joint for Air Lines:

1. Material: Type 316 stainless steel.

2. Exposed, bolted, split-sleeve, single-point closure couplings.

3. Buried teflon shouldered coupling with two end rings.

4. End Connections: Fixed by expansion.

5. Minimum Design Working Pressure: 25 psi at 280 degrees F.

6. Manufacturer: Depend-O-Lok.

E. Flexible Metal Hose:

1. Type: Close pitch, annular corrugated with single braided jacket.

2. Material: Stainless steel, ASTM A276, Type 321.
3. End Connections:
    a. 3 Inches and Larger: Shop fabricated flanged ends to match mating flanges.
    b. 2-1/2 Inches and Smaller: Screwed ends with one union end.
4. Minimum Burst Pressure: 600 psig at 70 degrees F for 12-inch and smaller.
5. Length: Provide hose live-length equal to the lengths shown on the Drawings.
6. Manufacturer:
    a. Senior Flexonics; Series 401M.
    b. Anamet Industrial, Inc.; BWC21-1.

2.08 SERVICE SADDLES

A. Double-Strap Iron:
    1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
    2. Run Diameter: Compatible with the outside diameter of the pipe on which the saddle is installed.
B. Taps: Iron pipe threads.
C. Materials:
    1. Body: Malleable or ductile iron.
    2. Straps: Galvanized steel.
D. Hex Nuts and Washers: Steel.
E. Seal: Rubber.
F. Manufacturers:
    1. Smith-Blair; Series 313 or 366.
    2. Dresser; Style 91.

2.09 PIPE SLEEVES

A. Steel Pipe Sleeve:
    1. Minimum thickness: 3/16 inch.
    2. Seep Ring: 3/16-inch minimum thickness center steel flange for water stoppage on sleeves in exterior or water-bearing walls.
    3. Outside Diameter: 3 inches greater than pipe sleeve outside diameter.
    4. Continuously fillet weld on each side all around.
B. Insulated and Encased Pipe Sleeve:

1. Manufacture: Pipe Shields, Inc or equal

C. Modular Mechanical Seal

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.

2. Fabrication: Assemble interconnected rubber links with ASTM A276.

3. Type 316 stainless steel bolts, nuts, and pressure plates.

4. Size: According to manufacturer's instructions for the size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.

5. Manufacturer: Thunderline Link-Seal.

## 2.10 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Ductile Iron Wall Pipe:

1. Diameter and Ends: Same as connecting ductile iron pipe.

2. Thickness: Equal to or greater than remainder of pipe in line.

3. Fittings: In accordance with the applicable Pipe Data Sheet.

B. Thrust Collars:

1. Rated for thrust load developed at 250 psi.

2. Safety Factor: Minimum of 2.

3. Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible.

4. Manufacturers:

a. American Cast Iron Pipe Co.

b. U.S. Pipe and Foundry Co.

C. Stainless Steel Wall Pipe:

1. Same material and thickness as connecting pipe; except 1/4-inch minimum thickness.

2. Lining: Same as connecting pipe.

3. Thrust Collar:

4. Outside diameter 3 inches greater than outside diameter of wall pipe.

5. Continuously fillet welded on each side all around

## 2.11 STRAINERS

A. Strainers, Water Service, 2 Inches and Smaller:

1. Type: Bronze body, Y-pattem, 200 psi nonshock rated, with screwed gasketed bronze cap.
2. Screen: Heavy-gauge Type 304 stainless steel or monel, 20-mesh.
3. Manufacturers:
    a. Armstrong International, Inc.; Model F.
    b. Mueller Steam Specialty; Model 351M.

B. Strainers, Water Service, 2-1/2 Inches and Larger:

1. Type: Cast iron or ductile iron body, Y-pattem, 175 psi nonshock rated, with flanged gasketed iron cap.
2. Screen: Heavy-gauge Type 316 stainless steel, 0.045-inch perforated.
3. Manufacturers:
    a. Armstrong International, Inc.; Model A7FL 125.
    b. Mueller Steam Specialty; Model 751.

C. Strainers, Plastic Piping Systems, 4 Inches and Smaller:

1. Type: Y-pattem PVC body, 150 psi nonshock rated, with screwed PVC cap and Viton seals.
2. End Connections: Screwed or solvent weld, 2 inches and smaller. Class 150 ANSI flanged, 2-1/2 inches and larger.
3. Screen: Heavy-gauge PVC, 1/32-inch mesh; minimum 2 to 1 screen area to pipe size ratio.
4. Manufacturer: Hayward

D. Chemical Basket Strainers:

1. Configuration: Simplex strainers shall have flanged or threaded ends and be rated at 150 psi.
2. Materials of Construction shall be compatible with aluminum sulfate (alum) and suitable for outdoor installation.
3. Manufacturers: Hayward or equal.

## 2.12 MISCELLANEOUS SPECIALTIES

A. Water Hose:

1. Furnish four 50-foot lengths of ¾ inch and four 50-foot lengths of 1-½-inch rubber hose. EPDM black cover and EPDM tube, reinforced with two textile braids. Provide each length with brass male and female NST hose thread couplings to fit hose nozzle and hose valve.
2. Rated minimum working pressure of 200 psi.
3. Manufacturers:

a. Goodyear.

b. Boston.

B. Hose Nozzles:

1. Furnish four ¾ inch and four 1-½-inch cast brass, stain finish, nozzles with adjustable fog, straight stream, and shut-off feature and rubber bumper. Provide nozzles with female NST hose thread.

2. Manufacturers:

a. Croker

b. Elkhart

C. Nonslip FRP Grating

1. Provide molded rubber grating suitable for use on concrete floors. Mats shall be interlocking tiles constructed of natural rubber or nitrile rubber. Grating shall be a minimum of ½" thick.

2. Grating shall provide drainage and be suitable for wet areas. Mats shall include grit or other surface abrasive components to create a non-slip service.

3. Grating shall be suitable for use in polymer solution containment areas.

4. Manufacturers:

a. IDS

b. McNichols

## PART 3: EXECUTION

### 3.01 PIPING FLEXIBILITY PROVISIONS

A. Flexible Joints at Concrete Backfill or Encasement: Install with 18 inches or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

B. Flexible Joints at Concrete Structures:

1. Install 18 inches or less from the face of structures; joint may be flush with face.

2. Install a second flexible joint, whether or not shown.

a. Pipe Diameter 18 Inches and Smaller: Within 18 inches of the first joint.

b. Pipe Diameter Larger than 18 Inches: Within one pipe diameter of the first joint.

### 3.02 PIPING TRANSITION

A. Applications:

1. Provide complete closure assembly where pipes meet other pipes or structures.

2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.

3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown.

4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.

5. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.

6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:

1. Flexible Transition Couplings: Install in accordance with coupling manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.

2. Concrete Closures:

a. Locate away from structures so that there are at least two joints between the closure and pipe entering the structure.

b. Clean pipe surface before placing closure collars.

c. Wet nonmetallic pipe thoroughly prior to pouring collars.

d. Prevent concrete from entering pipe.

e. Extend collar a minimum of 12 inches on each side of joint with minimum thickness of 6 inches around outside diameter of pipe.

f. Make entire collar in one placement.

g. After concrete has reached initial set, cure by covering with well-moistened earth.

## 3.03 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:

1. Flanged Piping Systems: Elastomer bellows expansion joint.

2. Nonmetallic Pipe: Teflon Bellows Expansion joint.

3. Water Service Above 120 Degrees F: Metal bellows expansion joint.

4. Air Service Above 200 Degrees F: Expansion joint for air lines.

5. Pipe Run Offset: Flexible metal hose.

6. Thermal Oil System: Braided Flexible Expansion Loops

3.04 SERVICE SADDLES

A. Service Saddles:

1. Ferrous Metal Piping (Except Stainless Steel): Double-strap iron.

2. Plastic Piping: Nylon-coated iron

3.05 COUPLINGS

A. General:

1. Install in accordance with manufacturer's written instructions.

2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.

3. Do not remove pipe coating. If damaged, repair before joint is made.

4. Application:

a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.

b. Concrete Encased Couplings: Flexible coupling.

3.06 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

A. Install to prevent piping from being supported by equipment, for vibration isolation and where shown.

B. Product Applications Unless Shown Otherwise:

1. Nonmetallic Piping: Teflon Bellows Connector.

2. Compressor and Blower Discharge: Metal Bellows Connector.

3. All Other Piping: Elastomer Bellows connector.

C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.07 PIPE SLEEVES

A. Application:

1. As specified in Section 15200, Piping General.

2. Above Grade in Non-submerged Areas: Hot-dip galvanized after fabrication.

3. Below-Grade or in Submerged or Damp Environments: Shop-lined and coated.

B. Installation:

1. Support non-insulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.

2. Caulk joint with rubber sealant or seal with wall penetration seal.

3.08 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Applications:

1. Watertight and Below Ground Penetrations:

a. Wall pipes with thrust collars.

b. Provide taps for stud bolts in flanges to be set flush with wall face.

2. Nonwatertight Penetrations: Pipe sleeves with seep ring.

3. Existing Walls: Rotary drilled holes.

4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.

B. Wall Pipe Installation:

1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations as specified in Section 09900 Painting.

2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

3.09 STRAINERS

A. Install in accordance with manufacturer's instructions.

3.10 MANUFACTURER'S SERVICES

A. Manufacturer's Representative for Expansion Bellows: Present at Site for minimum person-days listed below, travel time excluded:

1. 2 person days over 2 site visits for installation assistance and inspection

2. 2 person days over 2 site visits for functional testing and completion of Manufacturer's Certificate of Proper Installation

B. Manufacturer's Representative for Braided Flexible Expansion Loops: Present at Site for minimum person-days listed below, travel time excluded:

1. 1 person day for installation assistance and inspection

2. 2 person days over 2 site visits for functional testing and completion of Manufacturer's Certificate of Proper Installation.

END OF SECTION

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# SECTION 15200

# PROCESS PIPING - GENERAL

## PART 1: GENERAL

### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. American Society of Mechanical Engineers (ASME)
2. American Water Works Association (AWWA)

B. For Fiberglass Reinforced Piping (FRP) ductwork, see Specification Section 15201.

### 1.02 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
2. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
3. Thrust Restraints:
   a. Design for test pressure shown in Piping Schedule.
   b. Allowable Soil Pressure: 1,000 pounds per square foot.

### 1.03 SUBMITTALS

A. Action Submittals:

1. Shop Fabricated Piping:
   a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, pipe supports, and other pertinent information.
   b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
   c. Manufacturer’s literature showing letter sizes and styles for pipe labeling.
2. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
3. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
4. Pipe Corrosion Protection: See Section 09900, Painting.

5. Product Data: For pipe, tube, fittings, and couplings.

B. Informational Submittals:

1. Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.

2. Certified welding inspection and test results.

1.04 QUALIFICATIONS

A. Welder and Welding Operation Qualifications:

1. Qualified by accepted inspection and testing agency before starting work in accordance with Section IX, Article III of the ASME Boiler and Pressure Vessel Code.

2. Qualified to perform groove welds in Positions 2G and 5G for each welding process and pipe material specified.

3. Qualifications tests may be waived by Contractor based on evidence of prior qualifications.

B. Solvent Welder for Double Wall Containment Piping: Qualified in accordance with Chapter VII of the ASME B31.3 Code, Part 9, Paragraph A328.

1.05 QUALITY CONTROL

A. Provide services of an independent inspection and testing agency for welding operations.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

1.06 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01600, Delivery, Storage and Handling, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.

2. Linings and Coatings: Prevent excessive drying.

3. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2: PRODUCTS

2.01 PIPING

A. All piping shall be restrained joint unless otherwise called out on the Construction Drawings,

B. Piping shall be as specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement.

C. Diameters Shown: Standardized Products: Nominal size.

2.02 JOINTS

A. Flanged Joints:

1. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.

2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of a higher pressure rating than required for piping.

3. Flanged pipe shall be fabricated in the shop, not in the field and delivered to the site with flanges in place and properly faced.

B. Threaded Joints: NPT taper pipe thread in accordance with ANSI B1.20.1.

C. Thrust Tie-Rod Assemblies: NFPA 24; tie-rod attachments relying on clap friction with pipe barrel to restrain thrust are unacceptable.

D. Mechanical Joint Anchor Gland Follower:

1. Ductile iron anchor type, wedge action, with breakoff tightening bolts.

2. Thrust rated to 250 psi minimum.

3. Rated operating deflection not less than 2-1/2 degrees.

4. UL and FMG approved.

E. Flexible Mechanical Compression Joint Coupling:

1. Stainless Steel, ASTM A276, Type 305 bands.

2. Manufacturers:

a. Pipeline Products Corp.

b. Fernco Joint Sealer Co.

2.03 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or “or-equal” will be allowed.

2.04 PIPE CORROSION PROTECTION

A. Coatings: See Section 009900, Painting, for details of coating requirements.

2.05 THRUST TIES

A. Buried Ductile Iron Pipe and Fittings: Unless restraint is otherwise specified or shown, conform to NFPA 24. Tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

2.06 FABRICATION

A. Mark each pipe length on outside with the following:

1. Size or diameter and class.

2. Manufacturer's identification and pipe serial number.

3. Location number on laying drawing.

4. Date of manufacture.

B. Code markings according to approved Shop Drawings.

C. Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the manufacturer.

2.07 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Section 09900, Painting.

2.08 JOINTS FOR PIPING

A. Restrain all piping except as shown on the Drawings. New piping shall be restrained through welding or through the use of the manufacturer's proprietary restrained joint pipe and fittings.

B. Connections to existing piping systems

1. Contractor shall verify that existing piping system is restrained joint piping. In cases where the existing piping system is not restrained, Contractor shall coordinate with the Engineer to determine required length of existing piping to be restrained through the use of mechanical joint anchor glands.

2. Mechanical joint anchor glands shall be wedge-action type with torque limiting (break off bolts). Anchor glands shall be of the same material as the pipe to be restrained.

3. Manufacturer:

a. EBAA Iron, Inc

b. JCM Series

2.09 DETECTABLE PIPE LOCATING TAPE FOR NONMETALLIC BURIED PIPE

A. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.

B. Foil Thickness: Minimum 0.35 mil.

C. Width: Minimum 3 inches

D. Identifying Lettering: Minimum

E. Connections to existing piping systems

2.10 PIPE LABELS

A. Snap-On Labels:

1. Snap-on, reversible type with lettering and directional arrows, sized for outside diameter of pipe and insulation.
2. Provided with ties or straps for pipes of 6 inches and over diameter.
3. Designed to firmly grip pipe so labels remain fixed in vertical pipe funs.
4. Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistant to moisture, grease, and oils.
5. Letters and Arrows: Black on OSHA safety yellow background.
6. Color Field and Letter Height: Meet ASME A 13.1.
7. Message: Piping service name as indicated on Piping Schedule.
8. Manufacturers and Products:
    a. Brady Signmark: B-915 Brady Snap-On and Strap-On Pipe Markers.
    b. Seton Identification Products: Ultra-mark Pipe Markers.

B. Adhesive Labels:

1. Self-adhesive tape with separate directional arrows
2. Material: Pressure sensitive vinyl, suitable for exterior use, long lasting, and resistant to moisture, grease, and oils.
3. Letters and Arrows: Black on OSHA safety yellow background.
4. Color Field and Letter Height: Meet ASME A 13.1.
5. Message: Piping service name as indicated on Piping Schedule.
6. Manufacturers and Products:
    a. Brady Signmark: B-946 Self-Sticking Vinyl Pipe Markers and Arrows.
    b. Seton Identification Products: Opti-Code Pipe Markers.

## PART 3: EXECUTION

### 3.01 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

### 3.02 PREPARATION

A. See Piping Schedule and Section 09900, Painting, for additional requirements.

B. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

C. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

D. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturers instructions.

3.03 INSTALLATION—GENERAL

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.

2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.

3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.

4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.

5. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.

6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.

7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.

8. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.

9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.

10. Manufacturer: Same as pipe manufacturer.

D. Pipe Connections at Concrete Structures: As specified Section 15120, Pipe Specialties.

E. Pipeline fittings, plugs, and caps shall be furnished and installed of the type indicated and at the location shown on the Drawings or as directed by the Engineer. It shall be the responsibility of the Contractor to furnish and install all proper size pipe bends for both horizontal and vertical deflections that are required to construct the pipeline to the line and grade as shown on the construction drawings or as set by the Engineer.

F. Ductile Iron Piping:

1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.

2. Dressing Cut Ends:

a. General: As required for the type of joint to be made.

b. Rubber Gasketed Joints: Remove sharp edges or projections.

c. Push-On Joints: Bevel, as recommended by pipe manufacturer.

d. Flexible Couplings, and Flanged Coupling Adapters: As recommended by the coupling or adapter manufacturer.

3.04 INSTALLATION – SANITARY WASTE AND VENT PIPING

A. Install cleanouts cover flush with the finished floor. Install floor drains with the grate flush with the finished floor.

B. Install piping rigid and secure to the building structure to prevent movement.

C. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

D. Mechanical joint fittings on gravity flow piping shall be furnished with gland packs and sufficient quantities of accessories as required for each joint.

E. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

F. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Waste Piping: 2 percent downward in direction of flow for piping smaller than NPS 3; 1 percent downward in direction of flow for piping NPS 3 and larger.

2. Vent Piping: 0.5 percent down toward vertical fixture vent or toward vent stack.

G. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

H. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

I. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

J. Join no-hub cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

K. PVC Nonpressure 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. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

L. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.

1. Cut threads full and clean using sharp dies.

2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

c. Do not use pipe sections that have cracked or open welds.

3.05 INSTALLATION – DOMESTIC WATER PIPING

A. Pipe and Fitting Application

1. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

2. Flanges may be used on aboveground piping, unless otherwise indicated.

3. Under-Building-Slab, Domestic Water Piping on House Side of Water Meter, NPS ½" and Smaller: Soft copper tube, Type L; copper pressure fittings; and soldered joints.

4. Aboveground Domestic Water Piping: Use the following piping materials: Hard copper tube, Type L; copper press fittings; and soldered joints.

B. Valve Application

1. Install shutoff valve close to water main on each branch where indicated on the drawings. Use ball or gate valves for piping NPS 4 and smaller. Use gate valves for piping NPS 3 and larger.

2. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

C. Piping Installation

1. Install under-building-slab copper tubing according to CDA's "Copper Tube Handbook."

2. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.

3. Install domestic water piping level without pitch and plumb.

4. Install piping rigid and secure to the building structure to prevent movement.

D. Joint construction

1. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

2. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.

3.06 INSTALLATION – DOUBLE WALL CONTAINMENT PIPING SYSTEM

A. Install according to manufacturer's instructions.

B. All valves and equipment shall be supported independently from pipe. Anchor valves such that turning moment resulting from their operation will not be transmitted to the pipe.

C. Centering Devices for Double Wall Containment Piping:

1. Center 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.

D. Following Installation and Testing:

1. Flush clean carrier and containment piping system.

2. Purge annular space of moisture with clean, dry air.

3.07 INSTALLATION—EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.

2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 15094, Pipe Supports and Hangers.

C. Gaskets for pipe spanning over 15 feet in length shall be Toruseal gaskets as manufactured by American.

D. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

E. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

F. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install

to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

G. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of J feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation or hanger/support systems.

2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

3. Provide upstream and downstream lengths as required by equipment and instrumentation installed within the pipe run.

4. From Adjacent Work: Minimum 1 inch from nearest extremity of mechanisms, insulation, or hanger/support systems.

5. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.

6. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.

7. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.

8. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.08 INSTALLATION—BURIED PIPE

A. Joints:

1. Dissimilar Buried Pipes:

a. Provide flexible mechanical compression joints for pressure pipe.

2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown.

B. Placement:

1. Keep trench dry until pipe laying and joining are completed.

2. Pipe Base and Pipe Zone: As specified in Section 02320, Trench Backfill.

3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.

4. Measure for grade at pipe invert, not at top of pipe.

5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
    a. Shorter pipe lengths.
    b. Standard or special fabricated bends.
10. After joint has been made, check pipe alignment and grade.
11. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
12. Prevent uplift and floating of pipe prior to backfilling.

C. Tolerances:

1. Deflection from Horizontal Line, Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/4 inch.
3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.09 INSTALLATION—CONCRETE ENCASED

A. Provide reinforced concrete pipe encasement where shown on Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs and other structures shall be concrete encased. See details on Drawings for encasement requirements.

B. Where concrete encased piping crosses structure construction and expansion joints, provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.10 PIPE CORROSION PROTECTION

A. Ductile Iron Pipe:

1. Exposed: As specified in Section 09900, PAINTING, and as shown in Piping Schedule.

2. Buried: Factory coat with bituminous paint.

B. Piping Accessories:

1. Exposed:

a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09900, Painting, as applicable to base metal material.

b. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.

2. Buried:

a. Bolts, Nuts, and Similar Items: Coat with bituminous paint.

## 3.11 THRUST RESTRAINT

A. Location:

1. Buried Piping: At all joints in piping.

2. Exposed Piping: At all joints in piping.

B. Thrust Ties:

1. Ductile Iron Pipe: Attach with socket clamps anchored against a flange.

2. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through the coupling sleeve or use dismantling joints.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint manufacturer's adapter gland follower and pipe end retainer, or mechanical joint anchor gland follower.

## 3.12 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As specified in Section 15120, Pipe Specialties.

## 3.13 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:

1. Ductile Iron Piping: Connect only with service saddle or at a tapping boss of a fitting, valve body, or equipment casting.

3.14 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines as shown.

3.15 DISINFECTION

A. See Section 15041, Disinfecting of Potable Water Lines.

3.16 FIELD FINISHING

A. Notify Engineer at least 3 days prior to start of any surface preparation or coating application work.

B. As specified in Section 09900, Painting.

3.17 PIPE IDENTIFICATION

A. Locate at connections to equipment, valves or branching fittings at wall boundaries.

B. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.

C. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.

D. Supplementary Labels: Provide to Owner those listed on Piping Schedule that do not receive arrows.

E. Application: To pipe only after painting in vicinity is complete or as approved by Engineer.

F. Installed: In accordance with manufacturer’s instructions.

3.18 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified in Section 15955, Pipe Leakage Testing.

3.19 CLEANING

A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

C. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

D. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.20 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Canton WPCP Piping Schedule.

2. Data Sheets.

| Number | Title |
|---|---|
| 15200-01 | Cement-Mortar Ductile Iron Pipe and Fittings |
| 15200-02 | Stainless Steel Pipe and Fittings |
| 15200-03 | Polyvinyl Chloride (PVC) Pipe and Fittings |
| 15200-04 | Copper Piping |
| 15200-05 | Double Walled Containment Piping |
| 15200-06 | Tygon Tubing |
| 15200-07 | Sanitary Waste and Vent Piping |
| 15200-08 | Carbon Steel Piping |

END OF SECTION

# CANTON WPCP EXPANSION
# PIPING SCHEDULE

***MATERIAL LEGEND***

**DBL CONT = DOUBLE CONTAINED**
**C-900 = PVC C-900 SERIES - DR25**
**CS = CARBON STEEL**
**CLDI = CEMENT-LINED DUCTILE IRON**
**DWV = PVC DRAIN, WASTE, & VENT**
**FRP = FIBERGLASS REINFORCED PLASTIC**
**PVC = POLYVINYL CHLORIDE**
**SST= STAINLESS STEEL**
**TYG = TYGON TUBING**
*** = MATCH PROCESS PIPE MATERIAL**

***TEST LEGEND***

**P = PNEUMATIC**
**H = HYDRAULIC**

***INSTALLATION***

**BUR = BURIED**
**EXP = EXPOSED**
**SUB = SUBMERGED**

| | | | | | | PRESSURE (psig) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **SERVICE** | **LEGEND** | **SIZE (IN.)** | **MATERIAL** | **SPEC NO** | **INSTALLATION** | **TEST** | **OPER** | **TEST** | **PIPE COLORS** | **REMARKS** |
| AIR LOW PRESSURE | ALP | 2-14 | SST | 15200-02 | EXP | 20 | 12 | P | | |
| ALUMINUM SULFATE | ALUM | 2 - 4<br>0.5 | DBL CONT<br>TYG | 15200-05<br>15200-06 | EXP<br>BUR/EXP/SUB | 50 | 35 | H | Safety Yellow | Double contain all piping from fill station to tank and from tank to pump skid. Tygon tubing from pump skid to injection location to be transported in Sch. 40 PVC carrier pipe as shown on Drawings. |
| BIOLOGICAL NUTRIENT REMOVAL EFFLUENT | BNR-E | 30 - 42 | CLDI | 15200-01 | BUR/EXP/SUB | 50 | 25 | H | Dark Gray | |
| BIOLOGICAL NUTRIENT REMOVAL INFLUENT | BNR-I | 30 - 36 | CLDI | 15200-01 | BUR/EXP/SUB | 50 | 25 | H | Dark Gray | |
| CITRIC ACID | ACID | 1<br>1<br>2 | TYG<br>DBL CONT<br>DBL CONT | 15200-06<br>15200-05<br>15200-05 | EXP<br>EXP<br>EXP | 50<br>50<br>50 | 25<br>25<br>25 | H<br>H<br>H | Safety Yellow<br>Safety Yellow<br>Safety Yellow | Double containment piping from fill station to tank – 2” carrier, from tank to pump skid – 1” carrier. Tygon tubing from pump skid to injection location inside 3” Sch. 40 PVC containment pipe as shown on Drawings. |
| COMPRESSED AIR | CA | 3/4" - 2 | SST | 15200-02 | BUR/EXP/SUB | 20 | 12 | P | | |
| CONDENSATE DRAIN | CD | 0.5 - 6 | PVC | 15200-03 | BUR/EXP | 10 | 5 | H | | |
| DEWATERED SLUDGE | DSL | 6 - 8 | SST | 15200-02 | EXP | 250 | 175 | H | | |
| DEWATERED SLUDGE | SL | 4-8 | SST | 15200-02 | EXP | 500 | 350 | H | | |
| DRAIN | DR | 2 - 4<br>6 - 12 | PVC<br>CLDI | 15200-03<br>15200-01 | BUR/EXP | 50 | 30 | H | | |
| FORCE MAIN | FM | 10-16 | CLDI | 15200-01 | BUR/EXP | 150 | 40 | H | Dark Gray | |
| GRIT | GR | 4 - 6 | CLDI | 15200-01 | EXP | 25 | 10 | H | Dark Gray | |
| INTERNAL RECYCLE | IR | 8-12 | CLDI | 15200-01 | EXP/SUB | 30 | 15 | H | Dark Gray | |

# CANTON WPCP EXPANSION
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**SST= STAINLESS STEEL**
**TYG = TYGON TUBING**
*** = MATCH PROCESS PIPE MATERIAL**

***TEST LEGEND***

**P = PNEUMATIC**
**H = HYDRAULIC**

***INSTALLATION***

**BUR = BURIED**
**EXP = EXPOSED**
**SUB = SUBMERGED**

| | | | | | | PRESSURE (psig) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **SERVICE** | **LEGEND** | **SIZE (IN.)** | **MATERIAL** | **SPEC NO** | **INSTALLATION** | **TEST** | **OPER** | **TEST** | **PIPE COLORS** | **REMARKS** |
| MAGNESIUM HYDROXIDE | MgOH | 0.5 | TYG | 15200-06 | BUR/EXP | 50 | 35 | H | Safety Yellow | Double contain all piping from fill station to tank and from tank to pump skid. Tygon tubing from pump skid to injection location inside 3” Sch. 40 PVC containment pipe as shown on Drawings. |
| NATURAL GAS | GAS | 2 | CS | 15200-08 | BUR/EXP | 5 | 2 | P | Safety Yellow | |
| ODOROUS AIR | OA | 2 -24 | FRP | 15201 | EXP | 10 | -2 | P | | |
| OVERFLOW | OF | 36<br>2-6 | CLDI<br>PVC | 15200-01<br>15200-03 | EXP<br>EXP | 10 | 5 | H | | |
| PERMEATE | PER | 24-36 | CLDI | 15200-01 | EXP/BUR | 50 | 25 | H | Silver Gray | |
| PLANT EFFLUENT | EFF | 36 | CLDI | 15200-01 | BUR | 25 | 10 | H | Purple | |
| POLYMER | PO | 1-2 | PVC<br>DBL CONT | 15200-03<br>15200-05 | EXP<br>EXP | 50 | 25 | H | Buff | Provide double contained pipe for polymer fill lines from truck loading to top of polymer tank. |
| POTABLE WATER | PW | 4-12<br>1-3<br>1 - 2 | CLDI<br>PVC<br>SST | 15200-01<br>15200-03<br>15200-02 | BUR/EXP<br>EXP<br>BUR/EXP | 150 | 60 | H | Blue | Provide SST piping for 1 - 2" PW piping at sludge dryer. |
| RAW SEWAGE | RS | 1 - 3<br>36 | DWV<br>CLDI | 15200-07<br>15200-01 | BUR/EXP<br>BUR | 50 | 25 | H | Dark Gray | Concrete encase 1.25" lines beneath roadway. |
| RECIRCULATION | REC | 2 - 4 | PVC | 15200-03 | EXP | 30 | 20 | H | Buff | Recirculation lines at polymer tanks |
| RECLAIMED WATER | REW | 12 | CLDI | 15200-01 | EXP/BUR | 350 | 200 | H | Purple | |
| RETURN ACTIVATED SLUDGE | RAS | 16-36 | CLDI | 15200-01 | EXP/BUR | 50 | 25 | H | Brown | |
| SAMPLE LINE | S | 1-2 | PVC | 15200-03 | EXP | 20 | 10 | H | | |
| SANITARY SEWER | SS | 2 - 12 | DWV | 15200-07 | BUR | 10 | 5 | H | Dark Gray | |
| SCUM | SCUM | 4 - 8 | CLDI | 15200-01 | EXP | 50 | 25 | H | Brown | |

# CANTON WPCP EXPANSION
# PIPING SCHEDULE

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**PVC = POLYVINYL CHLORIDE**
**SST= STAINLESS STEEL**
**TYG = TYGON TUBING**
*** = MATCH PROCESS PIPE MATERIAL**

***TEST LEGEND***

**P = PNEUMATIC**
**H = HYDRAULIC**

***INSTALLATION***

**BUR = BURIED**
**EXP = EXPOSED**
**SUB = SUBMERGED**

| | | | | | | PRESSURE (psig) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **SERVICE** | **LEGEND** | **SIZE (IN.)** | **MATERIAL** | **SPEC NO** | **INSTALLATION** | **TEST** | **OPER** | **TEST** | **PIPE COLORS** | **REMARKS** |
| | | 1 | TYG | 15200-06 | EXP | 50 | 25 | H | Safety Yellow | Double containment piping from fill station to tank – 2" carrier, from tank to pump skid – 1" carrier. Tygon tubing from pump skid to injection location to be transported in Sch. 40 PVC carrier pipe as shown on Drawings. |
| | | 1 | DBL CONT | 15200-05 | EXP | 50 | 25 | H | Safety Yellow | |
| SODIUM HYPOCHLORIDE | NAOCI | 2 | DBL CONT | 15200-05 | EXP | 50 | 25 | H | Safety Yellow | |
| THERMAL OIL RETURN | TOR | 4 - 6 | CS | 15200-08 | EXP | 50 | 25 | H | | |
| THERMAL OIL SUPPLY | TOS | 4 - 6 | CS | 15200-08 | EXP | 50 | 25 | H | | |
| THICKENED WASTE ACTIVATED SLUDGE | TWAS | 4 - 6 | CLDI | 15200-01 | BUR/EXP | 75 | 50 | H | Brown | |
| VENT | V | VARIES | PVC | 15200-03 | EXP | 10 | - | P | | |
| WASTE ACTIVATED SLUDGE | WAS | 4 - 6 | CLDI | 15200-01 | BUR/EXP/SUB | 50 | 25 | H | Brown | |

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SECTION 15200-01

CEMENT-MORTAR DUCTILE IRON PIPE AND FITTINGS

| Item | Description |
|---|---|
| General | Materials in contact with potable water shall conform to NSF 61 acceptance.<br>Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of the specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA A21.51 shall be conducted in testing and laboratory facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another). |
| Pipe | Buried Liquid Service Using Proprietary Restrained Joints:<br>AWWA Cl 11/A21.11, and AWWA C151/A21.51, pressure class conforming to Table 5 and Table 7 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron.<br>Exposed Pipe Using Grooved End and Flange Joints: AWWA Cl15/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure for pipes less than 30-inches diameter; 150 psi minimum working pressure for pipes 30-inches diameter or larger. |
| Lining | Cement-mortar: AWWA C104/A21.4. |
| Fittings | Lined and coated same as pipe.<br>Proprietary Restrained: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53, ductile iron, 250 psi minimum working pressure. Restraint shall be achieved with removable metal elements fitted between a welded bar on the pipe barrel and the inside of the joint bell or fitting sizes smaller than 16 inches may be mechanical joint, restrained by anchor gland followers, ductile iron anchor type, wedge action, with break-off tightening bolts. Assembled joints shall be rated for deflection in operation at rated pressure. Rated deflection shall be not less than 1-1/2 degrees for 36-inch and smaller pipe. Rated deflection shall be not less than 1/2 degree for 42-inch and larger pipe. Clow Corp., American Cast Iron Pipe Co., U.S. Pipe.<br>Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted.<br>Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face. Gray cast iron will not be allowed. |

| Item | Description |
|---|---|
| Joints | Proprietary Restrained: 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex.<br>Flange: Class 125 flat face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed.<br>Branch connections 3 inches and smaller, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties. |
| Bolting | Mechanical and Proprietary Restrained Joints: Manufacturer's standard.<br>Class 125 Flat-Faced Flange: ASTM A307, Grade A carbon steel hex head bolts, ASTM A563, Grade A carbon steel hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.<br>Class 250 Raised-Face Flange: ASTM A307, Grade B carbon steel hex head bolts, ASTM A563, Grade A carbon steel heavy hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. |
| Gaskets | General: Gaskets in contact with potable water shall be NSF 61 certified.<br>Proprietary Restrained Joints; Water and Sewage Service: Rubber conforming to AWWA C111/A21.11.<br>Flanged, Water, Sewage and Hot Air Services: 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D2000 4CA 415 A25 B35 C32 EA14 F19.<br>Full face for Class 125 flat-faced flanges, flat-ring type for Class 250 raised- face flanges. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.<br>Gaskets for joints above 250 psi or pipe spanning over 15 feet in length shall be Toruseal gaskets as manufactured by American, specially designed for a working pressure of 350 psi.<br>Gasket pressure rating to equal or exceed the system hydrostatic test pressure. |
| Joint Lubricant | Manufacturer's standard. |

END OF SECTION

SECTION 15200-02

STAINLESS STEEL PIPE

| Item | Size | Description |
|---|---|---|
| Pipe | 2 inches & smaller | Schedule 40S: ASTM A312/A312M, Type 304 or 316 seamless, pickled and passivated. |
| | 2-1/2 inches & larger | Schedule 10S: ASTM A778 Rev A “as-welded” grade, Type 304L or 316L. |
| Joints | 2 inches & smaller | Threaded or flanged at equipment as required or shown. |
| | 2-1/2 inches & larger | Butt-welded or flanged at valves and equipment. |
| Fittings | 2 inches & smaller | Threaded Forged: 1,000 CWP, ASTM A182/A182M Rev C Grade F304L or F316L. |
| | 2-1/2 inches & larger | Butt-Welded: ASTM A774/A774M Grade 304L or 316L conforming to MSS SP-43, “as-welded” grade, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise. |
| Branch Connections | 2 inches & smaller | Tee or reducing tee in conformance with Fittings above. |
| | 2-1/2 inches & larger | Butt-welding tee or reducing tee in accordance with Fittings above. |
| Flanges | All | Forged Stainless Steel: ASTM A182/A182M Rev C Grad F304L or F316L, ANSIB16.5 Class 150 or Class 300, slip-on weld neck or raised face. |
| Unions | 2 inches & smaller | Threaded Forged: ASTM A182/A182M Rev C Grade F304 or 316, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe. |
| Bolting | All | Forged Flanges: Type 304 or 316 stainless steel, ASTM A320/A320M Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts. |

| Item | Size | Description |
|---|---|---|
| Gaskets | All Flanges | Flanged, Water and Sewage Service: 1/8 inch thick, unless otherwise specified, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F. conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.<br><br>Flanged Hot Air and Fuel Gas Service: 1/8 inch thick, unless otherwise specified, homogeneous black rubber (EPDM) hardness 60 (Shore A), rated to 300 degrees F., conforming to ANSI B16.21 and ASTM D1330 Steam Guide.<br><br>Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange. |
| Thread Lubricant | 2 inches & smaller | Teflon tape. |

END OF SECTION

SECTION 15200-03

POLYVINYL CHLORIDE (PVC) PRESSURE PIPES

| Item | Description |
|---|---|
| Pipe | Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785<br><br>Threaded Nipples: Schedule 80 PVC. |
| Fittings | Schedule 80 PVC as Specified Under Pipe Above: ASTM D2466 and ASTM D2467 for socket-weld type and ASTM D2464 for threaded type. |
| Joints | Solvent socket-weld except where connection to valves and equipment may require future disassembly. |
| Flanges | One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1 drilling. |
| Bolting | Flat Face Mating Flange or In Corrosive Areas: ASTM A193/A193M Rev A Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.<br><br>With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts. |
| Gaskets | Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber.<br><br>Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. |
| Solvent Cement | As recommended by the pipe and fitting manufacturer conforming to ASTM D2564. |
| Thread Lubricant | Teflon tape. |

END OF SECTION

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SECTION 15200-04

COPPER PIPE AND TUBING

| Item | Description |
|---|---|
| General | Copper pipe for domestic water. |
| Pipe | Soft Copper Tube: ASTM B 88, Types K and L , water tube, annealed temper.<br>Hard Copper Tube: ASTM B 88, Types L , water tube, drawn temper. |
| Fittings | Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought- copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.<br>Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, Viega Pro-Press copper fittings with EPDM O-rings or Elkhart. |
| Bolting | Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping. |
| Unions | Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends. |

END OF SECTION

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SECTION 15200-05

DOUBLE WALLED CONTAINMENT PIPING

| Item | Description |
|---|---|
| Carrier/Containment Pipe | Carrier and containment pipe shall be CPVC Sch. 80 "ProLock" as manufactured by Asahi/America or equal. |
| Leak Detection System | Leak detection system shall be low-point probe sensors with control panel as required by the double-wall piping manufacturer. All probes, control panels and connecting wiring shall be furnished and installed by the double wall piping manufacturer. 120V power for each panel shall be furnished and installed by the CONTRACTOR. Final operation, testing, and start-up of detection system shall be the responsibility of the double-wall piping manufacturer. |
| Manufacturers/Product | Containment system pipe consisting of containment pipe, all fittings and related accessories (centralizers, termination fittings, adhesive agents, leak detection systems, couplings, drain/vent ports, etc.), required for a complete installation. Containment pipe shall be the product of Asahi/America or equal. |
| Installation | Install in accordance with manufacturer's instructions. Slope pipe runs at a uniform rate to a visual inspection station. Contractor shall be trained and certified by the manufacturer for installation and start-up of all double-containment and associated leak detection systems. |
| Cleaning and Testing | Upon completion of installation, the carrier piping system shall be hydrostatically tested at the pressure specified in Section 15200, Process Piping-General.<br><br>Upon completion of the installation, the containment piping system shall be pressure tested in accordance with the containment piping manufacturer's instructions. Test pressure for containment piping shall not exceed 5 psi (pneumatic test).<br><br>Following installation and testing of the systems, the carrier piping system shall be flushed clean. The Contractor shall check the operation of all valves and appurtenances.<br><br>The annular space between carrier and containment piping shall be purged of moisture by purging with clean dry air. |

END OF SECTION

SECTION 15200-06

TYGON TUBING

| Item | Size | Description |
|---|---|---|
| Pipe | All | Teflon PTFE (polytetrafluoroethylene) friction resistant surface and low penetration by gases or liquids. Minimum wall thickness of 0.062 inch. ID ¼ inch and maximum psi at 70 degrees F to 200 degrees F. |
| Fittings and Valves | All | Swagelok Alloy 20 tube fittings and check valves. |
| Manufacturers | All | McMaster Carr/Swagelok or approved equal. |

END OF SECTION

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SECTION 15200-07

SANITARY WASTE AND VENT PIPING

| Item | Description |
|---|---|
| General | Sanitary waste and vent piping, above and below slab. |
| Pipe | Solid-Wall PVC Pipe: ASTM D 1784 and 1785, schedule 40 drain, waste, and vent.<br><br>Cast Iron, service weight, no-hub pipe, ASTM A 888 or CISPI 301 |
| Fittings | PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns<br><br>Cast Iron fittings, no-hub, ASTM A 888 or CISPI 301<br>Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve. |
| Solvent Cement | Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).<br><br>Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). |

END OF SECTION

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**SECTION 15200-08**

**CARBON STEEL PIPE AND FITTINGS – GENERAL SERVICE**

| Item | Size | Description |
|---|---|---|
| Pipe | All | Black carbon steel, ASTM A106, Grade B seamless or ASTM A53 Rev A, Grade B seamless or ERW. Threaded, butt-welded, grooved end, and flanged joints. |
| | Screwed:<br>2-inch & smaller | <br>Schedule 80. |
| | Welded:<br>2½- through 10-inch<br>12- through 16-inch<br>18- through 24-inch | <br>Schedule 40.<br>Schedule 30.<br>Schedule 20. |
| | Grooved:<br>2½- through 6-inch<br>8- through 12-inch<br>14-inch | <br>Schedule 40.<br>Schedule 30.<br>Standard weight. |
| Joints | 2-inch and smaller | Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606. |
| | 2½-inch and larger | Butt-welded or flanged at valves and equipment, or grooved end meeting the requirements of AWWA C606. |
| Fittings | 2-inch and smaller | Threaded: 150- or 300-pound malleable iron, ASTM A197 or ASTM A47, dimensions in accordance with ANSI B16.3. Fire sprinkler fittings to be UL listed.<br>*Fittings for Thermal Oil System:* 3000-lb malleable iron, butt weld or socket weld connections<br>Grooved end: Malleable iron ASTM A47 or ductile iron ASTM A536, grooved ends to accept couplings without field preparation. Victaulic; Grinnell. |
| | 2-inch and larger | Butt-welded: Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ANSI B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless otherwise shown.<br>Grooved end: Malleable iron ASTM A47 or ductile iron ASTM A536, grooved ends to accept couplings without field preparation. Victaulic; Grinnell. |
| Branch Connections | 2-inch and smaller | Threaded, straight, or reducing tees in conformance with Fittings specified above. |
| | 2½-inch and larger | Butt-welding or grooved end tee in conformance with Fittings specified above. |

| Item | Size | Description |
|---|---|---|
| Flanges | 2-inch and smaller | Forged carbon steel, ASTM A105/A105M, Grade II, ANSI B16.5 Class 150 or Class 300 socket-weld or threaded, 1/16-inch raised face. |
| | 2½-inch and larger | Butt-welded systems: Forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 or Class 300 slip-on or welding neck, 1/16-inch raised face.<br>Grooved end adapter flange: Malleable iron ASTM A47 or ductile iron ASTM A536. Victaulic; Grinnell.<br>Cast iron mating flange: AWWA C207, Class D or E, hub or ring type, ANSI B16.1, 125-pound drilling, AWWA C207 Class F hub type or ASTM A105/A105M, ANSI B16.5 Class 300-pound, drilling. |
| Unions | 2-inch and smaller | Threaded malleable iron, ASTM A197 or A47, 150- or 300-pound water, oil, gas (WOG), meeting the requirements of ANSI B16.3. |
| Couplings | 2½-inch and larger | Grooved end: Rigid joint malleable iron, ASTM A47 or ductile iron, ASTM A536. Victaulic; Grinnell.<br>Screwed end: Malleable iron, ASTM A197 or A47. |
| Bolting | All | Flanges: Carbon steel ASTM A307, Grade A hex-head bolts and ASTM A563, Grade A hex-head nuts. Use 1/8-inch undersize bolting material for insulating flanges.<br>Grooved end couplings: Carbon steel, ASTM A183 bolts and nuts, 110,000 psi minimum tensile strength. |
| Gaskets | All flanges | Water, steam, and air services: 1/16 inch thick, compressed inorganic fiber with nitrile binder, rated to 700 degrees Fahrenheit (°F) and 1,000 psi.<br>Fuel gas service: 1/8 inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 300 °F, conforming to ANSI B16.21 and ASTM D1330, Steam Grade.<br>*Gaskets for Thermal Oil System*: 300-lb Corrugated Metal Core, graphite Covered, Elastagraph or equal.<br>Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.<br>Grooved couplings: EPDM per ASTM D2000 for water and air to 230 °F, nitrile for oil service to 180 °F. |
| Threaded Lubricant | 2-inch and smaller | General service: Polytetrafluoroethylene (PTFE) thread tape, or Teflon® tape. |

END OF SECTION

# SECTION 15201

# FIBERGLASS REINFORCED PLASTIC DUCTWORK

## PART 1: GENERAL

### 1.01 SCOPE

A. The CONTRACTOR shall furnish and install fiberglass reinforced plastic (FRP) duct and all appurtenances, complete and in place, all in accordance with the requirements of the Drawings.

### 1.02 RELATED WORK

A. Section 11500 Odor Control Equipment

### 1.03 SUBMITTALS

A. Submit in accordance with Section 01300 SUBMITTALS, copies of all materials required to establish compliance with this Section. Submittals shall include at least the following:

1. Shop Drawings of FRP duct and fittings depicting the following information:
    a. Dimensioned duct layout.
    b. Location of supports, hangers, anchors, guides and expansion joints.
    c. Joints used at each connection and detail of each joint type.
2. The CONTRACTOR shall submit a copy of this specification with check-marks by each line to show full compliance or a note with attached supporting information noting any deviation for Engineer review.
3. Submit product data on all products proposed for installation under this section.
4. Statement of resins and reinforcing proposed for use along with resin and reinforcing manufacture’s product literature.
5. Manufacture’s data and descriptive literature for duct accessories.
6. A letter from the resin supplier stating that the material used for this project complies with the specification and meets all corrosion requirements.
7. Design calculations performed by the manufacturer and stamped by a Professional Engineer for record purposes.
8. Samples shall be representative of the ductwork (construction method and material used) to be supplied on this project.
9. Joint fabrication and/or installation instructions.
10. Detailed information regarding any proposed design modifications

1.04 OPERATION AND MAINTENANCE DATA

A. Submit complete operation and maintenance data on the valves in accordance with requirements of SECTION 01730 Operating and Maintenance Manual.

1.05 REFERENCE STANDARDS

A. Fiberglass reinforced plastic ductwork and accessories shall be constructed and inspected according to the following standards:

1. ASTM D 3567 – Practice for Determining Dimensions of “Fiberglass” (Glass Fiber Reinforced-Thermosetting-Resin) Pipe and Fittings.

2. ASTM C 582 – Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment.

3. ASTM D 2563-70 – Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.

4. ASTM D 3982 – Standard Specification for Contact Molded “Fiberglass” Duct and Hoods or NBS PS 15-69 Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment.

5. ASTM D 2310 – Standard Classification for Machine-Made “Fiberglass” Pipe.

6. ASTM D 2583 – Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

7. ASTM D 2996 – Specification for Filament-Wound "Fiberglass" (Glass Fiber-Reinforced Thermosetting Resin) Pipe

8. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials

9. 2018 Uniform Mechanical Code

B. In the event of conflict between these references, the most appropriate and stringent source shall be followed.

1.06 QUALITY ASSURANCE

A. Work shall be performed in a neat, proficient manner by skilled workers experienced in the fabrication and installation of ductwork systems of similar complexity.

B. The CONTRACTOR shall demonstrate experience on at least 5 projects requiring similar fabrication and installation methods. Both the Fabricator and the Installer shall have a minimum of five years’ experience for similar projects.

1.07 DELIVERY, STORAGE AND HANDLING

A. Material shall be delivered and stored on the Project site in a manner to protect from dirt, moisture, and physical damage. The CONTRACTOR shall be responsible for providing on-site storage facilities.

B. Do not install materials damaged prior to installation. Replace damaged materials with new materials.

1.08 SEQUENCING AND SCHEDULING

A. Coordinate demolition and installation schedule of ductwork with overall construction schedule.

B. Coordinate installation locations of ductwork with the work of other traders to maximize accessibility and, where necessary, operability and maintainability of all process and building systems.

1.09 WARRANTIES AND BONDS

A. The Contractor shall provide a warranty against defective or deficient materials and workmanship in accordance with the requirements of Section 01740 WARRANTIES AND BONDS.

PART 2: PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer: Provide FRP duct as manufactured by one of the following: Belco Manufacturing, Ershings, Bondstrand, Fibercast, Tankinetics, or Augusta Fiberglass, All equipment (ducts, dampers, and fittings) shall be the product of a single manufacturer. Out-sourcing of fabrication or parts of the system will not be accepted.

2.02 GENERAL

A. Service Conditions:

1. Duct Contents: hydrogen sulfide gas with concentrations up to 200 ppmv.

2. Ambient Temperature: -10 to 120 degrees F.

3. Gas Temperature: Ambient.

4. Location: Outdoor exposed. See Drawings.

5. Wind Load: Per International Building Code.

6. Seismic Requirements: Per International Building Code.

7. All equipment shall be designed for a minimum working pressure of 5 inch WC Positive and 12 inch WC Negative pressure.

8. The minimum wall thickness for all FRP duct shall conform to the following:

a. Wall thickness for internal positive pressure should be determined by ASTM 2310 using duct manufacturers Certified ASTM 2992 HDB test results. A full copy of the HDB testing should be submitted with the wall thickness calculations.

| Duct Inside Diameter (inches) | Minimum Wall Thickness (inches) |
|---|---|
| 3–16 | 0.1875 |
| 18–24 | 0.220 |
| 30–36 | 0.250 |

9. Duct Support Criteria
    a. Maximum Duct Deflection: 1/2-inch (between supports).
    b. Support spacing shall be as shown on the Drawings, but shall not exceed 10 feet unless noted on the Drawings.
10. Unless stated otherwise, all remaining aspects of the duct design shall be in accordance with ASTM D 3982.
11. Resin:
    a. Resin shall be a premium grade vinylester product formulated to withstand chemical and environmental exposures and temperature range listed above. All duct shall meet a flame spread rating of 25 or less in accordance with ASTM E 84. Fillers, which shall be permitted only for flame retardance, shall not exceed five percent by weight. Vinylester resin shall be Derakane 510C, Hetron FR992, Corezyn 8440 or Reichhold FR 9300. No alternate resins shall be allowed for construction of duct.
12. Reinforcement:
    a. Surfacing veil shall be C glass veil with a silane finish and a styrene soluble binder.
    b. Chopped strand mat shall be Type E glass minimum 1-1/2-oz/$ft^2$ with silane finish and styrene soluble binder.
    c. Continuous roving for chopper gun spray up shall be Type E glass.
    d. Woven roving shall be Type E glass minimum 24-oz/$yd^2$ with a five by four weave.
    e. Continuous roving for filament winding shall be Type E glass with a silane finish.

B. Construction:

1. All FRP duct shall be filament wound or contact molded, glass fiber reinforced vinylester resin pipe with a reinforced vinylester resin liner. Filament wound construction shall conform with the requirements of ASTM D 2996. Contact molded construction shall conform with the requirements of ASTM C 582 and ASTM D 3982.
2. Maximum allowable deflection for any size ductwork shall be 1/2-in between supports and for any size of duct under worst case operating conditions.
3. FRP ductwork shall be designed using a safety factor of 4 to 1 for pressure and 2 to 1 for vacuum without exception.
4. Out-of-roundness of duct shall be limited to 1 percent of the diameter.
5. Length of all flanged duct sections shall not vary more than ± 1/2-in at 70 F.
6. All un-flanged duct shall be square on the ends in relation to the center axis within ±1/8-in up to and including 24-in diameter and within ±3/16-in for all diameters greater than 24-in.

7. Laminates:
    a. All ductwork shall have a resin-rich inner surface, an interior corrosion barrier, an interior structural layer and an exterior corrosion layer, and UV resistant coating.
    b. Inner surface: Nominal 10 mils thick composed of a single ply of the C glass surfacing veil embedded in a resin-rich surface. Resin content shall be 90 percent.
    c. Interior layer: Nominal 90 mils thick composed of at least two layers of chopped strand mat or equivalent chopped strand. Resin content shall be 75 percent.
    d. Structural layer: Type E glass to meet minimum wall thickness as specified. The total wall thickness includes the inner surface.
        1) Contact molded structural layer shall include alternate layers of chopped strand mat and woven roving.
        2) Filament wound structural layer shall be preceded by a layer of chopped strand mat or spray chop. The structural layer shall consist of a minimum of two complete cross hatched layers of continuous filaments applied in a helix angle of 55 to 65 degrees for above-ground ductwork and 75 degrees for any buried ductwork.
    e. Exterior corrosion layer: Single A or C Veil shall be applied to all duct exterior.
    f. Exterior UV resistant coating: Factory applied paraffinated gel coat with UV inhibitors. Color shall be determined by the Engineer.
8. Fittings:
    a. All fittings shall be hand lay-up construction fabricated from the same resin and have the same strength as hand lay-up FRP ductwork.
    b. The internal diameter of all fittings shall be equal to the adjacent duct.
    c. The tolerance on angles of all fittings shall be ±1 degree up to and including 24-in diameter and ± 1/2 degree for 30-in diameter and above.
9. Elbows:
    a. The centerline radius of all elbows shall be 1-1/2 times the diameter.
    b. Elbows 24-in diameter and smaller shall be smooth radius. Elbows 30-in and larger shall be mitered. Provide a minimum of two mitered joints (3-piece) for all elbows above 45 degrees.
10. Flanges:
    a. Provide flanged connections to flexible connectors, expansion joints, vessels, demisters, fans, silencers, and other locations as shown on the Drawings.
    b. Flanges shall be hand lay-up construction. Dimensions shall be in accordance with ASTM D 3982, Table 1, and the Duct Dimension Schedule.

c. Flanges shall be drilled in accordance with ASTM D 3982, Table 1. Backs of flange face shall be flat so that washer seats fully on bolt face and flange backing.

d. Flange tolerances shall be in ASTM D 3982, Section 8, Tolerances.

e. Gaskets shall be EPDM, full face and minimum 1/8-in thickness.

f. All bolts, nuts and washers shall be Type 316 stainless steel.

11. Dampers:

a. Dampers shall be Use for volume flow control only as indicated on drawings.

b. Sizes 4" – 10":

1) Class: Flat Face Flanged.

2) Type: AMCA certified Bubble–Tight to 30 in.w.c., Flanged style.

3) Body: FRP.

4) Disc: FRP.

5) Shaft: 316 stainless steel.

6) Seals: Teflon.

7) Operator: Gear with Handwheel.

8) Manufactures: Belco, Composites USA, Daniel Mechanical, or approved equal.

c. All metal parts, fasteners, bolts, nuts, and washers required on fiberglass valves and dampers shall be of Type 316 stainless steel.

12. Joints:

a. Provide all butt and strap joints in accordance with ASTM D 3982, Table 2, and manufacturer's drawings.

b. Field weld kits shall be supplied by the duct manufacturer. All necessary fiberglass and reinforcing material shall be supplied pre-cut and individually packaged for each joint. Bulk Glass rolls will not be acceptable.

c. All resin, catalyst and putty shall be supplied in quantities to complete all field joints plus 20 percent extra for waste.

13. Expansion joints

a. Provide expansion joints where shown on the Drawings.

b. Expansion joints shall be manufactured by Mercer Rubber, RM-Holz, The Metraflex Company, or equal.

c. Expansion joints shall be flanged where connecting ductwork to equipment; otherwise, slip-type will be acceptable.

14. Duct Connectors

a. Manufactures: Subject to compliance with requirements, provide products by one of the following: Mercer Rubber, Duro Dyne, or equal.

b. Flanged or with split retaining rings

c. Outdoor System, Flexible Connector Fabric: synthetic rubber resistant to UV, oil particles, temperature, ozone and chemical exposure.

1) Minimum compression: 3 ½ Inch.

2) Minimum Extension: 2 Inch

3) Minimum Lateral movement: 2 Inch.

## PART 3: EXECUTION

### 3.01 GENERAL

A. Transitions shall be made with a slope not exceeding 1:4 where space permits.

B. Ductwork shall be assembled from manufactured sections of duct and fittings.

C. Ductwork joints shall be made-up in accordance with the duct fitting manufacturer's installation instructions.

D. All transitions shall be flat on bottom unless otherwise noted.

### 3.02 INSTALLATION

A. Verify dimensions and conditions in the field prior to preparing shop drawings and fabricating duct.

B. All duct and fittings shall be thoroughly cleaned and inspected prior to installation and shall be kept clean until installed.

C. Cut, fit and install duct in accordance with manufacturer's recommendations.

D. Seal cut edges with compatible resin.

E. Field Joints: Provide material for field joints in kit form; one kit for one joint. Make field joints when ambient temperature meets manufacturer’s recommendations.

F. Ductwork shall be installed level, plumb and true.

### 3.03 DUCT SUPPORT AND HANGERS

A. The CONTRACTOR shall be responsible for selecting and locating all outdoor supports and hangers. CONTRACTOR shall also select and locate all saddle types to ensure provision is made for adequate duct compression and expansion.

### 3.04 FIELD QUALITY CONTROL

A. All ductwork shall be leak tested in accordance with SMACNA Air Duct Leakage Test Manual. Duct system shall be sealed to provide a system that is within an allowable leakage limit of 2.5 percent of total air flow at system operating flow and pressure. The ductwork test report shall be submitted to the Engineer.

B. If the system is tested in sections, the leakage rates shall be added to define the performance of the whole system.

END OF SECTION

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# SECTION 15250

# PROCESS PIPING INSULATION

## PART 1: GENERAL

### 1.01 GENERAL

A. Piping and equipment insulation for the thermal oil system and piping are included in this section. See Section 11371 Sludge Drying Equipment for information on the equipment and piping associated with the thermal oil system.

B. Piping insulation shall be provided for all above grade piping located outdoors.

C. Heat tracing shall be provided for all piping below 4 inches in diameter and as specified in the Pipe Schedule located in Section 15200 Piping – General.

D. Heat tracing shall be provided as required in Section 16855 Heat Trace.

### 1.02 SUBMITTALS

A. The Shop Drawings: Manufacturer's descriptive literature.

B. Contract Closeout Submittals: Maintenance information.

## PART 2: PRODUCTS

### 2.01 PIPING INSULATION

A. Type 1:

1. Material: Flexible elastomeric pipe insulation, closed cell structure.
2. Temperature Rating: Minus 40 degrees F to 200 degrees F.
3. Nominal Density: 6 pcf.
4. Conductivity in accordance with ASHRAE 90.1.
5. Flame Spread Rating: Less than 25 per ASTM E84.
6. Manufacturers and Products:
    a. Armacell: AP Armaflex
    b. Or equal

B. Type 2:

1. Material: UL rated, preformed, sectional rigid fiberglass with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
2. Conductivity in accordance with ASHRAE 90.1.

3. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.

4. Manufacturers and Products:

   a. Owens-Corning Fiberglass; ASJ/SSL-11.

   b. Manville; Micro-Lok 650 with AP-T Jacket.

2.02 FITTING INSULATION

A. Type 1: Same as pipe.

B. Type 2:

1. Wired-in-place, premolded insulation or mitered segments, or soft fiberglass insulation inserts covered with premolded PVC fitting covers.

2. Manufacturers:

   a. Manville Zeston.

   b. Speedline

2.03 INSULATION AT PIPE HANGERS AND SUPPORTS

A. Type 1: Rigid insulation section with 9-inch long, 16-gauge galvanized steel saddle.

B. Type 2: UL rated, preformed rigid pipe insulation inserts of thickness equal to adjoining insulation, 10 inches in length, with factory applied, vinyl-coated and embossed vapor barrier jacket with self-sealing lap.

2.04 ALUMINUM JACKET

A. Thickness: 0.016 inch.

B. Fittings: Preformed aluminum jackets, two-piece elbows and flange covers, secured with stainless steel bands.

C. Manufacturers:

1. JM Aluminum Jacket

2. Or equal

2.05 INSULATION AND CLADDING OF SLUDGE DRYER EQUIPMENT

A. Condenser and Interconnecting Ductwork

1. Insulate Condenser using 2 inch thick mineral wool board with a 0.032 Stucco Embossed Aluminum Jacket.

B. Extraction Screw

1. Insulate the Extraction Screw with removable pads.

C. Recirculation Fans

1. Insulate the Recirculation Fans with removable pads.

2.06 INSULATION AND CLADDING OF THERMAL OIL SYSTEM

A. Thermal Fluid Piping

1. Insulate thermal fluid piping using 2” Pittsburgh Corning FOAMGLAS or equal. Cover with aluminum jacket.

B. Deaerator Section of Combination Tank

1. Insulate deaerator section of the thermal oil combination tank using 2” Pittsburgh Corning FOAMGLAS or equal. Provide insulation cover in accordance to Supplier’s recommendation. Ensure no other portion of the combination tank is insulated.

C. Exhaust Stack and Flue

1. Insulate exhaust stack using 4” Pittsburgh Corning FOAMGLAS or equal. Provide insulation cover in accordance to Supplier’s recommendation.

PART 3: EXECUTION

3.01 APPLICATION

A. General:

1. Insulate valve bodies, flanges, and pipe couplings.

2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.

3. Do not insulate flexible pipe couplings and expansion joints.

B. Service and Insulation Thickness: Refer to Supplemental Table and to Piping Schedule in Section 15200, Piping – General

C. Aluminum Jackets: Install on insulated Type 1 and Type 2 exterior piping and fittings.

D. PVC Fitting Covers: Install on Type 1 insulated interior piping and on all Type 2 insulated fittings.

3.02 INSTALLATION

A. General:

1. Install in accordance with manufacturer's instructions and as specified herein.

2. Install insulation after piping system has been pressure tested and leaks corrected.

3. Apply insulation over clean, finish painted and dry surfaces.

4. Do not allow insulation to cover nameplates or code inspection stamps.

5. Run insulation continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.

6. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions, strainer end plates, etc.

7. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

B. Connection to Existing Piping: Cut back existing insulation to remove the portion damaged by piping revisions. Install new insulation.

C. Cold Surfaces: Provide a continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

D. Placement:

1. Slip insulation on pipe or tubing before assembly, when practical to avoid longitudinal seams.

2. Insulate valves and fittings with sleeved or cut pieces of same material.

3. Seal and tape joints.

E. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.

F. Heat Traced Piping: Apply insulation after heat tracing work is completed and approved

G. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.

2. Install vapor barrier jackets with pipe hangers and supports outside the jacket.

3. Do not use staples and screws to secure vapor sealed system components.

H. Aluminum Jackets:

1. Use a continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.

2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.

3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.

4. Do not use screws or rivets to fasten the fitting covers.

5. Install removable prefabricated aluminum covers on exterior flanges and unions.

6. Caulk and seal all exterior joints to make watertight.

3.03 FIELD TESTING

A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

3.04 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

Canton WPCP Heat Trace and Insulation Schedule

END OF SECTION

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# CANTON WPCP EXPANSION

## Heat Trace and Insulation Schedule

**MATERIAL LEGEND**

**DBL CONT = DOUBLE CONTAINED**
**C-900 = PVC C-900 SERIES - DR25**
**CS = CARBON STEEL**
**CLDI = CEMENT-LINED DUCTILE IRON**
**DWV = PVC DRAIN, WASTE, & VENT**
**FRP = FIBERGLASS REINFORCED PLASTIC**
**PVC = POLYVINYL CHLORIDE**
**SST= STAINLESS STEEL**
**TYG = TYGON TUBING**
*** = MATCH PROCESS PIPE MATERIAL**

**Location Legend**

**ALL = All Aboveground Locations (Interior and Exterior)**
**EXP = Exposed**
**EXP/EXT = Exposed and Exterior**
**EXT = Exterior (Outdoors)**
**INT = Interior**
**Note: No buried piping on this project requires heat tracing or insulation.**

| SERVICE | MATERIAL | INSTALLATION | INSULATION | THICKNESS (in) | HEAT TRACE * | REMARKS |
|---|---|---|---|---|---|---|
| AIR LOW PRESSURE | SST | ALL | Type 2 | 1 | No | |
| ALUMINUM SULFATE | DBL CONT<br>PVC Carrier | EXP<br>EXP | Type 1<br>Type 2 | 1<br>1 | Yes<br>Yes | |
| CITRIC ACID | TYG | EXP | Type 1 | 1 | No | |
| CONDENSATE DRAIN | PVC | EXP/EXT | Type 2 | 1 | No | |
| DRAIN | PVC<br>CLDI | EXP/EXT | Type 2 | 1 | Yes<br>No | Insulate sump pump discharge lines in Solids Handling and MBR Facilities |
| GRIT | CLDI | EXP | Type 2 | 1 | Yes | |
| INTERNAL RECYCLE | CLDI | EXP | Type 2 | 1 | No | |
| MAGNESIUM HYDROXIDE | PVC Carrier | EXP | Type 2 | 1 | Yes | |
| ODOROUS AIR | FRP | INT<br>EXP/EXT | Type 1<br>Type 2 | 2<br>1 | No<br>No | |
| POLYMER | DBL CONT<br>PVC Carrier | EXP<br>EXP | Type 1<br>Type 2 | 1<br>1 | No<br>No | |
| POTABLE WATER | PVC<br>SST | EXP/EXT<br>EXP | Type 2<br>Type 2 | 1<br>1 | Yes<br>No | |
| RAW SEWAGE | DWV | EXP/EXT | Type 2 | 2 | No | 1.25-inch RS at Headworks |
| RETURN ACTIVATED SLUDGE | CLDI | EXP | Type 2 | 1 | No | Under 24" Diameter |
| RECLAIMED WATER | CLDI | EXP/EXT | Type 2 | 1 | Yes | |
| SAMPLE LINE | PVC | INT<br>EXP/EXT | Type 1<br>Type 2 | 2<br>1 | No<br>Yes | |
| SCUM | CLDI | EXP/EXT | Type 2 | 1 | Yes | |
| SODIUM HYPOCHLORIDE | TYG | EXP | Type 1 | 1 | No | |
| THERMAL OIL SUPPLY | CS | EXP | As Specified | 2 | No | |

# CANTON WPCP EXPANSION

## Heat Trace and Insulation Schedule

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**TYG = TYGON TUBING**
*** = MATCH PROCESS PIPE MATERIAL**

**Location Legend**

**ALL = All Aboveground Locations (Interior and Exterior)**
**EXP = Exposed**
**EXP/EXT = Exposed and Exterior**
**EXT = Exterior (Outdoors)**
**INT = Interior**
**Note: No buried piping on this project requires heat tracing or insulation.**

| SERVICE | MATERIAL | INSTALLATION | INSULATION | THICKNESS (in) | HEAT TRACE * | REMARKS |
|---|---|---|---|---|---|---|
| THERMAL OIL RETURN | CS | EXP | As Specified | 2 | No | |
| WASTE ACTIVATED SLUDGE | CLDI | EXP/EXT | Type 2 | 1 | Yes | |

* See Specification Section 16855 HEAT TRACE for details on Heat Tracing.

# SECTION 15500

# HEATING, VENTILATION AND AIR-CONDITIONING (HVAC)

## PART 1: SCOPE OF WORK

### 1.01 GENERAL

A. These Sections and Drawings cover(s) the requirements of the Heating, Ventilation and Air-Conditioning (HVAC) Work to be performed and shall not void any of the requirements specified under the General Conditions or General Requirements.

B. The requirements specified herein shall be modified only if specified otherwise for a particular application in other Divisions.

C. This HVAC specification is incomplete without the information contained on the Drawings and in the Schedules. The HVAC equipment schedules are located on the drawings.

D. Work included under the "Scope of Work" of this HVAC Section includes all labor, material, equipment, tools and services necessary to furnish, deliver, unload, install, test and place in satisfactory operation, the equipment, services and systems as called for under the HVAC Section(s) including any incidental work not shown, or not specified but which can reasonably be inferred as belonging to the various systems and necessary in good practice to provide complete and fully operational systems.

E. The following work descriptions are not intended to in any way limit the above broad statement, but are intended as a more specific mention of the most important items included therein.

F. This Section is incomplete without the information contained in the HVAC equipment schedules. Provide equipment of the type, size, capacity and arrangement as shown on the Drawings and as scheduled. Equipment shall consist of the particular components listed in the schedules in addition to those components normally required for the type of unit. The order of component assembly will be as stated in the schedule. Particular attention must be paid to the remarks and notes in the schedules and on the Drawings.

G. All ductwork, piping, and equipment shown on the Drawings is intended to be approximately correct to scale, but figured dimensions and detailed drawings of the actual equipment furnished shall be followed in every case. The Drawings shall be taken in a sense as diagrammatic. Size of ductwork and piping are shown, but it is not the intent to show every offset or fitting, nor every hanger or support, or structural difficulty that may be encountered. To carry out the intent and purpose of the drawings all necessary parts to make a complete working system ready for use shall be furnished without extra charge. The Contractor shall be responsible to coordinate the system installation and routing with the work of all trades.

### 1.02 RELATED WORK

A. Cutting and patching is included in Division 1, except for items specified herein.

B. Temporary heating, electric power and lighting is included in Division 1.

C. Trenching, excavation and backfill is included in Division 2, except for items specified herein.

D. Concrete work is included in Division 3, except for required HVAC anchor bolts, sleeves and templates which shall be furnished under this Section.

E. Structural steel and miscellaneous metal is included in Division 5, except for supplementary steel required for HVAC hangers, equipment supports, anchors and guides, which shall be furnished under this Section.

F. Flashing and counterflashing is included in Division 7, except for items specified herein.

G. Exterior louvers are included in Division 10.

H. Plumbing work is included under the Plumbing Section (Division) of this Division (Specification) except for water and drain closing in connections to HVAC equipment.

I. Gas piping to all required HVAC equipment items is included under the Plumbing Section (Division) of this Division (Specification).

J. Painting is included in Division 9, except for factory finished HVAC equipment, HVAC shop painting and HVAC identification labeling.

K. Electrical field wiring is included in Division 16, except for field wiring for automatic temperature controls as specified herein or as shown on the HVAC Drawings.

L. Line voltage thermostats for unit heaters are installed and wired under Division 16. Electric resistance radiation is furnished and installed under Division 16.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings and product data for the following:

1. Catalog cuts and data sheets for all equipment.

2. Automatic control drawings with composite wiring diagrams, including bills of material and descriptions of operation for all systems. Panel layouts and name plate lists for all local and central panels. Data sheets for all control system components.

3. Software licensing and user agreements will be submitted for approval with the shop drawings for the equipment using the software. The submittal shall be a copy of the final agreement document that is to be signed.

4. Complete damper schedules for damper submittals including the following for each type or model of damper to be furnished for the project: materials of construction for blades, frames, bearings, linkages and seals; flow and leakage characteristics; typical operating torque requirements or characteristics; options to be furnished; general installation and maintenance instructions. Damper schedules shall include damper type; unit served; damper service; damper size; duct size; drive linkage location; installation arrangement (flanged or in duct) and damper operator type.

5. All fans, submit in accordance with sections 01300 and 15500, all data on the fan schedules. In addition the submittal shall include catalog data, fan data sheets with a description of the proposed fan, fan size, type, arrangement, materials of construction, weight, motor horsepower, motor type, power supply, and frame size. Provide catalog data and selections for vibration isolators, include materials of construction. For belt drive equipment; provide drive data indicating the sheave sizes, belts size, number and length. Each submittal shall include pertinent equipment dimensional data, fan performance (operating data information, and a performance curve showing the fan operating point and range. Minimum curve size shall be 8-in by 6-in. Faxed copies of curves are not acceptable. A list of accessories to be furnished shall be included on each submittal. Copies of operating and maintenance manuals shall be submitted. Significant dimensional differences between the specified equipment and the proposed equipment shall be noted on the equipment submittal. The contractor shall provide data to show the dimensionally different equipment will fit within the space and still provide suitable clearance. Where corrosion resistance is required, provide conformation of material suitability for the specified service.

6. For all air handling units, submit, in accordance with Section 01300 and 15500, the following:

    a. Unit data sheets; to include catalog data, a description of the proposed unit, size, type, arrangement, and materials of construction.

    b. For belt drive equipment, provide drive data indicating sheave sizes, belt size, number and length.

    c. Each submittal shall include pertinent equipment dimensional data, heating and cooling coil operating data. Submit, in accordance with Sections 01300 and 15500, all data and the unit schedules. The submittal shall include fan data sheets with a description of the proposed fan, fan size, type, arrangement, materials of construction, weight, motor horsepower, motor type, power supply, and frame size. Provide catalog data and selections for vibration isolators, include materials of construction. For belt drive equipment; provide drive data indicating the sheave sizes, belts size, number and length. Each submittal shall include pertinent equipment dimensional data, fan performance (operating data information, and a performance curve showing the fan operating point and range. Minimum curve size shall be 8-in by 6-in. Faxed copies of curves are not acceptable. A list of accessories to be furnished shall be included on each submittal. Copies of operating and maintenance manuals shall be submitted. Significant dimensional differences between the specified equipment and the proposed equipment shall be noted on the equipment submittal. The Contractor shall provide data to show the dimensionally different equipment will fit within the space and still provide suitable clearance. Where corrosion resistance is required, provide conformation of material suitability for the specified service.

    d. For heating sections, provide information on type of heating, air entering and leaving conditions, air pressure drop, heating media entering and leaving conditions and flow or consumption, and pressure drop. Provide size, type, arrangement, materials of construction, and operating weight.

    e. For cooling sections, provide information on type of cooling, air entering and leaving conditions, air pressure drop, cooling media entering and

leaving conditions, flow, and pressure drop. Provide size, type, arrangement, materials of construction, and operating weight.

f. For condensing sections provide information on number and type of compressors, type of refrigerant and refrigerant charge, and controls provided and operating weight. Provide electrical data for power and controls. For condensing coils, provide air entering and leaving conditions, air pressure drop, size, type, arrangement, and materials of construction.

g. List of accessories to be furnished shall be included on each submittal.

h. Provide a recommended list of spare parts to be provided.

7. Detailed equipment, ductwork and piping layout drawings; minimum scale 1/4-in = 1-ft-0-in for interior systems and equipment, dimension clear service spaces for motors and drives, filter, coils and spacer section access doors, and duct-work access panels and doors. (Site layout drawings and roof plans showing HVAC equipment and systems may be prepared and submitted at scales smaller than 1/4-in = 1-ft-0-in, subject to Engineer's prior approval.)

8. Standard shop and field installation details for transitions, elbows, takeoffs, discharge nozzles, turning vanes, access panels and doors, volume control and splitter dampers and extractors.

9. Piping and appurtenances, materials and joining methods. Pipe hanger materials and methods.

10. Ductwork materials, joining methods, reinforcing and material gauges. Where options are allowed by SMACNA, the proposed option shall be clearly defined. Indicate proposed materials and methods for ductwork and equipment hangers.

11. Prepare dimensional comparisons between proposed equipment and scheduled equipment when the proposed equipment is dimensionally larger than that scheduled. Do not propose dimensionally larger equipment from an alternate manufacturer for installation in confined areas, or when the installation of alternate equipment will result in reduction of service access below that recommended by the manufacturer.

12. Prepare layouts showing size, arrangement, and routing of field fabricated refrigerant piping for split-systems and air handling units with remote condensers. Include a letter from the AC system manufacturer indicating their approval of the proposed sizing and routing.

13. For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit.

14. All submittals shall contain a statement that Section 15500 and all other referenced Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.

15. Submit air (and water) system testing, adjusting and balancing reports for review and approval.

16. Operation and Maintenance Data

    a. Submit to the Engineer as provided in Section 01730, Operating and Maintenance Manuals. The following information shall be considered a minimum. Where applicable, provide information required for specific pieces of equipment.

        1) Personnel familiar with the operation and maintenance of the specific information shall prepare manuals.

        2) Equipment shall be identified with the Engineers Equipment Numbers and Identification as shown in the Schedules and on the Drawings.

        3) Provide information in three ring binders. All sheets shall have reinforced punches. Tabbed dividers shall separate all sections. Drawings will be bound in the manual, or contained in envelopes bound into the manual.

    b. Contents - Each volume shall contain the following minimum contents:

        1) Installation including instructions for unpacking, installing, aligning, checking and testing. Foundation data, allowable piping loads, and electrical design shall be included.

        2) Operating Instructions to provide pre-operational checks, start up and shut down, and description of all control modes. Include emergency procedures for all fault conditions and actions to be taken for all alarms. Procedures for long term storage shall be included.

        3) Maintenance shall include preventive, and corrective. Schedules for test of other functions are to be included. Provide a list of tools required to service the equipment. Trouble shooting instructions to include a trouble-shooting guide shall be included.

    c. Spare Parts List

        1) Shop Drawing Data to include performance curves, data sheets, flow diagrams, wiring diagrams, and descriptive drawings.

17. Submit the following for each insulation by System: manufacturer's product data showing conformance with this Section for all required insulation, jackets, covers, coatings, adhesives, fasteners, supports and appurtenances; complete manufacturer's instructions for installation of all required items.

18. All materials deliveries must have accompanying manufacturer's certifications attesting to satisfactory results of product testing showing conformance with this Section.

19. Provide a recommended list of spare parts to be provided.

20. **In general, corrections or comments or lack there of, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the Drawings and Specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of**

**construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.**

1.04 REFERENCE STANDARDS

A. These standards shall be considered as minimum requirements. This is a general list and not all standards listed are necessarily referenced elsewhere in this Section. Specific requirements of this Section and/or Drawings shall have precedence. In case of conflict between published requirements, the Engineer shall determine which is to be followed.

B. Abbreviation and the title of Federal, State and industry standards, technical societies, associations and institutes and other organizations which may be used are as follows:

1. Associated Air Balance Council (AABC)
2. American Conference of Governmental Industrial Hygienists (ACGIH)
3. Air Diffusion Council (ADC)
4. American Bearing Manufacturers Association (ABMA)
5. Air Movement and Control Association (AMCA)
6. American National Standards Institute (ANSI)
7. Air Conditioning and Refrigeration Institute (ARI)
8. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
9. American Society of Mechanical Engineers (ASME)
10. American Society for Testing and Materials (ASTM)
11. Factory Mutual (FM)
12. Institute of Electrical and Electronic Engineers (IEEE)
13. National Institute of Standards and Technology (NIST)
14. National Environmental Balancing Bureau (NEBB)
15. National Electrical Code (NEC)
16. National Electrical Manufacturers Association (NEMA)
17. National Fire Protection Association (NFPA)
18. Occupational Safety and Health Administration (OSHA)
19. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
20. Underwriters Laboratories (UL)

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Provide single source supplier/installer responsibility for the following systems or services:

1. ATC Equipment

2. Thermal Insulation

3. Testing and Balancing

B. Provide single source supplier/installer responsibility for systems where specified in other related Sections.

C. Services of Manufacturer's Representative

1. Provide services of a manufacturer's service engineer or test engineer, as required in Section 01640, specifically trained on type of equipment supplied or service provided. Submit qualifications of service engineer for approval. Man-day 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.

D. Automatic Temperature Controls - Operation and maintenance instructions.

E. Testing and Balancing - Spot check HVAC system flows and system inspection during the first year of operation at Owner's request exclusive of repair, malfunction, or other trouble-shooting service calls.

F. The insulation materials to be furnished under this section shall be essentially the standard products of manufactures regularly engaged in the manufacture of insulation systems.

G. Several manufacturers are indicated as acceptable for each type of insulation in these specifications. The insulation sub-contractor shall be responsible for determining that all insulation supplied for the project is suitable for installation in the spaces indicated. The insulation sub-contractor shall also insure that all materials used are compatible and in compliance with applicable codes and standards.

H. All equipment of a given type included in this section shall be furnished by or through a single manufacturer or as specified on the schedules

I. Inspection by the Engineer’s representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents.

J. The Owner and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.

K. An authorized representative of the manufacturer shall perform the initial startup of the equipment. The Owner and Engineer shall witness startup. The use of local sales representatives to perform this work is not acceptable, unless the manufacturer provides documented evidence that the sales representative has been specifically trained for this work.

L. All rotating parts of equipment shall be statically and dynamically balanced at the factory.

1.06 DELIVERY, STORAGE AND HANDLING

A. A. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery.

B. Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner by the manufacturer.

C. All materials shall be suitably packed for shipment and long term storage. Each package shall labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.

D. All equipment shipped that is exposed such as on a flat bed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.

E. Instruction for the servicing and startup of equipment in long term or prolonged storage shall accompany each item.

F. All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.07 COORDINATION

A. The Drawings indicate the extent and general arrangement of the systems. If any departures from the drawings or specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted as soon as practical for review. No such departures shall be made without the prior written concurrence of the Engineer.

B. The Contractor shall coordinate the location and placement of all concrete inserts and welding attachments with the structural engineer.

C. The Contractor shall assume full responsibility for coordination of the HVAC systems, including; scheduling, and verification that all structures, ducts, piping and the mounting of equipment are compatible.

1.08 ENGINEERING SERVICES

A. When engineering services are specified to be provided by the Contractor, the Contractor shall retain a licensed professional engineer to perform the services. The engineer shall be licensed at the time the work is done and in the State in which the project is located. If the State issues discipline specific licenses, the engineer shall be licensed in the applicable discipline. In addition, the engineer shall be experienced in the type of work being provided.

B. All work is to be done according to the applicable regulations for professional engineers, to include signing, sealing and dating documents. When submittals are required by a professional engineer, in addition to state required signing and

sealing, a copy of the current wallet card or wall certificate indicating the date of expiration shall be included with the submittal.

1.09 MAINTENANCE

A. Maintain and service all equipment and systems until the particular equipment or the system has been accepted by the Owner.

B. Maintenance shall include compliance with the manufacturers operating and maintenance instructions as well as periodic [checking and cleaning of piping system strainers and] cleaning or replacement of air handling system filters.

C. Compile records of all maintenance and lubrication work performed on Owner or Contractor furnished equipment. Maintain records at the construction or installation site and make available at all times for review by the Owner or Engineer. At the request of the Owner or Engineer submit copies of these records to the Owner for information and/or review.

D. Provide all special tools required for normal maintenance. Tools shall be packaged in a steel case, clearly and indelibly marked on the exterior to indicate equipment for which tools are intended.

E. Provide to the Owner a list of all spare and replacement parts with individual prices and location where they are available. Prices shall remain in effect for a period of not less than 1 year after start-up and final acceptance.

1.10 DEFINITIONS

A. Particular terminology used under this Section is defined as follows:

1. Traffic Level and Personnel Level - Areas, including process areas, equipment rooms, boiler rooms and other areas where insulation may be damaged by normal activity and local personnel traffic. Area extends to 8-ft above floor, walkways, platforms and stairs, and horizontally 3-ft beyond the edge of walkways, platforms, and stairs.

2. Exposed Piping and Ductwork - Piping and ductwork visible from the floor level and includes all piping and ductwork in equipment rooms, boiler rooms, etc.

3. Concealed Piping and Ductwork - Piping and ductwork not visible from the floor level and includes piping and ductwork above hung ceilings and in shaftways.

4. Supply Air Ductwork - Ductwork carrying air from a fan or air handling unit to the space or spaces to which it will be introduced. This air may have been heated or cooled or in the case of ventilation system the air would be neither heated nor cooled. Supply air ductwork extends from the fan or air handling unit to the registers, grills or diffusers at the end of the ductwork.

5. Return Air Ductwork - Ductwork carrying air from the space it was supplied to back to a fan or air handling unit. Return air ductwork extends from the registers or grills at the end of the ductwork to the air handling unit or connection with an outdoor air intake duct.

6. Exhaust Air Ductwork - Ductwork carrying air from a space to a fan and then to be discharged to the outdoors. Exhaust air ductwork extends from the registers of grills at the end of the ductwork to the fan. From the fan exhaust ductwork

extends to the discharge point, exhaust air damper, or exhaust air plenum, whichever comes first.

7. Relief Air Ductwork - Ductwork carrying air from a space without a fan to be discharged to the outdoors. Relief air ductwork extends from the registers or grills at the end of the ductwork, to the discharge point, relief air damper, or relief air plenum, whichever comes first.

8. Outdoor Air Ductwork - Ductwork carrying untreated air from the outside to a fan or air handling unit. Outdoor air ductwork starts at the intake point, outdoor air damper, or outdoor air plenum, whichever comes last. The outdoor air ductwork extends to the fan, air handling unit, or connection with a return air duct, whichever comes first.

9. Mixed Air Ductwork - Ductwork that can carry either return air or outdoor air or a combination of both. Mixed air ductwork starts at the connection of the return air and outdoor air ducts and extends to the fan or air handling unit.

10. Outdoor Air Plenum - A plenum that extends from the opening in the skin of the structure to the outdoor air duct. If the outdoor air damper is directly at the intake or there is no outdoor air damper, the plenum will extend to the first size reduction. If the outdoor air damper is not at the intake, the plenum will extend to the outdoor air damper.

11. Exhaust Air Plenum - A plenum that extends from the opening in the skin of the structure to the exhaust air duct. If the exhaust air damper is directly at the discharge or there is no exhaust air damper, the plenum will extend from the last size reduction. If the exhaust air damper is not at the discharge, the plenum will extend to the exhaust air damper.

12. Relief Air Plenum - A plenum that extends from the opening in the skin of the structure to the relief air duct. If the relief air damper is directly at the discharge or there is no relief air damper, the plenum will extend from the last size reduction. If the relief air damper is not at the discharge, the plenum will extend to the relief air damper.

13. Ventilated Spaces - Areas supplied with outdoor air on a continuous or intermittent basis. The outdoor air may be heated and/or cooled or untreated.

14. Heated Spaces - Areas where heat is supplied to maintain a minimum temperature during the heating season.

15. Unheated Spaces - Areas where heat is not applied and there is no minimum temperature during the heating season.

16. Conditioned Spaces - Areas that are provided with heating and mechanical cooling.

17. Non-Conditioned Spaces - Areas that are not provided with mechanical cooling.

18. Indoor Piping - Piping within a building that is not exposed to the weather.

19. Outdoor Piping - Piping that is not within a building and which is exposed to the weather.

20. Indoor Ductwork - Ductwork within a building that is not exposed to the weather.

21. Outdoor Ductwork - Ductwork that is not within a building and is exposed to the weather.

22. Hot Ductwork - Ductwork carrying air with a temperature above the surrounding space temperature.

23. Cold Ductwork - Ductwork carrying air with a temperature below the surrounding space temperature.

24. Hot/Cold Ductwork - Ductwork carrying air with a temperature that can be either above or below the surrounding space temperature.

25. Thermal Conductivity - The rate of heat flow through unit area of a homogeneous substance under the influence of unit temperature gradient in the direction perpendicular to the area. Units-BTU per (hour)(sq ft)(degrees F temp. difference)(per inch thickness).

26. Flues/Stacks/Breeching - Ductwork carrying products of combustion to atmosphere.

## PART 2: PRODUCTS

### 2.01 ELECTRICAL EQUIPMENT

A. Electric Motors

1. Electric motors in NEMA frame sizes shall conform to the requirements in Section 01171, unless otherwise specified herein.

2. The motor manufacturer shall confirm that motors used to power equipment are provided with bearings that will provide a bearing life equal to the driven equipment or better. Confirmation shall be included with shop drawing submittal.

3. Motors will be selected to be non-overloading over the entire operating range of the equipment. A safety factor of 25 percent will be added to all motors up to and including 50 horsepower. A safety factor of 15 percent will be added to all motors over 50 horsepower. Motors indicated on the schedules are to be considered a minimum. This sizing is not to limit compliance with the above requirements

B. Electrical Equipment

1. Electrical equipment which is furnished under this Section shall meet the requirements specified in Division 16:

   a. Disconnect switches, motor starters and combination motor starters (starters with disconnecting means and short circuit protection) shall be as specified in Section 16155.

   b. Cord-connected controls for hazardous areas shall be provided with intrinsically safe relays, which shall be as specified in Section 16155.

   c. Raceways, boxes, fittings and supports shall be as specified in Section 16110.

   d. Wires and cables shall be as specified in Section 16120.

C. Electrical enclosures and panels to include automatic temperature control panels and components shall be suitable for the environment and electrical classification for the space they are located in. The type of enclosure for the various spaces shall be as specified in Division 16. Refer to the electrical drawings for the space classifications.

D. Where noted in the HVAC equipment schedules, or when shown on the Drawings, provide fan speed control switches and integral unit thermostats.

2.02 EQUIPMENT VIBRATION ISOLATOR AND MOUNTINGS

A. General

1. Unless otherwise specified in this Division all machinery or vibrating mechanical equipment shall be isolated from the building structure by vibration isolators with a minimum deflection as specified. Operating equipment that can transmit objectionable vibration and noise must be installed with special types of vibration isolators such as flexible connectors to ductwork, piping and wiring. In more critical areas and under particular conditions, additional vibration isolators shall be installed as specified in other related Sections in this Division, or in specific equipment schedules.

2. All equipment shall be provided with attachment points for floor or suspended mounting that will safety transmit all loads including seismic to the supports.

3. The vibration isolator manufacturer shall be responsible for the proper selection of vibration isolators suitable for the particular application. Selection of the vibration isolator shall include the following factors.

   a. Equipment Weight

   b. Equipment operating frequencies

   c. Type of building support structure

   d. Seismic forces as required by the applicable building codes to include shear, tension and compression due to the code specified loads.

4. All floor mounted vibration isolators shall be bolted to the floor or framing on which they rest. Bolts shall be arranged to prevent transmission of vibration through the bolts.

5. All isolation devices for a single piece of equipment shall be selected for a uniform static deflection according to distribution of weight in the equipment.

6. All pieces of equipment that have a variation in weight during operation or maintenance such as, but not limited to, cooling towers and hoppers, shall have built-in vertical limit restraints to limit motion to a maximum of 1/4-in.

7. After installation of equipment, isolators shall be adjusted for proper loading and distribution of weight.

B. Types - The following types of vibration isolators may be used.

1. Isolation Types for Floor Mounting

   a. Single elastomer-in-shear isolators, molded mound shaped element designed for 1/4-in deflection under the imposed static load. Double

elastomer-in-shear isolators shall be two such elements assembled in series or a molded element designed to provide 1/2-in deflection under the imposed static load. Elastomer-in-shear isolators shall be properly housed to prevent bulging and shall be provided with adequate facilities for bolting to equipment and floor slab.

b. Spring isolators shall be free standing and laterally stable and shall be equipped with acoustical-friction pads, leveling bolts and bolt holes for anchoring to floor slab. Springs shall have a minimum ratio of outside diameter to operating spring height of 0.8 and an additional travel to solid equal to 50 percent of the specified deflection. Where housed springs are specified or required, provide units with telescoping cast iron or steel housing, containing one or more springs, complete with resilient alignment insert and a minimum of 1/4-in thick rubber or neoprene sound deadening pad bonded to the base of housing.

c. Heavy load pads shall be 1-1/4-in thick and shall consist of a high load capacity elastomer pad and sandwiched between two 1/8-in thick steel load distribution plates capable of supporting loads up to 250 psi. For large pad area, steel plates of suitable thickness shall be provided to distribute the load.

d. Light load pads shall be neoprene corrugated single, laminated double or laminated with 1/2-in thick fine granular composition cork sandwiched between two 1/4-in layers of corrugated, oil resistant neoprene. Pads shall be capable of loading to 50 psi.

2. Isolation for Suspension

a. Isolation hangers for suspension of equipment and piping shall have a single element of elastomer for 1/4-in deflection, a double or a single molded element of 1/2-in deflection, a single spring element with an elastomer grommet for up to 3/4-in deflection and a combination of an elastomer and spring elements in series for 1-in deflection and up contained within a structural rigid one piece steel hanger box. Springs shall have a minimum ratio of outside diameter to operating spring height of 0.8 and an additional travel to solid equal to 50 percent of the specified deflection.

b. The neoprene element shall have a bushing to prevent hanger rod contact with the housing box. The lower rod shall be free to swing in a 30 degree arc without touching the spring or the housing.

3. Rails and Bases - Rails and bases shall be of the following types based on the equipment and deflection required.

a. Rubber in shear type shall be steel rails running the full length of the supported equipment and extending under any overhang to counteract cantilever effects. The rails shall incorporate single or double deflection elastomer-in-shear fastened in place and a continuous steel floor bearing plate running the full length of each rail. The rails shall be drilled and tapped to accept the supported equipment and shall serve as a template.

b. Steel spring type shall be steel rails running the full length of the supported equipment and extending under any overhang to counteract cantilever effects. The rails shall consist of structural members supported by indi-

vidual free standing springs. The rails shall be drilled to accept the supported equipment and shall serve as a template.

c. Fans and their driving motors shall be mounted on structural steel channel members forming a rigid base. A common member parallel to the V-belt drive, shall run the full length of the fan and motor and shall be of sufficient rigidity to resist the bending stress of belt pull. The structural steel base shall incorporate single or double deflection elastomer-in-shear elements or free standing springs located for proper weight distribution. The base shall be drilled and tapped to accept the fan and motor and shall serve as a template. Integral motor slide rails shall be provided and welded in place.

d. Unless specifically noted in other sections of the specification or on specific equipment schedules, all equipment will be provided with vibration isolation as defined by the following table:

| Type of Equipment | Vibration Isolation Type | Minimum Deflection for Slab on Grade Inches | Minimum Deflection for up to 20-ft floor span inches | Minimum Deflection for 20-ft to 30-ft Floor Span Inches | Minimum Deflection for 30-ft to 40-ft Floor Span Inches |
|---|---|---|---|---|---|
| **Axial & Cabinet Fans** | | | | | |
| 22-in dia. and less | Rubber | 0.25 | -- | -- | -- |
| | Spring | -- | 0.75 | 0.75 | 0.75 |
| Over 22-in dia. Less than 2-in S.P. | Spring | 0.75 | 1.75 | 1.75 | 1.75 |
| Over 22-in dia.Over 2-in S.P. | Spring | 0.75 | 1.75 | 1.75 | 2.50 |
| **Centrifugal Fans** | | | | | |
| 22-in dia. and less | Rubber | 0.25 | -- | -- | -- |
| | Spring | -- | 0.75 | 0.75 | 1.75 |
| 24-in dia. and greater | | | | | |
| 40 HP and less | Spring | 0.75 | 0.75 | 0.75 | 1.75 |
| 50 HP and greater | Spring | 1.00 | 1.75 | 1.75 | 2.50 |
| **Condensing Units** | Rubber | 0.25 | -- | -- | -- |
| | Spring | -- | 0.75 | 1.75 | 1.75 |
| **Air Handling Units** | | | | | |
| 10 HP and less | Spring | 0.75 | 0.75 | 0.75 | 0.75 |
| | | | | | |
| 4-in S.P. and less | Spring | 0.75 | 1.75 | 1.75 | 1.75 |
| 4-in. S.P. and greater | Spring | 0.75 | 1.75 | 1.75 | 2.50 |
| **Duct Mounted Fans** | | | | | |
| 600 CFM and less | Spring | 0.50 | 0.50 | 0.50 | 0.50 |
| 600 CFM and greater | Spring | 0.75 | 0.75 | 0.75 | 0.75 |

C. Rigidly Mounted Equipment

1. When equipment doesn't require vibration isolation, it shall be firmly attached to the building structure. Bolts and support structure shall include allowances for

seismic loads as required by the applicable building codes to include shear and moment loads.

D. For vertical pipe runs, where the pipe has to be guided, a vibration mount shall be used. The mount shall consist of elastomer isolators.

E. Isolators shall be Korfund, Mason, Peabody Noise Control Inc., Vibration Eliminator Co., Vibration Mountings & Controls Inc.

2.03 FLAME AND SMOKE RATINGS

A. All materials, including adhesives, surface coatings, sealers, assemblies of several materials, insulation, jacketing, finish, etc, shall have flame spread ratings not over 25 (fire resistive), and smoke development ratings not over 50 and fuel contributed rating not over 50, as established by tests conducted in accordance with the Federal Standard 00136B, National Bureau of Standards Radiant Energy Fire Test and the National Fire Code of the NFPA.

B. These requirements apply to all circumstances whether the materials are field applied or applied by a manufacturer in his/her shop, or elsewhere, prior to delivery to the project.

2.04 V-BELT DRIVES

A. V-belt drives shall consist of the driver and driven sheaves and one or multiple matched V-belts. Select V-belt drives with belt horsepower ratings equal to or greater than 1.5 times the driving motor nameplate horsepower. Provide sheaves with steel, cast iron, or malleable iron split taper bushings and keyways on driven shafts of 3/4-in and larger diameter.

2.05 NOISE CRITERIA

A. The selection of pumps, fans, air handling equipment, air conditioners, heating ventilating and air conditioning machinery and mechanical equipment and the installation of the system components such as duct work and piping shall be such as not to exceed to maximum permissible noise for non-equipment spaces as defined in Table 2, Design Guidelines for HVAC System Noise in Unoccupied Spaces contained in the 2019 edition of the ASHRAE Application Handbook. Under no conditions shall the noise created by equipment exceed the levels of permissible noise exposures of occupational areas as established by the OSHA and other Federal, State and local safety and health standards, codes and ordinances.

B. Bearings for all equipment in the schedule below shall have heavy-duty grease lubricated ball or roller bearings. Bearings shall have ample thrust provision to prevent end play during the normal life of the bearing. Unless specifically noted otherwise, all fans and pumps shall have bearings for both the equipment and motors with the following ABMA L-10 life.

1. Fans over 3000 cfm - 40,000 hours.

2. Pumps over 500 cfm - 40,000 hours.

3. Continuous duty fans or pumps with motors over 25 horse power 100,000 hours.

4. All fans or pumps with motors over 50 horse power 100,000 hours.

C. For systems with bearings requiring L-10 lives of 100,000 hours or greater, the equipment supplier shall provide calculations for both the equipment bearings and the motor bearings to confirm the bearing selections. For belt drives, the calculations shall include the effect of the sheave size, number of belts, the sheave location on the shaft, and the location of the motor to the driven sheave.

2.06 BEARINGS

A. General - Furnish equipment bearings suitable for the intended equipment service. Furnish bearings designed to carry both thrust and radial loads for equipment designed for all angle operation.

B. Provide extended lube lines with pressure relief equipped grease fittings for all bearings which are not readily accessible from outside the equipment.

C. Belt driven fans, including air handling unit fans shall be equipped with self aligning single row ball bearings, double row tapered or spherical roller bearings.

1. Furnish bearings to give 100,000 average life hours (ABMA-L50) for the following services:

a. Fan impellers greater than 10-in diameter.

b. Intermittent duty.

2. Furnish 200,000 average life hours bearings for the following services:

a. Continuous duty applications.

b. Class III and Class IV construction.

3. Provide seals for bearings installed in airstreams, exposed outdoors, and for applications in corrosive or dusty atmosphere.

D. Provide bearings suitable for high temperature service where heat fan construction is required.

2.07 HANGERS, SUPPORTS AND ANCHORS

A. General

1. Furnish supports, hangers and other devices necessary to support firmly and substantially the piping, equipment and ductwork described in this Section. Piping and duct support systems shall include restraints as required by the applicable building codes to withstand seismic loading. Design shall be provided by a professional engineer hired by the Contractor as specified in other sections of the specifications.

2. All equipment shall be provided with lugs or brackets to allow the equipment to be firmly fastened to the structure. The lugs and brackets shall be sized to withstand the expected seismic loads for the area and type of application. Location of the attachments shall be based on the equipment being hung or base mounted as shown on the Drawings and the schedules.

3. Furnish and install all metalwork in accordance with Division 5 requirements.

4. Provide stainless steel hanger rods, hangers, supplementary steel, anchors and guides in areas classified as corrosive, wet, and in outdoor exposed applications.

B. Where C-clamp type hangers are used, furnish with a retainer strap.

C. Hangers shall not be supported from roof decking or bulb tees. Where required, provide supplemental steel to span between the building structure

D. Piping

1. All piping supported at a maximum of 10-ft-0-in intervals. Hangers or rings, sized to fit outside the insulation.

2. All piping 2-in diameter and smaller supported by pipe rings or bands with one 3/8-in adjustable steel rod hanger and one concrete insert.

3. Anchor piping mains where indicated or wherever necessary to limit pipe expansion and to prevent vibration.

E. Ductwork

1. Rectangular, Round and Flat-Oval Ductwork - Spacing and size of hangers shall be as called for in the SMACNA standards, except as detailed below:

a. Rectangular ductwork 48-in wide and larger shall be supported by adjustable threaded rod.

b. Round ductwork 37-in and larger shall be supported by two adjustable threaded rods.

c. The following methods of hanger attachment to the building structure are NOT allowed. The numbers and letters refer to hanger methods shown in Figure 4-1, 4-2 and 4-3 of the latest edition of the HVAC Duct Construction Standards Metal and Flexible as published by SMACNA.

d. "T" wrap around straps of open web joist.

e. "W" bent over band on open web joist.

f. "14" Friction clamps

g. "17" Bent wire in metal deck.

F. All hanger and fastener material shall be of same finish as ductwork which they serve, e.g., galvanized, aluminum, black steel, etc, except for PVC ductwork which shall be aluminum. When a material other than the duct construction material must be used, the material used must be as corrosion resistant or greater than the duct material.

G. Perforated band iron or wire for supporting ducts shall not be permitted.

H. Support flexible duct by band hangers, 1-in wide minimum, attached so as not to crush the ductwork. The use of wire to hang flexible ductwork shall not be permitted.

I. Duct supports at flexible connections shall be adjustable.

J. Design of hangers shall include the effect of all loads applied to the duct as well as the load of the duct. These loads include, but are not limited to wind, snow and internal dirt or liquid buildup.

2.08 PAINTING AND COATINGS

A. Unless otherwise specified, all machinery and factory finished equipment such as pumps, fans, air handling units, air conditioning units, and other items of manufacture shall be hot dipped galvanized or will have a factory applied finish, color as standard with the manufacturer. Components fabricated from stainless steel do not require a coating finish unless otherwise specified. All tanks, supporting steel, hangers, rods and all other uncoated or non galvanized steel other than standard piping and fittings shall have a shop coat consisting of a suitable primer and finish coat. If not factory applied, the prime coat shall be as specified in Division 9. All items not factory or shop primed prior to installation shall be suitably cleaned of rust and mill scale by wire brushing, sanding, or other means and prime painted, immediately after installation.

B. The Contractor shall be responsible for the repair of all defects, blemishes, holidays and the like apparent in manufactures coatings and shall ensure that the materials used for such repair shall match and be compatible with the manufacturer's standard color, coatings and practices. Surfaces to be repaired or recoated are to be prepared as recommended by the paint or coating supplier. Care shall be taken not to paint over nameplates.

C. Furnish touch up paint for the various types of equipment furnished and deliver unopened paint to the Owner at completion of the project. The amount of touch-up paint supplied shall be sufficient to cover 15 percent of the applicable painted surfaces or one pint, whichever is greater.

D. Where specified, or called for on the following schedule, special corrosion resistant/ protective coatings shall be provided. Whenever a protective coating is specified, the equipment shall be coated both inside and out. Whenever necessary to provide full coverage of the equipment, the equipment shall be completely disassembled to allow proper preparation and coating application. Any component that would block the coating process shall be removed. Equipment provided with gaskets or liners shall be coated before the application of the gasketing or liner. The equipment Vendor shall test rotating equipment after coating to confirm dynamic balance. If work needs to be done to correct the equipment balance, the integrity of the coating must be corrected after such work.

E. Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self tapping screws or other fastening methods that will damage the coating are not acceptable.

F. All items to be provided with a protective coating shall have the following data on the coating included with the unit submittal. Submittal shall include vendor data sheets on the specific coating being used, corrosion resistance data sheets, detailed application data sheets to include surface preparation procedures. For baked coatings submit a letter from the coating manufacturer, that the company doing the actual coating operation is an approved coating company. When an equipment

supplier provides the coating, the information shall be supplied by the coating manufacturers.

G. Coatings shall be of the following types:

1. MANUFACTURER STANDARD COATINGS

a. Coating material shall be manufacturer's standard as specified in the schedule below. Surfaces shall be prepared, primed and coated as required be the coating supplier. Heat curing shall be provided where required by the coating supplier.

2. BAKED PHENOLIC (for heat transfer coils, dipped) TYPE 1

a. Coating Material Heresite P-413C baking phenolic with a plastizer or approved equal. The surface shall be degreased and etched or phosphatizing by immersion. The coating shall be applied by immersion, with a baking following each immersion. After the final immersion, the coating shall be completely cured with a baking at 400 degrees F. The coating shall provide a final dry film thickness of approximately 2 mils.

3. BAKED PHENOLIC (equipment) TYPE 2A and TYPE 2B

a. Coating Material Heresite baked phenolic coating. The surface shall be prepared by degreasing with an appropriate solvent. Steel surfaces for emersion shall be sand blasted in accordance with NACE No.1 or SSPC-SP5. Steel surfaces for non-emersion shall be sand blasted in accordance with NACE No. 3 or SSPC-SP6. Surface profile shall be 20 to 25 percent of dry film thickness in accordance with the supplier's recommendations. Thinner where required shall be of the same manufacturer as the coating. Coating shall be applied by spraying in multiple passes. The piece shall be baked in accordance to the manufacture's time and temperature schedules with the final baking at 400 degrees F.

b. Type 2A - Heresite P-403 baked phenolic coatings. Dry film thickness shall be 5 to 7 mils applied in 3 to 4 coats.

c. Type 2B - Herresite P-413 baked pheniloc coating. If surface cannot be adequately cleaned use Heresite P-700 primer in accordance with the manufacturer's recommendations. Dry film thickness shall be 4 to 6 mils applied in 4 to 5 coats.

4. AIR DRIED PHENOLIC (equipment) TYPE 3

a. Coating Material Heresite VR-507 air dried phenolic coating. The surface shall be prepared by degreasing with an appropriate solvent. Steel surfaces for non-emersion shall be sand blasted in accordance with NACE No. 3 or SSPC-SP6. Surface profile shall be 20 to 25 percent of dry film thickness. If blasting is not possible, the surface shall be primed with Heresite P-750 in accordance with the supplier's recommendations. Dry film thickness shall be 0.5 to 0.75 mills. Thinner where required shall be of the same manufacturer as the coating. Coating shall be applied by spraying in multiple passes. The piece shall be dried in accordance to the manufactures time schedule. The equipment shall be given a minimum of three coats resulting in a dry film thickness of 4 to 6mils. All equipment coated with VR-500 shall be given a topcoat of Heresite UC-5500. The UC-

5500 series shall be applied by spraying and shall have a dry film thickness of 4 to 5 mils.

5. Any holidays, runs, sags, blisters, or inclusions in the coating are unacceptable and will be corrected. With the approval of the engineer, small areas no more than 4-in by 4-in may be corrected in the field. Larger faults shall be returned to the coater to be repaired. The faulty material shall be removed by sanding and in the case of blisters, the edges feathered. The material used for recoating shall be manufactured by the same manufacturer as the original coating and shall be suitable for field repairs. The touch up material shall have the same corrosion resistance as the original coating, and if the original coating required an ultraviolet protection, the same protection will be provided as part of the repair. The final mil thickness of the repaired coating shall be equal to the originally specified thickness. Where baked coatings have been damaged, the repair shall be made with heat applied to the repaired surface to cure the coating. After curing a solvent test as recommended by the manufacturer shall be used to confirm that the coating is cured.

6. The coating manufacturer shall supply direct to the engineer, a set of coupons showing the final appearance of the cured coatings. Any coating that does not match the supplied coupons will be rejected.

COATING SCHEDULE

| EQUIPMENT IDENTIFICATION | LOCATION | CONTAMINANTS | COATING TYPE |
|---|---|---|---|

2.09 TESTING, ADJUSTING AND BALANCING

A. Testing, balancing and operation of the systems shall be performed by competent and experienced personnel, having formerly done similar work and whose qualifications and performance shall be subject to the approval of the Engineer. Test and balance air and water system and submit testing and balancing reports to the Engineer for review and approval. Re-balance when required by the Engineer, incorporating all changes and certify the systems have been tested and balanced to meet specified requirements.

B. When the work includes modifications to existing systems, the entire system including existing portions shall be rebalanced. Where capacities of existing components are not shown as changed, the original capacities shall be used for balancing.

C. To perform required professional services, the balancing agency shall have a minimum of two test-and-balance engineers certified by the AABC or NEBB. This certified test-and-balance engineer shall be responsible for supervision and certification for the total work specified herein.

D. The balancing agency shall furnish all necessary calibrated instrumentation to adequately perform the specified services. An inventory of all instruments and devices in possession of the balancing agency may be required by the Engineer to determine the balancing agency's performance capability.

E. Forms: Furnish test report data on 8-1/2-in by 11-in bond AABC or NEBB form paper in accordance with Section 01300. Submit format for recording data and receive approval prior to use.

F. The report shall contain the following general data in a format selected by the balancing agency:

1. Project number
2. Contract number
3. Project title
4. Project location
5. Project architect/engineer (primary)
6. Project mechanical engineer
7. Test and balance agency
8. Test and balance engineer
9. General contractor
10. Mechanical subcontractor
11. Dates tests were performed
12. Certification

G. At a minimum, the report shall include:

1. Preface. A general discussion of the systems, any abnormalities and problems encountered.
2. Instrumentation list. The list of instruments including type, model, manufacturer, serial number and calibration dates.
3. System Identification. In each report, the VAV boxes, zones, supply, return and exhaust openings and traverse points shall be numbered and/or lettered to correspond to the numbers and letters used on the report data sheets and on the report diagrams.

H. Prepare 11-in by 17-in single line diagrams or 12-in by 18-in half size drawings showing all duct systems indicating all terminal air outlets including diffusers, grilles and registers, perforated plates, nozzles and other types of air supply, exhaust or return outlets. The minimum scale for diagrams showing the measurement points shall be 1/8-in=1-ft-0-in in the final form as submitted. The use of faxed copies of diagrams is not acceptable. Location of test points shown on the diagrams shall be clear and easy to locate on the diagram. The identification mark of the test points shall be the same as is shown on the test report showing the test data. The identification for test points shall include indication of the units served, and shall not have a duplicate in the project. All supply outlets shall be adjusted so that there are no drafts. Grille and register readings may be made by a vane anemometer, but diffuser readings shall be made by a flow hood or a velometer, using the tip

recommended by the diffuser manufacturer. Each test sheet shall include the following data:

1. Job name and address.
2. Name of HVAC Contractor.
3. Name of balancing organization.
4. Instruments used to perform the test.
5. Name of test technician or test engineer.
6. Fan system and/or zone number.
7. Room number or area name.
8. Size of outlet.
9. Type outlet.
10. Manufacturer of outlet.
11. The cfm at each outlet on system and corresponding cfm at each outlet as noted on the plans.
12. Percent deviation of the measured flow versus the design flow.
13. Indication of the branch and terminal that are the open/low that are the basis for balancing the remainder of the system

2.10 INSULATION

A. Provide insulation adhesives, coatings and vapor barrier materials, which are compatible and recommended, for use by the insulation manufacturer. Submit a certified statement from the insulation manufacturer attesting to their approval of the adhesives, coatings, and vapor barrier materials. The following adhesives and coatings, as manufactured by Foster Div.; H.B. Fuller Co. or Childers Products Co. are representative of approved products that meet the above requirements. (Other manufacturers who demonstrate to the Engineer that their products are equivalent are acceptable.)

1. Lagging adhesive: 30-36, CP50, AMV-1.
2. Vapor barrier coating: 30-35, CP30.
3. Vaporseal adhesive: 85-75, CP82.
4. Duct adhesive: 85-20, CP82.
5. Sealing compound adhesive: 30-45, CP70.
6. Weatherproof mastic: 35-01, CP10-1.

B. Insulation for cold piping with vapor barrier shall include but not be limited to the following:

1. Condensate Drains (Air Conditioners)

a. Insulation Material - Molded rigid fiberglass sectional pipe insulation rated to 500 degrees F. The insulation shall have a minimum density of 3.5 lbs/cu ft and a maximum "K" factor of 0.24 at 75 degrees F mean temperature.

b. Jacket

1) Indoor Piping - Jacket shall be kraft paper bonded to aluminum foil reinforced with fiberglass yarn and self sealing lap with maximum permeability of 0.02 perms.

2) Outdoor Piping - Jacket shall be kraft paper bonded to aluminum foil reinforced with fiberglass yarn and self sealing lap with a maximum permeability of 0.02 perms with field applied 0.016-in thick aluminum jacket.

c. Fitting Covers

1) Indoor Piping - Premolded one piece PVC covers.

2) Outdoor Piping - Preformed aluminum covers.

C. Insulation for Cold Piping-Close Cell Foam Type (Type I-12)

1. Closed cell foam type insulation applications include, but are not limited to:

a. Refrigerant Piping

b. Condensate Drain Piping

2. Insulation Material - Preformed flexible closed cell foam sheet, minimum density 5.5 lbs/cu ft, maximum "K" factor of 0.27 at 75 degrees F mean temperature.

3. Acceptable manufacturers shall be Armstrong Cork; Manville Corp. or equal.

D. Blanket type duct insulation shall include but not be limited to the following:

1. Concealed round and rectangular hot, cold and hot/cold ductwork.

2. Exposed round hot ductwork.

3. Exposed round cold and hot/cold ductwork.

a. Insulation Material - Fibrous glass insulation, minimum density 1 lb/cu ft and a maximum "K" factor of 0.29 at 75 degrees F mean temperature.

b. Facing - Factory applied vapor barrier 0.10 perm consisting of glass fiber scrim reinforced laminated facing of 2 mil aluminum foil and kraft paper.

E. Fiberglass board type insulation shall include but not be limited to the following:

1. Exposed rectangular hot, cold and hot/cold ductwork.

a. Insulation Material - Fibrous glass insulation, minimum density 3 lbs/cu ft and a maximum "K" factor of 0.24 at 75 degrees F mean temperature.

b. Facing - Factory applied vapor barrier 0.02 perm, consisting of glass fiber scrim reinforced laminated facing of 2 mil aluminum foil and kraft paper.

F. Acceptable manufacturers shall be Armstrong Cork; Certain-Teed; Owens Corning; Manville.

## 2.11 PIPE AND FITTINGS

A. Condensate Drains

1. Pipe - Copper tube ANSI H23.1 Type K or ANSI H23.6 Type DWV hard drawn. Fittings - Soldered cast brass or wrought copper drainage fittings ANSI B16.29.

2. Solder - 95 percent tin and 5 percent antimony per ASTM B32 Alloy 95TA.

B. Refrigerant Piping

1. Pipe - Type L hard drawn copper, precleaned, inert gas filled, and capped. Fittings - Soldered wrought copper.

2. Solder - Hard silver solder with a minimum melting point of 1,300 degrees F. Fit up and solder joints while using an inert gas purge.

## 2.12 PACKAGED HEATERS

A. Unit Heaters

1. Unit heaters shall be substantially constructed, self-contained factory-assembled unit consisting of heating element, fan, motor, housing, outlet diffuser or vanes. They shall be the suspended or wall-mounted type arranged for horizontal or vertical air flow, as shown on the Drawings and Schedules. Casings shall be painted with a primer and finished with baked-on enamel at the factory. Heavily brace and stiffen all parts to prevent vibration and hold all working parts rigidly in line. Casing sides shall be readily removable for access to interior parts. Casings of suspended-type units shall be designed for direct attachment of the hangers. Provide adjustable, horizontal and vertical vanes, nozzles or diffusers, arranged to give uniform air distribution without objectionable drafts for each heater. Furnish hanger brackets and other accessories as scheduled.

2. Heaters designated on the schedules as being corrosion resistant shall be constructed with Monel fintube elements; have all fan, casing and sheet metal parts epoxy coated; have epoxy painted totally enclosed permanently lubricated ball bearing motors.

B. Cabinet Heaters

1. Units shall consist of chassis, heating element, fan, housing, motor and insulation. Chassis shall be galvanized steel with all edges flanged. Insulation shall be faced, heavy-density glass fiber. Units shall have removable front panels. All cabinets shall be cleaned, primed, for final painting in the field under another related Section.

2. Where schedules indicate filters, they shall be fiberglass throw away type. Vertical units shall have front panel removable. Provide access door for coil and top discharge grille with return air from toe space.

3. Electric wall heaters shall be designed for recessed, semi-recessed of surface mounting as indicated in the schedules.

4. Heating element shall be of the type specified in the schedules.

5. A fan delay switch shall be provided to delay operation of the fan until the heating element reaches a preset temperature.

6. The fan shall be balanced, and the fan and motor assembly shall be mounted for vibration-free operation. The fan motor shall be totally enclosed and self-lubricated. The unit shall be a non-radio interfering type.

7. A hydraulic action unit mounted thermostat shall be provided for positive temperature control when a two-button switch is in the on position.

8. A DPST manual ON/OFF switch shall be provided which disconnects all ungrounded conductors from the heater circuits when in the OFF position.

9. The heater shall include a built in SPST relay for a remote wall-mounted thermostat when called for in the schedules.

C. Controls

1. Furnish units with built-in packaged controls unless indicated otherwise in the schedules or shown otherwise on the Drawings.

D. Heating Sections

1. Open electric heating coils shall be open resistance heating type with coil and unit UL listed. Coils and coil controls shall meet NEC requirements. Coil frame shall be galvanized steel with vertical element supports. Elements shall be constructed of 80-20 nickel-chromium wire and shall be insulated from the supports with ceramic bushings. Where three-phase power is specified in the schedule, each stage of heating shall be balanced. Each coil shall be provided with automatic and manual-reset thermal protection.

## 2.13 AIR HANDLING UNITS

A. In general, all air handling units, package, thru the wall type and split systems shall be factory assembled with cabinet fan, heating and/or cooling section, filters, dampers, access sections with hinged access doors, motor, motor base, drive, drive guard and vibration isolators.

1. Units shall be designed to provide an integrated assembly when all of the components are assembled. All transition sections and filler pieces required between sections are to be provided as part of the unit.

2. Provide support brackets or rails with the unit. Type of support shall be as required by the schedules and as shown on the Drawings, e.g. suspended, floor mounted, etc.

3. Self-contained package units shall also contain compressors, refrigerant piping system, condenser, condenser fans and drives, mounting curb and factory wired control panel.

4. Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self tapping screws or other fastening methods that will damage the coating are not acceptable.

B. Casings

1. Casings shall be galvanized sheet steel construction with structural framing members as required. Pressure class rating shall be for the total fan static pressure. All sections of the unit shall be of the same pressure class.

2. Where specified on the schedules, and in all units with heating and/or cooling sections, the unit shall be insulated. All sections including, but not limited to, return plenum, coils, filter, spacers, access sections, fan cabinet, mixing box and by-pass sections, shall be insulated. Insulation shall be 1-in mat faced or neoprene coated fiberglass liner, 1-1/2 pound minimum density, installed with stick clips and adhesives to prevent erosion of the insulation.

3. Units for outdoor installation shall comply with the following:

   a. Materials of construction shall be corrosion resistant, or provided with a corrosion resistant coating system for weather protection.

   b. The casing shall enclose all components for weather protection, with gasketed access doors provided for all sections to facilitate maintenance. Doors shall have provision for key locking to prevent unauthorized tampering.

   c. Top of housing shall be constructed to prevent buckling and ponding of water.

C. Fan Section

1. Fans shall be centrifugal cabinet fans with belt or direct drive as scheduled. Extended external lubrication fittings shall be provided.

2. On belt driven fans, mount motor on an adjustable slide base, equipped with jack screws.

3. Where scheduled, backwardly curved wheels shall be air foil type.

4. All fans shall be statically and dynamically balanced before shipment.

5. Whenever possible, fans shall be AMCA certified for sound and air performance, per AMCA 210-85 and AMCA 330-86.

6. Where called for on the schedules, fans shall be of spark resistant construction. On spark resistant fans, bearings shall not be placed in the air stream. Construction shall conform to AMCA 99-0401-82 Classification.

7. Fan bearings shall be furnished as specified elsewhere in this Section.

8. Jack screws, nuts, bolts and all thread shall be grade 316 stainless steel.

D. Cooling Section

1. Cooling coil section shall be insulated with drain pan, coil support slide rails and coil closure plate. Coil mounting shall minimize air by-pass around the coil. Provide insulated drain pan with a corrosion resistant lining and drain connections on both ends of the drain pan.

2. Refrigerant cooling coils shall be cartridge type with copper tubes, aluminum fins, galvanized steel frame, copper suction header and distribution tubes. Fins

shall be mechanically attached to the tubes. Coils shall be pressure and leak tested at 300 psig with air under water. Coils shall be certified per ARI Standard 410.

E. Heating Sections

1. Heating section shall be insulated. Where heating is provided by coils, coil support slide rails and closure plates shall be provided.

2. Location of heating sections, preheat and reheat, shall be as shown on the schedules or Drawings.

3. Furnish electric heating coils as scheduled and in accordance with heating sections specified under Packaged Heaters elsewhere in this Section.

F. Filters

1. See makeup and air handling unit schedules for filter types by unit.

2. Filter Box shall have tracks for the specified filter types, except roll filters, to allow filter replacement from either side. Sealing material shall be provided at tracks and ends to prevent air by-passing the filters.

3. Disposable Filters shall be framed filters, 2-in thickness (as scheduled). Filter pressure drop for clean filters at 300 fpm face velocity shall be 0.15-in wg for 2-in thick filters. Filter shall have 30 to 35 percent efficiency on ASHRAE test standard 52-76. Manufacturers and type shall be American Air Filter Co., Am Air 300X; Farr Co., 30/30 Disposable or equal.

4. A total of three complete sets of filter media shall be provided for each unit.

5. For all types of filters, each filter section shall be provided with a differential static pressure gauge across the filter. Where more than one filter is used in series, each filter shall be provided with a separate gauge. Each gauge shall be provided with shut off-vent valves similar to Dwyer A-301A vent valves on each side of the gauge to permit zeroing of the gauge without disconnecting the gauge. Tubing shall be stainless steel. Static pressure sensors, valves and fittings shall be stainless steel. Pressure range of gauges shall be three times the clean pressure loss of filters provided.

6. Gauges for local indication of indoor units shall be magnehelic gauges accurate to within plus/minus 2 percent of full scale. Gauges shall have a zero adjustment screw and an adjustable set point indicator. Fluid shall be a low specific gravity oil. Oil shall remain functional to minus 20 degrees F. Casing shall be cast aluminum. The unit shall be able to withstand an over pressure of 15 pounds per square inch. Gauges shall be by Dwyer Magnehelic Series 2000 or equal.

7. Gauges for local indication of outdoor units shall be combination vertical/ inclined manometer type. Gauges shall have zero adjustment screw and set point indicator. Casing shall be one piece plastic and epoxy coated aluminum scale. A weatherproof housing shall be provided for protection of the unit from direct sun light. Gauges shall be Dwyer Mark II No. 25 inclined manometer or equal.

8. Remote indication of pressure differential shall be provided by a transmitter using silicon strain gauge transducer. Casing shall be cast aluminum. The unit shall be able to withstand an over pressure of 15 pounds per square inch. Unit shall have zero and span adjustment. The transmitters shall be provided with an LCD readout on the face of the transmitter. Transmitters shall be Dwyer Series 603A differential pressure transmitter.

G. Condensing Unit

1. Condensing unit shall consist of casing, compressor(s), refrigerant piping system, condenser, condenser fans and drives and factory wired controls and panel.

2. All rotating components shall be internally isolated with vibration isolators from the main unit.

3. Condenser section for self contained package units shall be an integral part of the unit and shall be part of a complete factory assembled unit.

4. Condensing unit for split systems shall be designed and constructed for mounting remote from its associated air handler with field fabricated interconnecting refrigerant piping, including associated specialties.

5. Refrigerant compressors shall be of the type, number, and capacity specified on the schedules. Compressors shall be provided with unloading or hot gas by-pass as required by the schedule. Compressor shall include suction strainer, crank case oil sight glass, oil strainer and oil heater and forced feed lubrication. Compressor controls shall include three-phase manual reset overload protection, hi-low refrigerant pressure cutout, manual reset low oil pressure cutout, non-cycle pump down relay. In addition, multiple compressor units shall have a compressor sequence switch.

6. Air cooled condenser shall have propeller or centrifugal fans as shown on the schedules. Exposed fans shall be provided with fan guards. Coils shall have copper tubes, aluminum fins, galvanized steel frame and copper headers. Fins shall be mechanically attached to the tubes. Coils shall be pressure and leak tested at 425 psig with air under water.

H. A complete refrigerant piping system shall be factory fabricated and installed in the unit.

1. Piping shall be Type K copper tubing with joints silver brazed. Brazing shall be done with an inert gas purge. Suction lines shall be insulated with closed cell foam insulation. Hot gas piping shall be insulated to protect personnel as required.

2. Valves shall be bronze body brazed connection and shall include compressor and condenser relief valves, condenser liquid line service valve, refrigerant charging valve, compressor discharge, suction service valves, liquid line solenoid and thermal expansion valve.

3. Complete refrigerant system shall be cleaned, leak tested and charged with refrigerant.

4. Size of field fabricated piping for split systems shall be determined by the equipment manufacturer.

I. Unit Control Panel

1. For self-contained package units, split systems and fuel burning units, factory wired control panel shall be furnished and mounted on the unit. Panels shall include all controls required in other sections and all safety controls and interlocks, heavy duty fused visible break disconnect, control devices, motor starters and terminal strip for remote wired devices. Control type and sequence shall be as specified in other related Sections or on the Drawings. Control voltage shall not exceed 120 Volts. Control panel door shall be provided with a keyed lock. A complete wiring diagram shall be permanently attached to the inside of the panel door. Step control sensors and step controller will be provided under the temperature control portion of the specification unless specified with unit on the equipment schedule.

2. Furnish gas heating section controls as scheduled and in accordance with gas controls specified in Packaged Heaters, elsewhere in this Section.

3. Furnish electric heater section controls as scheduled and in accordance with the controls specified under Electric Duct Heaters, elsewhere in this Section.

J. Accessory Sections

2.14 FANS

A. General

1. Fans shall be factory assembled, complete with fan wheel, fan housing or cabinet, bearings, drives, drive guard, motor, motor base, unit base, vibration isolators and bird screens, unless otherwise specified.

2. All fans shall be statically and dynamically balanced before shipment.

3. Where belt drives are used, motors shall be provided with adjustable slide bases with jack screws.

4. All fans shall be AMCA rated for sound and air performance per AMCA 210-85 and 330-86.

5. Where shown on the Drawings and Schedules, fans shall be of spark resistant construction. Bearings shall not be placed in the air stream. Construction shall conform to AMCA 99-0401-82 Classifications. All electrical components shall be explosion proof.

a. TYPE A - All parts in contact with the gas stream shall be non-ferrous material.

b. TYPE B - Aluminum wheel and non-ferrous ring around shaft openings.

c. TYPE C - Non-ferrous ring on inlet bell and shaft opening.

6. Inlet and/or discharge screens shall be provided for fans that are not directly duct connected.

7. Unless spark proof construction or other materials of construction are scheduled fans shall be of steel construction.

8. Electric motors and electrical disconnects shall be provided as specified elsewhere in this Section.

9. Fans shall be UL listed when noted in the schedules or when code required for the specific application.

10. Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self tapping screws or other fastening methods that will damage the coating are not acceptable.

11. Jack screws, nuts, bolts and all thread shall be grade 316 stainless steel.

B. Centrifugal fans shall have forward curved, backwardly curved, backward inclined, or radial blades as scheduled. Backwardly curved wheels shall be air foil type. Fan shafts shall be solid steel unless otherwise scheduled. Provide shaft seals where scheduled. Manufacturers shall be Buffalo Forge Co.; American Standard; Loren Cook Co.; HK Porter Co.; New York Blower Co.; Hartzell Propeller Fan Co.

C. Centrifugal cabinet fans shall be belt or direct drive as scheduled. Where specified as insulated on the schedule, cabinets shall be lined with 1-in mat faced neoprene coated fiberglass insulation, 1-1/2 lb density.

D. Tube and vane axial fans shall have flanged inlet and discharge connections and access door in fan tube. Belt drive fans shall have shroud over the belt drive in the air stream. Mounting brackets shall be provided based on fan mounting orientation. Fans shall have cast aluminum wheels.

E. Inline centrifugal fans shall have flanged inlet and discharge, wheel inspection door and variable belt drive. Belt drive shall have a shroud over the belt in the air stream. Wheel shall be backward inclined or backward curved air foil type as scheduled. Mounting brackets shall be provided based on fan mounting orientation.

F. Propeller fans shall have cast aluminum, fabricated aluminum wheels. Plastic fan wheels are not acceptable. Manufacturers shall be Acme Eng. & Mfg. Corp.; Aerovent, Inc.; American Fan Co.; Buffalo Forge Co.; Hartzell Propeller Fan Co.; New York Blower Co.; H.K. Porter Co., Inc.

G. Centrifugal Wall and Roof Exhaust Fans - Motor and drive shall be located out of the exhaust air stream. Roof mounted fans shall be furnished with factory fabricated insulated curbs. Fan wheel shall be backward inclined. Fans shall be aluminum construction with spun aluminum drive housing and shroud unless other materials of construction are specified on the Schedule. Manufacturers shall be Acme Eng. & Mfg. Corp.; Jenn-Air Products; Loren Cook Co.

H. Propeller Roof Exhaust Fans - Mushroom weather cap shall be provided, with removable cap for access to the fan and drive. Factory fabricated insulated curbs shall be provided. Unless spark proof construction or other materials of construction are specified on the Schedules, the housing shall be of aluminum with cast or formed aluminum wheel. Manufacturers shall be ACME Eng. & Mfg. Corp.; Buffalo Forge Co.; Hartzell Propeller Fan Co.; Zurn; Swartwout Div.

I. Propeller Roof Intake Fans - Mushroom weather cap shall be provided, with removable cap for access to fan and drive. Factory fabricated insulated curbs shall be provided. Inlet shall be provided with 2-in throwaway filter serviceable without disassembly of the fan housing. Bird screen shall be provided downstream of the filters. Filter face velocity and inlet velocity shall not exceed 350 fpm. Bottom of filters shall be a minimum of 30-in from the roof with a maximum velocity at the perimeter of the mushroom weather cap of 350 fpm. Unless spark proof construction or other materials of construction are specified on the Schedules, the housing shall be aluminum with cast or formed aluminum wheel. Manufacturers shall be ACME; Buffalo Forge Co.; Hartzell Propeller Fan Co.; Zurn; Swartwout Div.; Loren Cook Co.; Jenn-Air Products.

## 2.15 DUCTWORK

A. Sheet metal ductwork shall be constructed of the materials specified using the gauges or thicknesses and reinforcing called for by SMACNA for the material specified. Unless otherwise specified, all components of duct systems shall be constructed of the same material as the ductwork. This is to include braces and turning vanes.

1. Aluminum ductwork shall be constructed of 3003H-14 alloy B&S Gauges.

2. Stainless steel ductwork shall be constructed of Type 316 stainless steel.

3. PVC ductwork and fittings shall conform to the PVC Materials Standard ASTM D1784. Type [I] PVC is acceptable.

4. FRP ductwork and fittings shall conform to SECTION 15201 FIBERGLASS REINFORCED PLASTIC DUCTWORK.

B. Ductwork shall be constructed to the following standards:

M&F SMACNA HVAC Duct Construction Standards - 1st Ed. - Metal & Flexible
IRD SMACNA Round Industrial Duct Construction Standards
IRT SMACNA Rectangular Industrial Duct Construction Standards
TP SMACNA Thermoplastic Duct (PVC) Construction Manual - 1st Ed.

C. Design of ductwork shall include all loads applied to the ductwork, in addition to the load of the duct. These loads include but are not limited to wind, snow and internal dirt or liquid buildup.

D. Construction

1. All ductwork shall be substantially built with joints and seams smooth on the inside and given a neat appearance on the outside. Inside surfaces and joints shall be smooth and free from pockets, burrs and projections. All joints shall be substantially air tight with laps made in the direction of air flow and no flanges projecting into the air stream. All changes in direction and duct transitions shall be shaped to permit the easiest possible air flow.

2. Pressure Classes

a. Pressure classes for determination of sheet metal gauge and reinforcing shall be as defined by the latest issue of the SMACNA standards for duct construction.

b. For ductwork with a static pressure higher than 2-in water gauge, pressure class shall be as shown on the Drawings. For ductwork with a static pressure 2-in water gauge or less pressure class shall be equal to the maximum pressure indicated for the fans or air handling units on the Schedules and the pressure class shall be the same for the entire length, including branches, of the specific duct system.

3. Rectangular Ductwork

   a. Ductwork shall be constructed as shown on the Drawings in accordance with the specified SMACNA Construction Standard, latest edition.

   b. Cross-breaking shall conform to SMACNA Standard. Cross-breaking shall be applied to the sheet metal between the standing seams or reinforcing angles. The center of the cross-break shall be of the required height to assure rigidity for each panel.

   c. All square elbows for rectangular ductwork shall be provided with turning vanes unless otherwise noted on the Drawings. Turning vanes shall be as detailed in the SMACNA Manual and or as shown on the Drawings.

   d. Alternate Construction (Rectangular Only) - Factory-fabricated joint systems may be offered as an alternate form of construction. The system offered shall meet all requirements of SMACNA. Alternate joint systems shall be "Ductmate System" as manufactured by Ductmate Industries, Inc., installed in accordance with the manufacturer's recommendations. The system shall be sealed for zero leakage and angle attachment to the main duct section shall be by tack welding. The use of screws is not allowed.

4. Round Ductwork

   a. Ductwork shall be constructed as shown on the Drawings in accordance with the specified SMACNA Construction Standard latest edition.

   b. Round Ductwork

      1) Round ductwork shall be either lock type, welded longitudinal seam construction or spiral ductwork.

      2) Gauges of ductwork and fittings shall be as specified in SMACNA. Draw bands will not be permitted. Slip joint shall be used on ductwork up to 36-in in diameter and the "loose flange" or Vanstone joint shall be used on ducts over 36-in in diameter.

      3) All seams and joints shall be continuously welded.

      4) Round ductwork shall be manufactured by United Sheet Metal; SEMCO or equal.

5. Round Ductwork Fittings

   a. All 90 degree turns shall be made of five piece mitered welded construction made by the manufacturer of the conduit. Fittings less than 90 degrees in the riser shall be made of multiple pieced mitered welded construction.

   b. All fittings in the round duct system shall be of the male and female type and in assembling these together, there shall be applied an approved synthetic rubber sealing compound on the joint. Also, on the outside of the duct apply this synthetic rubber sealing compound in order to further make

these joints air tight. Mechanically fasten the conduits together using sheet metal screws not less than four per fitting 6-in on centers maximum and equally spaced around the circumference of fitting.

c. Round duct fittings shall be manufactured by United Sheet Metal; SEMCO or equal.

6. Round Flexible Ductwork

a. Aluminum flexible ductwork shall be self supporting, suitable for both high and low velocity systems. Duct shall be "United Flex" as manufactured by United Sheet Metal.

b. Stainless steel flexible ductwork shall be self supporting, suitable for both high and low velocity systems. Duct shall be "United Flex" as manufactured by United Sheet Metal.

c. Fabric flexible ductwork shall be vinyl coated glass fabric with cold rolled flat steel spiral support. Duct shall be suitable for both high and low velocity systems. Duct shall be Type 57 as manufactured by Wiremold Co. or equal.

d. Connections, joints, and termination shall be made air tight as recommended by the manufacturer. Where joints are made to rigid sheet metal ductwork, 3M Company EC-800 sealer shall be applied and the joint shall be drawn tight with a drawband.

e. Maximum length shall be 10-ft. The remainder shall be sheet metal. Duct run shall be as short and straight as possible to minimize static pressure resistance.

f. Insulated Round Flexible Ducts

g. Round flexible ducts shall comply with specified SMACNA Construction Standards and be constructed of corrugated ductile aluminum that can be bent and rebent by hand and is self-supporting. 1-in insulation shall be applied around the outside and be finished with a vinyl cover.

h. Thermal conductivity of the insulation shall not exceed 0.27 BTU/hr/sq ft/1 degree F at 75 degree mean temperature. Duct shall be Class I, per UL 181.

i. Maximum length shall be 5-ft. The remainder shall be hard ducted. Duct run shall be as short and straight as possible to minimize static resistance.

j. Ducts shall be Bendway as manufactured by Flexaust Company or equal.

7. Volume Dampers

a. Dampers shall be standard opposed or parallel multi-blade type on 2-in channel frame, flanged connection with external damper position indicator, manual adjustment, and position locking arrangement. Damper blades shall not exceed 6-in in width. Dampers shall be constructed of the same material as the ductwork, or of a material of equal corrosion resistance. Balancing and balancing/shutoff dampers shall be opposed blades and shutoff dampers shall be parallel blade.

b. Locking quadrants shall have a positive method of holding the damper in its selected position such as a bolt through both the quadrant and the lever

arm. Systems using springs or other devices that can vibrate loose are not acceptable.

c. Where manual dampers are used for shut off service, dampers shall have a replaceable butyl rubber or bulb vinyl seals provided with the damper. Install seals along the top, bottom and sides of the frame and along each blade edge.

8. Access Doors

a. Access doors shall be 24-in by 24-in minimum, except where the duct size is less than 26-in, where the largest door that will fit the duct will be used. Unhinged access panels are not acceptable, except where shown on the Drawings. Access doors shall be of the same material as the duct, pan type construction for metal ductwork, with smooth edges and fitted seals, constructed and installed for air-tight fit with ease of opening and closing. Doors shall be substantially butt hinged, with heavy sash locks and substantial door pulls. Door openings and door frames shall be reinforced with bar stock or angle. Where ductwork is installed with duct liner or exterior duct insulation, the access door shall be of the insulated type. Access doors may be factory fabricated. Where ductwork is constructed of aluminum or stainless steel, access door hardware shall be of similar material.

9. Fasteners

a. Sheet metal screws, drive cleats, cinch bands and other fasteners shall be fabricated from materials with an equal of greater corrosion resistance than the ductwork in which they are installed. Where a material other than the duct material is used, it shall be approved by the Engineer before installation.

10. Ductwork Material Table

| System | Location | Material |
|---|---|---|
| SA | Office/Admin | AL |
| EA | Office/Admin | AL |
| RA | Office/Admin | AL |
| OA | Office/Admin | AL |
| EA | Admin Lab | SS |
| SA | Elec. Room (s) | AL |
| EA | Solids Handling Bldg. | FRP |
| SA | Solids Handling Bldg. | FRP |
| EA | MBR Bldg. | FRP |
| SA | MBR Bldg. | FRP |

## 2.16 FIRE AND SMOKE DAMPERS

A. Fire and smoke dampers shall meet local codes and the requirements of the NFPA Pamphlet No. 90A.

B. Dampers shall be designed and tested for their specific application in the system. Dampers shall be suitable for the following services:

1. Fire dampers for systems that are automatically shut down in the event of a fire.

2. Fire dampers for systems that are operational in the event of a fire.

3. Smoke dampers activated by smoke sensors.

4. Combination fire and smoke dampers where both types of dampers are required in the same location.

C. Dampers shall be sized so that the free air space is not less than the connected duct free area. Location shall be as shown on the Drawings and required by code.

D. Fire dampers shall have a minimum 1-1/2 hour standard fire protection rating in accordance with NFPA Pamphlet No. 252 and UL-555. Where the fire protection rating of the partition exceeds 2 hours, multiple dampers in series may be used to provide a rating equal to the partition. Dampers with fusible links shall be arranged to close automatically and remain tightly closed upon the operation of a UL approved fusible link or other approved heat actuated device, located where readily affected by an abnormal rise of temperature in the duct. Fusible links shall have a temperature rating of 50 degrees F above the maximum normal duct operating temperature, but not less than 165 degrees F.

E. Smoke dampers shall be located on the HVAC drawings and shall interface with the smoke detection system on the electrical drawings. Dampers shall comply with UL 555S.

F. Workmanship - Install dampers in sleeve unless noted otherwise on the Drawings or in the case of dampers listed for installation without sleeves after specific approval from the Engineer. Fire and smoke dampers shall be installed to provide a positive barrier to passage of air when in a closed position. Dampers shall be installed so they will be self-supporting in case of duct destruction due to heat. Care shall be exercised that the frame be set so that the closing device will not bind. Damper operators for fire and smoke dampers shall be spring to close and shall be as specified in the automatic control systems.

G. Factory fabricated, steel-curtain type, UL approved fire dampers, with damper blades out of the air stream. These fire dampers shall be tested and installed in accordance with the manufacturer's instructions and the latest editions of UL 555 and UL 555S. Damper operators shall be factory installed and tested. Operators shall not be removed and reinstalled or installed in the field.

H. Access Doors - Tight fitting access doors shall be provided for accessibility to dampers and fusible links for inspection and maintenance.

I. All fire and smoke dampers shall have written approval from local authorities.

**J.** Instrument ports and mounting holes for sensors, indicators, flow switches, detectors, gauges and other items to be mounted on the ductwork by the automatic control contractor shall be coordinated with Section 15950. Mounting shall be in accordance with the automatic control contractor’s and the manufacturer’s instructions.

## 2.17 DIFFUSERS, REGISTERS AND GRILLES

A. General

1. All diffusers, registers and grilles shall be of the shape, sizes, capacity and type as shown on the Drawings.

2. On all duct openings that do not have a specific diffuser, register, grill or mesh covers, provided a wire mesh cover.

3. Finish - Unless otherwise specified, diffusers, registers and grilles shall have the following finish. All diffusers, registers and grilles located in ceilings shall have a baked white enamel finish except where the ceiling system has an exposed aluminum support grid. Where the ceiling has an exposed aluminum support grid the diffusers, registers and grilles shall have a baked aluminum enamel finish. All diffusers, registers and grilles not located in ceilings shall have baked aluminum enamel finish.

B. Supply Air Diffusers

1. General - In general, diffusers shall be a factory-assembled unit of aluminum welded construction consisting of a housing with built-in louvers, cones, vanes or other means of directing discharge of air in a particular pattern principally for overhead or ceiling air diffusion. All diffusers shall be equipped with a volume control device. Distribution of air may be adjustable if so specified.

2. Exposed Duct Mounted Diffusers

   a. Diffusers shall be of the fixed type for horizontal air pattern. Refer to Drawings for direction of air throw. Each diffuser shall be equipped with an equalizing grid, baffles as required and extended bottom plate flange designed specifically for air diffusion from diffusers mounted on exposed ductwork.

   b. Acceptable manufacturers shall be as listed.

      1. Hart & Cooley Inc.
      2. Krueger.
      3. METALAIRE, Inc.
      4. Nailor Industries Inc.
      5. Price Industries.
      6. Titus.

3. Ceiling Mounted Diffusers

   a. Diffusers shall be of type suitable for installation in the particular ceiling system as shown on the Reflected Ceiling Plans and Architectural Drawings. Special attention shall be given to the exact location of these ceiling diffusers for best air diffusing characteristics as well as architectural aesthetics. Diffusers shall have removable core with vanes to diffuse supply air in the various directional patterns as shown on the Drawings. Equalizing grid control devices baffles as required, and throw reducing vanes as required shall be furnished with each diffuser. Throw reducing vanes shall be furnished loose for field installation.

4. Square and Rectangular Perforated Ceiling Diffusers

    a. Diffusers shall be of a type suitable for installation in the particular ceiling system as shown on the Reflected Ceiling Plans and Architectural Drawings. (Diffusers shall have a removable, perforated faceplate finished in off-white baked enamel.) Cores shall have means for adjustment of air pattern. Separate or combination volume and equalizing grid control devices shall be furnished with each diffuser.

    b. Diffusers shall have square or rectangular inlets of size as shown on the Drawings.

    c. Acceptable manufacturers shall be as listed.

        1) Hart & Cooley Inc.

        2) Krueger.

        3) METALAIRE, Inc.

        4) Nailor Industries Inc.

        5) Price Industries.

        6) Titus.

C. Supply Air Grilles

1. In general, grilles shall be a factory-assembled unit consisting of a grille with double deflecting adjustable airfoil vanes to diffuse supply air in the various directional patterns as shown on the Drawings. Grilles shall be of aluminum frame and border with aluminum louver blades. All grilles shall be furnished with a sponge rubber gasket to prevent streaking. Front and rear louver blades shall be individually adjustable. Where wall mounted, front blades shall be vertical and rear blades shall be horizontal. Where ceiling mounted, front blades shall be parallel to long dimension.

D. Supply Air Registers

1. General - In general, registers shall be a factory-assembled unit consisting of a grille with adjustable vanes to diffuse supply air in the various directional patterns as shown on the Drawings and a damper. Grilles shall be of aluminum frame and border with aluminum louver blades. All registers shall be furnished with a sponge rubber gasket to prevent streaking. Supply air registers shall have opposed-blade dampers. Front and rear louver blades shall be individually adjustable. Where wall mounted, front blades shall be vertical and rear blades shall be horizontal. Where ceiling mounted, front blades shall be parallel to the long dimension.

2. Acceptable manufacturer shall be Series 272F by Titus Manufacturing Corp.; Carnes, Model RNFA Series or equal.

E. Return Air Grilles

1. Louver-Faced Return Air Grilles

    a. In general, grilles shall be a factory-fabricated unit of aluminum frame border and louver blades. All grilles shall be furnished with a sponge rubber gasket to prevent streaking.

2. Stamped Metal Return Air Grilles

    a. Grilles shall be a factory-fabricated unit consisting of a stamped aluminum lattice face. All grilles shall be furnished with a sponge rubber gasket to prevent streaking. Minimum free area shall be 50 percent.

3. Eggcrate Type Return Air Grilles

    a. Return air grilles shall be of all aluminum construction consisting of 1/2-in thick cores with 1/2-in square grid size. The square grid pattern shall provide maximum free area with minimum "see through".

    b. Acceptable manufacturers shall be as listed:

        1) Hart & Cooley Inc.

        2) Krueger.

        3) METALAIRE, Inc.

        4) Nailor Industries Inc.

        5) Price Industries.

        6) Titus.

F. Return Air Registers

1. Louver-Faced Return Air Registers

    a. In general, registers shall be a factory-assembled unit consisting of a grille and damper. Grille shall be of aluminum frame border with aluminum louver blades. Dampers shall be aluminum, opposed blade type. All registers shall be furnished with a sponge rubber gasket to prevent streaking.

    b. Acceptable manufacturer shall be Model 4F, Titus Manufacturing Corp.; Carnes, Model RNHA and RNJA Series; Air Devices, Inc. or equal.

2. Stamped Metal Return Air Registers

    a. Registers shall consist of a grille and damper. Grille shall be a factory-fabricated unit consisting of a stamped aluminum lattice face. All grilles shall be furnished with a sponge rubber gasket to prevent streaking. Minimum free area shall be 50 percent. Dampers shall be steel opposed blade type.

    b. Acceptable manufacturer shall be Tuttle and Bailey Series A7908 or equal.

3. Eggcrate-Type Registers

    a. Return or exhaust air registers shall consist of an all aluminum grid type grille with an opposed blade damper. Grille shall have an extruded aluminum flat border with 1/2-in by 1/2-in square grid core of 1/2-in thickness.

    b. Acceptable manufacturers shall be as listed or equal:

        1) Model 50F - Titus Manufacturing Corp.

        2) Model RNPA Series - Cranes

        3) Series EGC-5 - Krueger Manufacturing Co., Inc.

G. Wire Mesh Covers

1. Where wire mesh covers are called for on the Drawings, the wire mesh and support frame shall be the same material as the duct where the cover is installed. Unless otherwise noted the wire mesh shall be 0.5-in mesh.

2. The wire mesh shall be contained in a metal frame. The mesh shall be firmly attached to the frame to prevent it being pulled out of the frame by casual contact. The frame shall be a minimum of 16 gauge sheet metal, or the minimum gauge for a flange based on SMACNA, whichever is greater. The frame shall be on both sides of the mesh creating a sandwich with the mesh in the middle. Fastenings shall go through the frame on both sides of the cover.

## 2.18 WEATHER HOODS

A. Weather hoods shall be a factory-fabricated and assembled sheet metal housing. Air intake hoods shall have a pleasing contour and a minimum free area for the handling of outdoor air at a maximum of 500 fpm. Weatherhoods shall consist of a "dome" or "mushroom" head, a stack section and a base for mounting of the entire unit over a curbed roof opening. Weather hoods shall be of substantial construction with rigid framing, bracing and supports. Weather hoods shall be of all aluminum construction, low silhouette. All hoods shall be provided with bird screens of 1/2-in mesh, welded wire, and stainless steel. Hoods shall be of type, size and capacity as shown on the Drawings. Provide anti-condensation coating on internal surfaces.

B. Air Intake Roof Hoods - Acceptable equipment shall be Trim Line-Skymaster by Acme Engineering & Manufacturing Corp.; Carnes.

## 2.19 ROOF CURBS

A. Roof curbs shall be furnished for all roof mounted HVAC equipment including fans and relief vents.

B. Roof curbs shall be pre-fabricated type, minimum 12-in height and sized to match the dimensions of the equipment base supported. Curbs shall provide a horizontal mounting surface for the equipment and shall be designed to allow for roof slope where applicable.

C. Curbs shall be straight sided type of all aluminum welded construction with nominal 2-in thick acoustical/thermal insulation in curb walls. A perforated metal liner shall be provided to protect the insulation.

D. Curb interiors shall be provided with protective coatings when a coating is specified for a particular fan. Refer to Fan Schedules for applicable units.

E. Roof curbs shall be "Sonotrol" type as manufactured by Penn Ventilator Co. or equal.

## 2.20 PACKAGED ROOFTOP AIR-CONDITIONERS

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

1. Carrier Corporation.

2. Trane.

3. YORK; a Johnson Controls company.

B. Unit Casings

1. 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.

2. Double-Wall Construction:

3. Outside Casing Wall: Galvanized steel, minimum 18 gauge (1.3 mm) thick with manufacturer's standard finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

4. Inside Casing Wall: G90 (Z275)-coated galvanized steel, 0.034 inch (0.86 mm) thick.

5. Floor Plate: G90 (Z275) galvanized steel,minimum thick.

6. Casing Insulation:

a. Materials: Injected polyurethane foam insulation.

b. Casing Panel R-Value: Minimum 4.

c. Insulation Thickness: 1 inch (25 mm).

d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. Static-Pressure Classifications:

1. For Unit Sections Upstream of Fans: Minus 2-inch wg (500 Pa).

2. For Unit Sections Downstream and Including Fans: 2-inch wg (500 Pa).

E. Panels and Doors:

1. Panels:

a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.

b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.

c. Gasket: Neoprene, applied around entire perimeters of panel frames.

d. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

2. Access Doors:

    a. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.

    b. Gasket: Neoprene, applied around entire perimeters of panel frames.

    c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

3. Locations and Applications:

    a. Fan Section: Inspection and access panels.

    b. Access Section: Doors.

    c. Coil Section: Inspection and access panels.

    d. Damper Section: Inspection and access panels.

    e. Filter Section: Inspection and access panels large enough to allow periodic removal and installation of filters.

    f. Mixing Section: Doors.

F. Condensate Drain Pans:

1. Location: Each type of cooling coil.

2. Construction:

    a. Single-wall, stainless steel sheet.

3. Drain Connection:

    a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

    b. Minimum Connection Size: NPS 1 (DN 25).

4. Slope: Minimum 0.125-in./ft. (10-mm/mm) slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.

5. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.

6. Width: Entire width of water producing device.

7. Depth: A minimum of 2 inches (50 mm) deep.

8. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.

9. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

G. Fans, Drives and Motors

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

2. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.

3. Shafts: With field-adjustable alignment.

   a. Turned, ground, and polished hot-rolled steel with keyway.

4. Shaft Bearings:

   a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours according to ABMA 9.

5. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

   a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

6. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.

7. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch (25 mm).

8. Shaft Lubrication Lines: Extended to a location outside the casing.

9. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches (89 mm) wide, attached to two strips of minimum 2-3/4-inch- (70-mm-)wide by 0.028-inch- (0.7-mm-) thick, galvanized-steel sheet.

   a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

H. Drives, Direct: Factory-mounted, direct drive.

1. Drives, Belt: Factory-mounted, V-belt drive, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.

2. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.

3. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.

4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146-inch- (2.7-mm-) thick, diamond-mesh wire screen, welded to steel angle frame; prime coated.

I. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated ECM motors.

J. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Common Motor Requirements for HVAC Equipment.

2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

3. Enclosure Type: Open, dripproof.

4. Enclosure Materials: Cast iron.Efficiency: Premium efficient as defined in NEMA MG 1.

5. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

6. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

K. Coils

1. General Requirements for Coils:

2. Comply with AHRI 410.

3. Fabricate coils section to allow for removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).

4. Coils shall not act as structural component of unit.

5. Supply-Air Refrigerant Coil:

6. Tubes: Copper.

7. Fins:

   a. Material: Aluminum.

   b. Fin Spacing: Maximum 12 fins per inch (mm).

8. Fin and Tube Joints: Mechanical bond.

9. Headers: Seamless-copper headers with brazed connections.

10. Frames: Galvanized steel.

11. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

    a. Working Pressure: Minimum 300 psig (2070 kPa).

L. Electric-Resistance Heating Coils: Comply with UL 1995.

1. Casing Assembly: Slip-in type with galvanized-steel frame.

2. 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.

3. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.

4. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

5. Control Panel: Unit mounted with disconnecting means and overcurrent protection.

a. Magnetic contactor.

b. Solid-state, stepless pulse controller.

c. Toggle switches, one per step.

d. Step controller.

e. Time-delay relay.

f. Pilot lights, one per step.

g. Airflow proving switch.

M. Refrigerant Components

1. Refrigeration Specialties:

a. Refrigerant: R-410A.

b. Expansion valve with replaceable thermostatic element.

c. Refrigerant filter/dryer.

d. Manual-reset high-pressure safety switch.

e. Automatic-reset low-pressure safety switch.

f. Minimum off-time relay.

g. Automatic-reset compressor motor thermal overload.

h. Brass service valves installed in compressor suction and liquid lines.

i. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

N. Air Filtration

1. Panel Filters: Flat, non-pleated factory-fabricated, self-supported, disposable air filters with holding frames.

2. Filter Unit Class: UL 900.

3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.

4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

O. Electrical Power Connections

1. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

P. Controls

1. Basic Unit Controls:
   a. Control-voltage transformer.
   b. Wall-mounted thermostat or sensor with the following features:
      1) Heat-cool-off switch.
      2) Fan on-auto switch.
      3) Fan-speed switch.
      4) Automatic changeover.
      5) Adjustable deadband.
      6) Exposed set point.
      7) Exposed indication.
      8) Degree F indication.
      9) Unoccupied-period-override push button.
      10) Data entry and access port to input temperature and humidity set points, occupied and unoccupied periods, and output room temperature and humidity, supply-air temperature, operating mode, and status.

2. Wall-mounted humidistat or sensor with the following features:
   a. Exposed set point.
   b. Exposed indication.

3. Remote Wall-Mounted Annunciator Panel for Each Unit:
   a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
   b. DDC controller or programmable timer and interface with HVAC instrumentation and control system.

c. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.

4. Electronic Controller:

   a. Controller shall have volatile-memory backup.

5. Safety Control Operation:

   a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire-alarm control panel.

   b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F (54 deg C) enters unit. Provide additional contacts for alarm interface to fire-alarm control panel.

   c. Fire-Alarm Control Panel Interface: Provide control interface to coordinate with the fire alarm system.

   d. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply-air temperature is less than 40 deg F (4 deg C).

   e. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.

6. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of two programmable periods per day.

7. Unoccupied Period:

   a. Heating Setback: 10 deg F (5.6 deg C).

   b. Cooling Setback: System off.

   c. Override Operation: Two hours.

8. Supply Fan Operation:

   a. Occupied Periods: Run fan continuously.

   b. Unoccupied Periods: Cycle fan to maintain setback temperature.

9. Refrigerant Circuit Operation:

   a. Occupied Periods: Cycle or stage compressors to match compressor output to cooling load to maintain room temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure.

   b. Unoccupied Periods: Cycle compressors and condenser fans for cooling to maintain setpoint temperature.

   c. Switch reversing valve for heating or cooling mode on air-to-air heat pump.

   d. Unoccupied Periods: Cycle burner to maintain setback temperature.

10. Electric-Heating-Coil Operation:

    a. Occupied Periods: Cycle coil to maintain room temperature.

    b. Unoccupied Periods: Energize coil to maintain setback temperature.

    c. Operate supplemental electric heating coil with compressor for heating with outdoor temperature below 25 deg F (minus 4 deg C).

11. Fixed Minimum Outdoor-Air Damper Operation:

    a. Unoccupied/Occupied Periods: Open to 5 percent.

Q. Roof Curbs

1. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

2. 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 (38 mm).

3. 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 airstream 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.

4. Curb Dimensions: Height of 14 inches (355 mm).

R. Accessories

1. Electric heater with integral thermostat maintains minimum 50 deg F (10 deg C) temperature in gas burner compartment.

2. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

3. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

4. Safeties:

    a. Smoke detector.

    b. Condensate overflow switch

c. Phase-loss protection

d. High pressure control

## 2.21 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

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

1. Carrier Corporation.
2. ENVIRO-TEC; by Johnson Controls, Inc.
3. Johnson Controls.
4. Titus, a division of Air System Components; Johnson Controls, Inc.
5. Trane.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.040-inch- (1.0-mm-) thick galvanized steel, single wall.

1. Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections, size matching inlet size.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F (minus 18 to plus 60 deg C), shall be impervious to moisture and fungus, shall be suitable for 10-inch wg (2500-Pa) static pressure, and shall be factory tested for leaks.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
2. Damper Position: Normally open.

F. Attenuator Section: 0.034-inch (0.85-mm) steel sheet.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.

2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

G. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.

1. Stage(s): 2.
2. SCR controlled.
3. Access door interlocked disconnect switch.
4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
5. Nickel chrome 80/20 heating elements.
6. Airflow switch for proof of airflow.
7. Fan interlock contacts.
8. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
9. Mercury contactors.
10. Pneumatic-electric switches and relays.
11. Magnetic contactor for each step of control (for three-phase coils).

H. Control devices shall be compatible with temperature controls system specified in the Automatic Temperature Control (ATC) Section.

1. Electric Damper Actuator: 24 V, powered open, spring return.
2. Electronic Damper Actuator: 24 V, powered open, spring return.
3. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
4. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
5. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
6. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

a. Occupied and unoccupied operating mode.

b. Remote reset of airflow or temperature set points.

c. Adjusting and monitoring with portable terminal.

7. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

I. Controls:

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg (60- and 750-Pa) inlet static pressure.

2. System-powered, wall-mounted thermostat.

J. Control Sequences:

1. Occupied:

a. In a call for cooling, airflow will increase as the damper opens towards maximum setting to satisfy set point.

b. In a call for less cooling, airflow will decrease as the damper closes towards minimum setting to satisfy set point.

2. Unoccupied:

a. Damper closes to minimum maximum setting.

## 2.22 PACKAGED DIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUO-AIR UNITS

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

1. Applied Air, a Mestek company.

2. Engineered Air.

3. Greenheck Fan Corporation.

4. REZNOR, a brand of Nortek Global HVAC.

5. Trane Inc.

B. Unit Casings

1. General Fabrication Requirements for Casings:

2. Forming: Form walls, roofs, and floors with at least two breaks at each joint.

3. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.

4. Makeup Air Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

C. Configuration: Horizontal unit with bottom discharge for roof-mounting installation.

D. Double-Wall Construction:

1. Outside Casing Wall: Galvanized steel, minimum 18 gauge (1.3 mm) thick, with manufacturer's standard finish.

2. Inside Casing Wall:

a. Inside Casing, Burner Section: Galvanized steel, solid, minimum 14-gauge-(0.759-mm-) thick steel.

b. Inside Casing, All Other Sections: Galvanized steel solid steel.

3. Floor Plate: Galvanized steel, minimum 18 gauge (1.3 mm) thick.

4. Casing Insulation:

a. Materials: Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071.

b. Casing Panel R-Value: Minimum 8.

c. Insulation Thickness: 2 inches (50 mm).

d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

5. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

E. Panels and Doors:

1. Panels:

a. Fabrication: Formed and reinforced, with same materials and insulation thickness as casing.

b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow.

c. Gasket: Neoprene, applied around entire perimeters of panel frames.

d. Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

2. Doors:

a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.

b. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.

c. Gasket: Neoprene, applied around entire perimeters of panel frames.

d. Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

3. Locations and Applications:

a. Fan Section: Doors.

b. Access Section: Doors.

c. Gas-Fired Burner Section: Doors.

d. Damper Section: Doors.

e. Filter Section: Doors large enough to allow periodic removal and installation of filters.

f. Mixing Section: Doors.

4. Service Light: 100-W vaporproof fixture with switched junction box located inside adjacent to door.

a. Locations: Each section accessed with door.

F. Outdoor Air-Intake Hood

1. Type: Manufacturer's standard hood or louver.

2. Materials: Match cabinet.

3. Bird Screen: Comply with requirements in ASHRAE 62.1.

4. Filter: Aluminum, 1 inch (25 mm) cleanable.

5. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

G. Roof Curb

1. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

2. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

a. Materials: ASTM C1071, Type I or Type II.

b. Thickness: 1 inch (25 mm).

3. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

a. Liner Adhesive: Comply with ASTM C916, 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 C916, Type I.

4. Curb Height: 14 inches (355 mm).

5. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site.

H. Fans, Drives and Motors

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

2. Fans: Centrifugal, rated according to AMCA 210; galvanized steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.

b. Shaft Bearings: Heavy-duty, self-aligning, permanently lubricated ball bearings, pillow-block bearings with an L50 rated life of 100,000 hours according to ABMA 9.

c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

d. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch25 mm.

e. Shaft Lubrication Lines: Extended to a location outside the casing.

3. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches (89 mm) wide, attached to two strips of minimum 2-3/4-inch- (70-mm-) wide by 0.028-inch- (0.7-mm-) thick, galvanized-steel sheet.

a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

4. Drives: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.

5. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.

6. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.

7. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146-inch- (2.7-mm-) thick, diamond-mesh wire screen, welded to steel angle frame; prime coated.

8. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Common Motor Requirements for HVAC Equipment.

a. Motor Sizes: Maximum sizes as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

b. Verify enclosure types with manufacturer of specified equipment.

c. Enclosure: Open, dripproof.

d. Enclosure Materials: Cast iron.

e. Efficiency: Premium efficient as defined in NEMA MG 1.

f. NEMA Design: .

g. 5-hp limit in "Motor Pulleys" Subparagraph below is standard with many manufacturers but is a designer's choice.

h. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

I. Air Filtration

1. Particulate Panel Filters:

a. Description: Flat, non-pleated factory-fabricated, self-supported, disposable air filters with holding frames.

b. Filter Unit Class: UL 900.

c. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.

d. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

2. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. Galvanized steel track.

a. Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

J. Dampers

1. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa) rated in accordance with AMCA 500D.

2. Electronic Damper Operators:

a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

b. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

c. Operator Motors:

1) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

2) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

3. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).

4. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).

5. Size dampers for running torque calculated as follows:

a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.

b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.

c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.

d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.

e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.

f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

6. Coupling: V-bolt and V-shaped, toothed cradle.

7. Overload Protection: Electronic overload or digital rotation-sensing circuitry.

8. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.

9. Power Requirements (Two-Position Spring Return): 24 V dc.

10. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.

11. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

12. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).

13. Run Time: 12 seconds open, 5 seconds closed.

K. DIRECT-FIRED GAS BURNER

1. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.

2. CSA Approval: Designed and certified by and bearing label of CSA.

3. Burners: Stainless steel.

   a. Rated Minimum Turndown Ratio: 30 to 1.

   b. Fuel: Natural gas.

   c. Ignition: Electronically controlled electric spark with flame sensor.

   d. Gas Control Valve: Modulating.

   e. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

4. High-altitude feature in High-Altitude (Model) (Kit)" Subparagraph below is available from some manufacturers; consult manufacturers.

5. Safety Controls:

   a. Owner's insurance underwriter may require gas train by FM Global or another insurer. Verify with Owner.

   b. Gas Manifold: Safety switches and controls complying with ANSI standards and FM Global.

   c. Vent Flow Verification: Differential pressure switch to verify open vent.

   d. High Limit: Thermal switch or fuse to stop burner.

   e. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.

   f. Airflow proving switch feature in "Airflow Proving Switch" Subparagraph below is provided by some manufacturers.

   g. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.

   h. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.

   i. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

   j. Control Transformer: 24 V ac.

L. UNIT CONTROL PANEL

1. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.

2. Control Panel: Surface-mounted remote panel, with engraved plastic cover and the following lights and switches:

a. On-off-auto fan switch.

b. Heat-vent-off switch.

c. Supply-fan operation indicating light.

d. Heating operation indicating light.

e. Thermostat.

f. Damper position potentiometer.

g. Dirty-filter indicating light operated by unit-mounted differential pressure switch.

h. Safety-lockout indicating light.

i. Enclosure: NEMA 250, Type 3R.

M. CONTROLS

1. Comply with requirements in the Automatic Temperature Control Section.

2. Control Devices:

a. Remote Thermostat: Adjustable room thermostat with temperature readout.

b. Remote Setback Thermostat: Adjustable room thermostat without temperature readout.

c. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

d. Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature.

e. Timers, Seven Day:

1) Programming-switch timer with synchronous-timing motor and seven-day dial.

2) Continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover.

3) Multiple-switch trippers.

4) Minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

3. Ionization-Type Smoke Detectors:

a. 24-V dc, nominal.

b. Self-restoring.

c. Plug-in arrangement.

d. Integral visual-indicating light.

e. Sensitivity that can be tested and adjusted in place after installation.

f. Integral addressable module.

g. Remote controllability.

h. Responsive to both visible and invisible products of combustion.

i. Self-compensating for changes in environmental conditions.

N. Fan Control, Interlocked: Fan to start with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.

O. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.

P. Temperature Control:

1. Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in blower outlet.

2. Timer shall select remote setback thermostat to maintain space temperature at 50 deg F (10 deg C).

3. Burner Control, Stepped: Two or four steps of control using one or two burner sections in series.

4. Burner Control, Modulating: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual burner units.

5. Hardwired Points:

a. Room temperature.

b. Discharge-air temperature.

c. Burner operating.

Q. ACCESSORIES

1. Electric heater with integral thermostat maintains minimum 50 deg F (10 deg C) temperature in gas burner compartment.

2. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

3. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

## 2.23 AUTOMATIC TEMPERATURE CONTROL (ATC) EQUIPMENT

A. Area Classification

1. Where specific area classifications are called for or shown on the electrical drawings, all equipment and wiring shall be in conformance with the requirements for that classification as specified in Division 16. Special attention shall be given to hazardous areas specifically "Class I Div. 1 Group D" and "Class I Div. 2 Group D" to comply with code requirements for equipment selection and installation procedures.

B. Room Thermostats

1. Electric room thermostat shall be of the heavy duty all metal type, provided with concealed adjustment and exposed thermometer.

2. Temperature sensors shall be of the wire-wound resistive element type (RTD) using either nickel or platinum alloy as the resistive element. All temperature sensors shall have an end to end (element to readout display) accuracy of plus or minus 0.5 degree F.

3. Room thermostat and temperature sensors mounted on exterior walls shall be provided with insulated mounting plates.

4. All room thermostats and sensors shall be mounted 5-ft-6-in above finish floor except where otherwise indicated on the Drawings or specified herein.

5. Electric thermostats in corrosive areas shall be installed in electric boxes with remote stainless steel bulbs.

C. Static Pressure Sensors - Shall be adjustable, set point proportional type, with adjustable range in inches of water to meet the performance or function specified.

D. Ionization Type Smoke Detectors (Four Wire Type)

1. Furnish and install ionization type smoke duct detectors in the supply air duct and return air duct or plenum of each air handling unit and in the exhaust air duct of systems which exhaust greater than 50 percent of the supply air. This applies to all air systems of 2000 cfm or greater or where shown on the Drawings.

2. The detector housing shall be listed per UL 268A specifically for use in air handling systems. The detector shall operate at air velocities of 500 to 4000 feet per minute. The detector housing shall be equipped with an integral mounting base capable of accommodating either photo electronic or ionization detector heads. It shall be capable of local testing via remote testing station. The duct detector housing shall incorporate an airtight smoke chamber in compliance with UL 268A, Standard for Smoke Detectors for Duct Applications. The housing shall be capable of mounting to either rectangular or round ducts without brackets. An integral filter system shall be included to reduce dust and residue effects on detector and housing, thereby reducing maintenance and service.

3. Detectors shall be provided with two sets of contacts to provide smoke alarm signals. One is to be used by the ATC systems, and the second is for use in Division 16 for interface to fire alarm system.

4. Remote test switch and alarm indicator stations shall be furnished for all duct smoke detectors as specified above. The installation and wiring of the remote stations will be provided under this Section. The remote test stations shall be wall mounted within the visible location of the smoke detector and easily accessible from the floor.

E. Dampers

1. Automatic dampers shall be parallel or opposed blade as specified under “Sequence of Operation.”

2. All damper frames are to be constructed of the same material as the duct or with grade 316 stainless steel with greater corrosion resistance and shall have flanges for duct mounting. Damper blades shall not exceed 6-in in width. All

blades are to be of corrugated type construction, fabricated from two sheets metal, spot welded together. Blades are to be suitable for high velocity performance. Maximum blade length in any section shall be 48-in. Additional stiffening or bracing shall be provided for sections exceeding 48-in in height. Multi-section dampers shall be provided with sufficient interconnecting hardware to provide unison operation of blades in the entire assembly.

3. All damper bearings shall be made of nylon.

4. Replaceable butyl rubber or bulb vinyl seals are to be provided with the damper. Seals are to be installed along the top, bottom and sides of the frame and along each blade edge. Seals shall provide a tight closing, low (1 percent) maximum leakage damper.

5. Dampers shall be selected for the velocity and pressure differential required without excessive deflections.

6. Modulating dampers shall be of opposed blade construction. Dampers for two position operation may be single direction multiple-leaf type.

7. Dampers may be furnished for in duct mounting and with face linkages if the following conditions are met.

   a. Service is for supply or makeup air in either process or non-process areas or service is for return or exhaust of non-corrosive air.

   b. Space is available to install a 24 by 24 (minimum) access door in the duct on the linkage side of the damper.

8. Dampers shall be furnished for flange mounting with exposed jamb mounted blade linkages for any of the following applications:

   a. Where installation clearances do not allow the installation of full size access doors to allow inspection and adjustment of face linkages.

   b. For corrosive, dirty or particle laden air service.

   c. Where called out on the Drawings.

F. Electronic Damper Actuators

1. Electronic actuators, less than 600 in-lb of rated torque, shall have ISO 9001 quality certification and be UL listed under standard 873, CSA C22.2 No. 24 and have CE certification. Electronic actuators used on dampers shall be designed to directly couple and mount to a stem, shaft or ISO style-mounting pad. Actuator mounting clamps shall be a V-bolt with a toothed V-clamp creating a cold weld, positive grip effect. Single point, bolt or single screw actuator type fastening techniques or direct-coupled actuators requiring field assembly of the universal clamp is not acceptable.

2. Actuators shall be fully modulating/proportional, pulse width, floating/tri-state, or two position as required and be factory or field selectable. Actuators shall have visual position indicators and shall operate in sequence with other devices if required. Proportional actuators shall be capable of digital communication, as built.

3. Two sets of DPDT switches with fully adjustable set points shall be provided to activate panel indicators and provide signals for equipment operation.

4. Actuator shall have an operating range of minus 22 to 122 degrees F.

5. Proportional actuators shall accept a 0 to 10 VDC or 0-20 mA input signal and provide a 2 to 10 VDC or 4-20 mA (with a load resistor) operating range.

6. Actuators shall be capable of operating on 24, 120 or 230 VAC or 24 VDC and Class 2 wiring as directed by the application. Power consumption shall not exceed 10 VA for AC, including 120 VAC actuators and 8 watts per actuator for applications

7. NEMA 2 rated actuators shall be provided with a three foot (minimum), prewired, electrical cable. Actuators requiring removal of the actuator cover for access to wiring terminals, exposing electronics, printed circuit boards to damage, are unacceptable.

8. Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation. End switches to deactivate the actuator at the end of rotation or magnetic clutches are not acceptable.

9. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Spring return actuators shall be capable of CW or CCW mounting orientation. Spring return models >60 in-lb will be capable of mounting on shafts up to 1.05-in diameter. Spring return actuators with more than 60 in-lb of torque shall have a manual override metal crank. Upon loss of control signal, a proportional actuator shall fail open or closed based on the minimum control signal. Upon loss of power, a non-spring return actuator shall maintain the last position.

10. Actuators using “on-board” chemical storage systems, capacitors or other “on-board” non-mechanical forms of fail-safe operation are unacceptable.

11. Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required. Dampers requiring greater torque or higher close off may be assembled with multiple low torque actuators. Dual mounted actuators using additional anti-rotation strap mechanical linkages, or special factory wiring to function are not acceptable. Actuators in a tandem pair must be “off the shelf” standard actuators ready for field wiring.

12. Dampers actuators will not produce more than 62 dbA when furnished with a mechanical fail-safe spring. Non-spring return actuators shall conform to a maximum noise rating of 45 dbA with power on or in the running or driving mode.

13. Proportional actuators shall be fully programmable. Control input, position feedback and running time shall be factory or field programmable. Diagnostic feedback shall provide indications of hunting or oscillation, mechanical overload, mechanical travel and mechanical load limit. The actuators shall also provide actuator service data, at a minimum, number of hours powered and number of hours in motion.

14. Actuators shall not be manufactured by a control manufacturer.

15. Where special classifications are shown on the electrical drawings damper actuators shall be provided with suitable enclosures.

16. NEMA 4X enclosures shall be Type 304 stainless steel and shall have a shaft seal and all electrical connections shall be suitable for the space classification. Enclosure shall be UL listed.

17. Explosion-proof enclosure shall be suitable for Class I, II and III. A suitable shaft seal must be provided. Housing shall be cast copper fill aluminum with stainless steel fasteners and shall be UL listed. Housing shall be suitable for NEMA 4, 7 and 9.

G. Local ATC Panels

1. Where shown on the Drawings or required by the control sequence, provide local ATC panels.

2. All controllers, relays, switches, etc, for equipment shall be mounted within ATC cabinets with hinge lock type doors where shown on the Drawings. All temperature settings, adjustments and calibrations shall be made at the system control panel.

3. Submit details of each ATC panel for approval prior to fabrication. Locations of each panel are to be convenient for adjustment and service. Provide engraved nameplates beneath each panel mounted control device clearly describing the function of said device and range of operation. All manual switches and dial thermometers shall be flush mounted on the hinged door, with permanent labels showing the function of each item. All other devices shall be located within the cabinet mounted to a sub panel.

4. All electrical devices within the panels shall be factory pre-wired to a numbered terminal strip. All wiring within the panel shall be in accordance with NEMA and UL standards and shall meet all local codes.

5. Unless otherwise specified herein or shown on the Drawings, control panels shall meet the requirements for Electrical Products specified elsewhere in this Section.

6. Electrical power supplied to automatic temperature control panels shall be 120V, single phase, 60Hz. Where 24V power is required, a 120/24 transformer shall be provided. The transformers shall be sized for their control system electrical loads. Transformers shall be mounted in the local control panel.

7. Provide a 110V power receptacle in each panel.

8. Provide a copy of the wiring and control diagram for all work in each panel. The diagram is to be stored in a pocket on the door.

H. Miscellaneous Devices - Provide all the necessary relays, limit switches, positioners, clocks, transformers, etc., to make a complete and operable system. Locate these devices on local ATC panel unless specified otherwise.

I. Name Tags - All sensing devices, transmitters, controllers, not mounted in a clearly labeled panel, or which are not an obvious part of a clearly labeled device, shall be provided with an engraved plastic plate containing the name, function and system or system number for the device.

J. Set points on thermostats and temperature controllers, shown on the Drawings are indicative only and devices shall be adjustable above and below such set points. If a set point is not stated, the control range of devices shall be suitable for the intended service. Range of devices shall be approximately 50 percent greater in both directions than span of variable, with a minimum of 25 degrees and a maximum of 100 degrees F for air systems.

K. Thermometers - Thermometers shall be flush mounted on local panels. These thermometers shall be of the dial type, minimum 3-in diameter.

L. Break Glass Switches

1. Break glass switch enclosures shall be made from corrosion resistant fiberglass reinforced polyester. The enclosure cover shall be gasketed and fasteners shall be Type 316 stainless steel. The hammer shall be attached to the side of the enclosure with an 11-in chain. The unit shall be the automatic type that when the glass is broken, the alarm circuit shall activate. The alarm circuit shall consist of one NO and one NC contact. The front of the enclosure shall be labeled “VENTILATION SYSTEM, EMERGENCY SHUTOFF”,

2. Units shall be 8146/552 as manufactured by Killark Electrical Manufacturing Company.

M. Flow Switches and Sensors

1. Flow switches for clean air applications (supply and makeup air) shall be adjustable differential pressure type with an adjustment range suitable for the application. Switches shall be arranged for sensing system velocity pressure through the use of a pitot tube arrangement. Pitot tubes shall be accessible and removable for inspection and maintenance.

2. Flow switches for general HVAC exhaust applications shall be vane (paddle) type switches suitably selected for the expected duct velocity, positioned in the ductwork to be accessible and located so as to avoid nuisance tripping and unreliable operation due to flow turbulence. Vane and vane blocks shall be Type 316 stainless steel. Switches and control wiring shall be arranged so switch is easily removable from ductwork to permit vane inspection, without disconnecting the wiring.

3. Flow switches for spaces classified wet, corrosive or explosive shall be thermal dispersion type sensors using a heater and a heated and unheated RTD sensor to define flow based on temperature differential between the two sensor RTDs. Housing shall be aluminum construction NEMA 4X and all parts of the sensor in contact with the measured air stream shall be Type 316 stainless steel. Units shall be powered by 120 Volt, single phase, 60 Hz power taken from the control panel. The unit set point shall be field adjustable and shall activate a set of NC, NO contacts. Flow switches shall be Model 12-64 Insertion Flow Switch manufactured by Fluid Components, Inc San Marcos, CA or equal. Each duct airflow switch for system status shall activate two SPDT 10 amp dry contacts located in its respective control panel for status indication. Provide panel indicator lights for system “normal” and “failure” status indication and provide “failure” annunciation. Provide a portable monitor/calibrator or equivalent service for testing and calibrating the flow sensors. The monitor calibrator shall

be manufactured by the same manufacturer as the flow switch. Sensors shall be set after the system has been balanced.

4. Flow sensors for spaces classified wet; corrosive or explosive shall be thermal dispersion type sensors using a heated and RTD sensor probe to define flow. Housing shall be aluminum construction NEMA 4X and all parts of the sensor in contact with the measured air stream shall be Type 316 stainless steel. Units shall be powered by 120 Volt, single phase, 60 Hz power taken from the control panel. The unit set point shall be field adjustable and shall provide a 24 Volt DC signal. Flow sensors shall be Model FLT 9 3B manufactured by Fluid Components, Inc San Marcos, CA or equal. Each duct airflow sensor for system status shall provide flow indication by LED and activate two SPDT 10 amp dry contacts located in its respective control panel for status indication. Provide panel indicator lights for system “normal” and “failure” status indication and provide “failure” annunciation. Provide a portable monitor/calibrator or equivalent service for testing and calibrating the flow sensors. The monitor calibrator shall be manufactured by the same manufacturer as the flow switch. Sensor alarm points shall be set after the system has been balanced.

5. Where specifically called for on the Drawings or in the control sequences, current measuring devices shall be used for flow monitoring. Devices shall measure the actual current for the fan or pump motor and compare it to a predetermined range. The range is to be determined by measurement during system balancing. The use of sensors that only respond to a condition of current or no current are not acceptable.

6. Where specifically called for on the Drawings on in the control sequences, ON_OFF current sensing devices that sense current are acceptable. ON_OFF current devices are only to be used where specifically allowed.

N. Electronic Sensors

1. All mixed air and coil discharge sensors shall utilize industry standard 4-20 mA sensors with averaging elements. Sensing elements shall be a minimum of 25-ft and temperature sensed shall be averaged over the entire length of the element. Thermistor type sensors will not be acceptable for this application.

2. Space type sensors shall have an accuracy of plus/minus .5 degrees over sensed temperature range (20 to 120 degrees F).

3. Well type sensors used for liquid immersion shall have stainless steel removable wells. Sensing element shall have an accuracy of plus/minus .5 degrees over range (70 to 220 degrees F or 20 to 120 degrees F) of the sensor. Each sensor shall have a suitable electrical box to enclose all wiring connections.

4. Temperature control wells shall be installed by the HVAC Contractor under supervision of the temperature control contractor.

O. Field Wiring

1. All field wiring, other than power wiring, between control cabinets (A.T.C. control), control devices, unitary control panels and control terminals in motor control centers shall be furnished under this Section and shall conform to the requirements of Division 16.

2. 120V line voltage wiring to suspended and cabinet unit heaters and their thermostats shall be considered power wiring. All interlocking wiring within MCC shall be installed under Division 16.

3. Refer to the electrical drawings for NEMA enclosure types, other than NEMA 1, by room or location designation such as "Damp", "Wet", "Corrosive", "Class - Div. - Group -".

4. Installation of all conduit, wire, sleeves, outlet boxes, insulating bushings, system cabinets, terminal boxes, pull boxes, junction boxes, inserts, anchors, system devices, etc, shall be in accordance with the appropriate requirements of Division 16 and in accordance with the requirements of the current edition of the local codes for signal systems and electrical systems.

5. Run wiring in rigid steel conduit except in dry locations above ceilings and wood or metal stud framed partition walls, where EMT may be used. Conduit, boxes and fittings and their installation and testing shall be as specified in Section 16110.

6. Wire, with the exception of DDC cable and thermostat wire, shall be copper type THHN/THWN insulated for 600 Volts. Wire and its installation and testing shall be as specified in Section 16120.

7. In the event of any conflict among referenced codes, current editions of the applicable local codes shall take precedence for interpretation of "Signal System" installation requirements.

8. Installation of sensor wiring in finished areas shall be concealed whenever possible. Where concealed wiring is not possible, written approval for exposed work must be obtained from the Engineer prior to installation.

9. A power supply 115V, single phase, 60 Hz, 20 Amp circuit for ATC, requirements will be available at each local control panel. Power shall not be taken from the control power transformers of the motor control center.

10. Coordination Issues

    a. When motors are manually or automatically controlled from the HVAC ATC panels, the panels shall include a set of normally dry (unpowered) contacts (for connection to the motor started) which close when the motor is to operate. The ATC contractor will wire these contacts to the motor starter and make connections to the terminals provided. Contacts shall be rated 120 Volts, 10 Amperes, 60 Hz for inductive and resistive loads.

    b. A set of normally open dry (unpowered) contacts (for connection to the HVAC ATC panel) which close when the motor starter has pulled in, shall be provided under Section 16000. The ATC contractor will make connections to the terminals provided and wire these contacts from the motor starter to the HVAC ATC panel to signal the motor is operating.

    c. Line voltage thermostats will be furnished and installed under this section.

    d. The electrical contractor will provide a 120V circuit to all control panels shown on the Drawings. Power for the control systems is to be taken from the panels and no other source.

e. Flow alarms that require line voltage electric power to operate are to be furnished and installed under this Section. Units shall be powered by 120 Volt, single phase, 60 Hz power taken from the control panel. The flow alarms shall be provided with two sets of contacts. One set will be wired by the electrical contractor for the instrumentation system. The second contact will be used to provide an HVAC signal which will be wired under this Section.

f. Alarms from the HVAC systems that provide a signal to the central control system will be furnished and installed under this Section. The alarms shall be provided with two sets of contacts. One set will be wired by the electrical contractor for the instrumentation system. The second contact will be used to provide an HVAC signal which will be wired under the Section.

g. The electrical contractor will provide an NO contact input to the generator room ATC panel to indicate operation of the generator for use in the control sequences.

h. The following wiring is to be done under this Section:

i. Between ATC panels and MCCs.

j. Between ATC panels and control panels on equipment provided by the HVAC contractor.

k. Between alarm devices provided by the other trades and ATC panels.

l. Power wiring from the ATC panels to smoke detectors and flow sensors.

m. Wiring from smoke detectors provided under this Section to the building fire alarm systems will be provided under Division 16.

n. Refer to electrical drawings for details of wiring at motor control panels. Provide all interconnecting wiring to start and stop motors.

P. Software licensing and user agreements shall be based on a one time fee. Agreements that remove all responsibility for the software and its performance are not acceptable.

2.24 SEQUENCE OF CONTROLS

A. General

1. HVAC equipment will operate with the following sequences of operation.

2. The following will apply to all sequences.

a. All sequences are reversible unless otherwise noted.

b. Manual reset of control functions with manual reset will be at the local control panel unless otherwise noted.

c. Where required to prevent nuisance shut downs of systems, provide time delay of sensors to allow system start up before the sensors are activated. This would include, but not be limited to low temperature freeze protection on 100 percent outdoor air units.

d. For fan systems with shut off dampers and air flows greater than 2000 cfm and fan operating static pressure greater than 1-in water gauge, fans shall be stopped and started by damper end switches. When the sequence calls

for the fan to run, the control system shall open the respective damper. When the damper is open as indicated by an end switch on the damper the fan shall start.

e. Where control sequences refer to activation of an alarm indicator, it will be understood to mean activation of a labeled pilot light at the local ATC panel. A dedicated pilot light will be provided for each alarm unless a common alarm light is specified.

f. The ATC contractor shall provide all connections, relays and other devices required to operate the system under the control of the firefighter control panel.

3. Reference drawings for control drawings and sequences.

4. Exhaust Fan with Exhaust Damper and Outdoor Air Intake Damper Manual Control

PART 3: EXECUTION

3.01 INSTALLATION

A. The Contractor shall start up each piece of equipment and system and shall make all adjustments so that the system is placed in proper operating condition.

B. The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

C. Equipment

1. Install equipment in accordance with manufacturer's recommendation. Provide piping and ductwork connections in accordance with the requirements as specified elsewhere in this Section.

D. Insulation – General

1. Do not apply insulation prior to testing and acceptance of piping, ductwork and/or equipment. Insulation shall not be applied to damp or frosty surfaces. Clean dust, dirt, grease and moisture from surfaces of pipe and ducts before applying insulation or insulation adhesives. Install all insulation in a neat and workmanlike manner. Nameplates and equipment certification and data tags affixed to any piece of apparatus must remain exposed to view. Where two layers of insulation are used, stagger all joints both ways. Secure each layer independently. Continue insulation through walls, partitions, floors and pipe sleeves.

2. The recommendations and instructions of the manufacturers of products used in the work are hereby made part of this Section except as they may be superseded by other requirements of this Section.

3. Adhesives, coatings and vapor barrier materials shall be applied as specified by the manufacturer. Do not apply these materials when ambient temperature is above or below the maximum and minimum ambient temperature respectively, specified as limits by the manufacturer. In general, these limits are 90 degrees

F and 40 degrees F, however, the limitations are to be checked for each product.

4. All penetrations through a vapor barrier for hangers, instruments, etc, shall be sealed to provide a complete vapor barrier. The use of staples or other fasteners that penetrate the vapor barrier shall not be permitted.

5. Insulation systems that require a vapor barrier shall be installed with an intact vapor barrier that covers the entire pipe, duct, or piece of equipment to be insulated. All edges of insulation that do not abut another piece of insulation shall have the vapor barrier extended, and sealed to the item being insulated. All penetrations through the insulation such as for thermowells, test ports, dampers, nameplates, or other items shall have the vapor barrier extend over the edges of the insulation and sealed to the item being insulated. Where items are mounted on ductwork a standoff shall be provided to protect the vapor barrier. The vapor barrier shall be sealed to the standoff.

6. For insulated items exceeding 100 square feet, or 20 feet in length, extend the vapor barrier to the item being insulated to reduce the area or length within a single enclosed area to the dimensions listed above.

E. Fiber Glass Piping Insulation

1. Omit the specified insulation at pipe supports and substitute rigid insulation such as cellular glass, calcium silicate, or expanded silica with a protective metal shield of a thickness and length as specified in MSS Bulletin SP-69 Table 4. Secure the shield with at least three 1/2-in aluminum bands. Where piping is supported by roller hangers insulation saddles shall be installed. The space within the insulating saddles at pipe hangers shall be filled with insulation.

2. Approved vaporseal adhesive shall be used to seal seams and to butt sections on all cold piping if self sealing laps are not provided. The use of staples or any other fastening method that would penetrate the vapor barrier will not be used on cold piping systems. Staples may be used on hot piping systems where there is no potential for condensation.

3. Apply insulation in thicknesses listed. Seal laps and joints using self-sealing laps or vapor barrier tape. Lap in horizontal piping shall be at the top. Seal ends of insulation sections at flanges, valves and fittings on 15-ft centers in straight pipe with vapor barrier coating that extends from vapor barrier jacket to the piping. Seal all penetration of the vapor barrier vapor tight.

4. Fittings shall be molded fiberglass or mitered sections of pipe insulation to provide the same insulation value as required for straight piping. Seal PVC fitting covers, where specified, with vaporseal adhesive. Wrap circumferential edges with vapor barrier tape. Where preformed aluminum fitting covers are specified, apply a vapor barrier coating reinforced with glass cloth directly to the insulation before installing the fitting cover. Install the vapor barrier in accordance with the coating manufacturer's instructions. Attach aluminum fitting covers with aluminum draw bands with joints located to shed water. Flange covers shall be designed for removal without damaging the pipe insulation.

5. Where possible, all insulation shall be continuous through wall and floor openings and sleeves.

6. Insulation Thickness

| Service | Pipe Size | Insulation Thickness |
|---|---|---|
| Condensation Drains (All Metal Jackets) | All Sizes | 1-in |

F. Closed Cell Foam Piping Insulation

1. Insulation for Cold Piping Closed Cell Foam (Type I-12)

a. Installation

1) Apply insulation in thicknesses indicated. Joints shall be sealed using self-sealing seams or adhesive.

2) Fittings shall be covered with the same insulation, mitered to fit.

3) Apply insulation in the thickness indicated. Attach insulation to sheet metal duct. Joints shall be made to have compression fit with the joints sealed with adhesive. Manufacturer's installation instructions shall be followed. Adhesives and coatings shall be provided by the insulation manufacturer and shall be compatible with the insulation. Insulation shall be provided with a protective finish for outdoor use in accordance with manufacturer's recommendations.

2. Insulation thickness shall be as specified in the respective Piping System Sections.

G. Ductwork Insulation

1. For purposes of insulation, flexible ductwork shall be treated as sheet metal ductwork.

2. Provide all cold ductwork with a vapor barrier. Where the method of attachment causes penetrations of the vapor barrier, seal such penetrations with vaporseal adhesive and vapor barrier tape.

3. Clips, pins, washers, staples, and other metal components shall be grade 316 stainless steel. Where items of grade 316 stainless steel material are not available, material shall be of the same material as the corrosion resistance duct to be insulated. If a different material of equal corrosion resistance is to be used, it must be approved by the Engineer.

4. All outside corners of ductwork in the traffic level shall be protected by sheet metal angles. Angles shall be 22 gauge galvanized steel with 2-in legs. When the duct is constructed of materials other than galvanized steel, the protective angle shall be fabricated of the same material as the duct, or of equal corrosion resistance. If a different material of equal corrosion resistance is to be used, it must be approved by the Engineer. Angles shall be attached to the outside of the vapor barrier with adhesive. The entire inside surface of the corner angle shall be coated with adhesive before being installed.

5. All joints in insulation shall be compressed 0.25-in. Corner insulation shall be lapped with the overlap extending over the full thickness of the insulation layers. Open spaces in joints are not acceptable. A minimum of two layers of insulation shall be used when the required insulation thickness is greater than 2-in. Joints in adjacent layers shall be staggered a minimum of 3-in.

6. All ductwork, except as specifically noted below, shall be insulated unless approved in writing by the Engineer.
    a. Exposed supply and return air ductwork located in the area it serves.
    b. Exposed ventilation exhaust and relief ductwork located in the area it serves.
    c. Exposed ventilation and relief ductwork located in areas that are neither heated nor cooled.
    d. Exposed outdoor air intake ductwork and plenums located in areas that are neither heated nor cooled.
    e. Return air ductwork located in return air ceiling spaces above the area it serves, except where the return ductwork is installed in ceiling spaces with a roof above.
    f. Toilet exhaust from toilets without showers, up to the exhaust air plenum if applicable.
    g. Toilet exhaust from toilets with showers in heated spaces, up to the exhaust air plenum if applicable.
    h. Process exhaust ductwork when the exhaust air temperature is within plus/minus 10 degrees F of the surrounding space, up to the exhaust air plenum if applicable.

H. Ductwork Insulation - Blanket Type

1. Hot Ductwork
    a. Installation - Apply insulation in the thickness listed below. Adhere insulation to the duct surface with adhesive applied in strips 6-in wide on 12-in centers. Butt all joints and lap jacket 2-in over adjoining jacket. Seal all lap joints with vaporseal adhesive and staples. For ducts 30-in wide and over, additionally support insulation on bottom of duct with rows of welded or adhesive clips and washers on 18-in centers.
    b. Insulation Thickness - Concealed round and rectangular hot ductwork and exposed round hot ductwork.

| | | |
|---|---|---|
| 1) | Supply ducts in heated spaces | 1-1/2-in |
| 2) | Supply ducts in unheated spaces | 2-in |
| 3) | Return ducts | 1-1/2-in |
| 4) | Mixed air ducts | 1-1/2-in |

2. Cold and Hot/Cold Ductwork
    a. Installation - Apply insulation in the thickness listed below. Adhere insulation to the duct surface with adhesive applied in strips 6-in wide on 12-in centers. Butt all joints and lap jacket 2-in over adjoining jacket. Seal all lap joints with vaporseal adhesive and staples. For ducts 30-in wide and over, additionally support insulation on bottom of duct with rows of welded or adhesive clips an washers on 18-in centers. Seal penetrations, staples and terminations of vapor barrier with vapor barrier coating.

b. Insulation Thickness - Concealed round and rectangular cold and hot/cold ductwork and exposed round cold and hot/cold ductwork.

| | | |
|---|---|---|
| 1) | All ducts in non-conditioned spaces | 2-in |
| 2) | All ducts in conditioned spaces | 1-1/2-in |
| 3) | Outdoor air ducts and plenums | 2-in |
| 4) | Discharge air ducts and plenums | 2-in |
| 5) | Exhaust air ducts and plenums between shut-off damper and outdoors | 2-in |
| 6) | Ventilation supply air ducts and plenums between shut-off damper and outdoors | 2-in |

I. Ductwork Insulation - Fiberglass Board Type

J. Ductwork Insulation - Closed Cell Foam Type

1. Installation - Apply insulation in the thickness listed below. Attach insulation to sheet metal ductwork with a full coverage coat of adhesive. Make joints to have a compression fit with the joints sealed with adhesive. Cut insulation at standing joints and seams in the ductwork and apply additional layers of insulation over the standing joint or seam to obtain an insulation thickness equal to that on the surface of the duct. Follow all manufacturer's installation instructions. Adhesives and coatings shall be provided by the insulation manufacturer and shall be compatible with the insulation. Insulation shall be provided with a protective finish for outdoor use in accordance with manufacturer□s recommendations.

2. Insulation Thickness

a. Outdoor mounted round and rectangular hot, cold and hot/cold ductwork.

| | | |
|---|---|---|
| 1) | All air ducts | 2-in |

K. Installation of Ductwork

1. Fabricate and erect all ductwork where shown on the Drawings, as specified herein and in accordance with SMACNA requirements. Rigidly support and secure ductwork in an approved manner. Install hangers plumb and securely suspended from supplementary steel or inserts in concrete slabs. Sufficiently thread lower ends of hanger rods to allow for adequate vertical adjustment. Do not use building siding and metal decking to hang ductwork.

2. Wherever ducts are divided, maintain the cross-sectional area. All such changes must be approved and installed as directed by the Engineer or as approved on shop or erection drawings.

3. During installation, close the open ends of ducts to prevent debris and dirt from entering. Install work in accordance with the overall approved progress schedule and in cooperation with all other trades so there will be no delay to other trades.

4. Provide the unused portion of external louvers (where it is not used as a fresh air intake or exhaust) with a blank-off constructed of 0.0625-in aluminum. Provide blank-off panels with aluminum reinforcing angles to prevent buckling and secured to the exterior wall with aluminum angles and rustproof fasteners

on not more than 12-in centers. Provide caulking completely around the outside edge of the angle and the aluminum.

5. Install automatic dampers when supplied by other trades.

6. Cross-break sheet metal in accordance with SMACNA duct construction standard. Apply cross-breaking to the sheet metal between the standing seams or reinforcing angles. The center of the cross-break shall be of the required height to assure each panel section being rigid.

7. Cross-break steamlined ducts on top only and adequately brace internally.

8. Beading as specified in SMACNA will be acceptable in lieu of cross-breaking.

9. The Drawings of the air ducts and air risers show the general location for installation of the ducts and risers. Should additional offsets or changes in direction be made, these changes must be considered in the original bid and shall be installed at no additional cost to the Owner.

10. All necessary allowances and provisions shall be made in the installation of the ducts for the structural conditions of the building. Ducts shall be transformed or divided as may be required. Wherever this is necessary, maintain the cross-sectional area. All of these changes, however, must be approved and ducts installed as directed by the Engineer or as approved on shop or erection drawings.

11. The taper of all transformations shall be not more than 15 degrees.

12. Secure casing to curbs according to SMACNA Duct Construction Standards.

13. Provide baffle plates as required to prevent stratification and to provide proper operation of controls.

14. Where ducts are constructed of materials other than galvanized steel the reinforcing members shall be of the same material as the ductwork.

15. For PVC ductwork where reinforcing members of material other than PVC are required, totally encase the reinforcing member in PVC.

16. The use of button punching or snap locks on ductwork constructed of aluminum shall not be permitted.

L. Hangers

1. The use of wire to hang flexible ductwork shall not be permitted.

2. Ductwork shall not come in contact with any of the ceiling construction or any other equipment in the ceiling cavity.

M. Sealing of Ductwork

1. General - Unless otherwise indicated, seal all ductwork joints and seams using sealant in accordance with the instructions of the sealant manufacturer and this Section. All transverse seams, joints and fitting connections, both shop and field assembled, shall be sealed in accordance with this Specification. Not more than one longitudinal seam shall be unsealed in each section of duct.

2. Application of Sealant - Thoroughly clean all seams, joints, etc, of dirt, oil, grease, or other coatings which might interfere with the adhesion of the duct sealant before the sealant is applied.

3. Uncured sealant may be forced into the slotted side of the seam or joint before shop or field assembly, and the joint or seam completed while the sealant is still uncured. Excess sealant shall be removed from both the inside and outside of the duct before it sets.

4. Duct Tape - The use of duct tape alone for sealing ductwork is prohibited. Duct tape may be used primarily for the purpose of retaining the uncured duct sealant in seams and joints until it has cured. Duct tape shall not be applied to the inside of any duct nor shall it be applied to standing type joints at any time. All duct tape used shall be compatible with the sealant.

5. Sealant shall be either in liquid form or a mastic with a maximum flame spread of 25 and a maximum rate of fuel contributed and smoke developed of 50 when tested in accordance with ASTM E84, NFPA 255 and UL 723.

6. Sealing systems shall be suitable for the environment. The following schedule is to be used to select the sealant.

    a. Indoor, dry galvanized round and rectangular duct is to be sealed with Iron Grip 601 or equal.

    b. Indoor, dry, stainless steel, aluminum and PVC coated is to be sealed with FTA 20 adhesive and DT-Tape gypsum or equal.

    c. All other areas unless otherwise noted are to be sealed with FTA 50 adhesive and DT-Tape gypsum or equal.

    d. All sealers listed or manufactured by Hardcast Inc. and are to define the type of sealer. Other equal sealants are acceptable.

N. Ductwork Fittings and Accessory Items

1. Duct Elbows - For rectangular ductwork where full radius elbows cannot be installed, provide abrupt elbows equipped with shop-installed hollow, air foil turning vanes.

2. Flexible Connectors

    a. Install flexible connectors at all duct connections to fans, fan units or blowers, air handling units and air conditioning units. Make connections substantially air tight at all seams and joints.

    b. Where the construction of the flexible connection or vibration isolator results in a cross sectional area of the connection which is less than 90 percent of the adjacent ductwork, the size of the connection shall be increased to provide a cross sectional area equal to or greater than 90 percent of the adjacent duct.

    c. Provide flexible duct connections at both the intake and discharge connections for all fans and air handling units except as noted below:

        1) Wall and roof fans that have integral motor/fan wheel isolation.

        2) Air handling units where the fan is isolated from the intake and discharge connections by internal flexible connections or separations,

and the unit is mounted without vibration isolators between the unit and the support structure.

3. Dampers

   a. Install manual volume control dampers wherever it may be necessary to regulate air volume for system air balancing and where shown on the Drawings.

   b. Install splitter dampers, where shown on the Drawings, to regulate air volume for system air balancing. Splitter dampers shall be single blade, end pivoted type, manual adjustment and position locking arrangement.

   c. Factory-fabricated volume extractors shall be used at all supply air diffusers.

   d. An access door, of ample size to permit maintenance and resetting of damper blades, shall be installed at each opposed blade damper, splitter damper and volume extractor so located for easy access to the damper blades.

4. Access Doors

   a. Provide access doors at the following locations (minimum requirements):

      1) Automatic dampers - linkage side.

      2) Duct mounted temperature controllers.

      3) Freeze-stats.

      4) Fire dampers.

      5) Smoke dampers.

      6) Filter banks.

   b. Where access doors are required in ductwork located above ceilings, coordinate the location of the access doors to clear the ceiling support system and to be accessible through the ceiling grid.

5. Duct Liner - Duct liner shall be shop installed on the interior surfaces of ductwork, where shown on the Drawings or specified herein. Duct liner shall meet with requirements of the NFPA Standard No. 90A for flame spread and smoke development. Duct liner shall be 1-in thick, 1-1/2 lb density, mat-faced, neoprene coated, glass fiber insulation. Installation shall be made using a single thickness of duct liner and shall be in accordance with SMACNA "Acoustical Liner." Liner shall be adhered with adhesive having a minimum of 90 percent coverage. Fasteners shall be spaced in accordance with SMACNA. After the duct has been formed the leading edges of the insulation that will be abutting another lined duct shall be spray-coated with fire-resistive adhesive. For ductwork with velocities exceeding 4000 fpm a metal nosing shall be installed at all transverse edges to secure the duct liner.

6. Blast Gates - Shall be factory fabricated of the type that completely encircles the duct in which it is mounted. After final balancing of the system, drill a hole through both the frame and gate and insert a positive locking device, such as a pop rivet, to prevent moving the gate.

O. Grilles, Registers and Diffusers

1. The location of diffusers, registers and grilles shall be as shown on the Reflected Ceiling Plans. Where diffusers, registers and grilles are not located in the ceiling, there are no Reflected Ceiling Plans provided, the location shall be as shown on the ductwork drawings. The exact location of these devices shall be determined in the field in cooperation with the other trades.

2. Install all devices in an approved manner in accordance with the manufacturer's recommendation.

P. Flexible Ductwork

1. Make connections, joints and terminations air tight as recommended by the manufacturer. Where joints are made to rigid sheet metal ductwork, apply 3M Company EC-800 sealer and the joint shall be drawn tight with a drawband. Collars shall be 2-in long minimum and sleeves shall be 4-in long minimum.

2. Install flexible ducts with one duct diameter-radius elbows and cut as short as possible. Duct shall not be compressed and the length shall be kept short so minimum hangers or supports are required, and static pressure losses are kept to a minimum. Sag in flexible duct shall not exceed 1/2-in/ft between duct supports.

Q. Filling in Space Around Ductwork

1. To prevent sound passing through the area between the duct and the framed or cut opening in the floors, walls or partitions, pack mineral wool to completely fill the space the full depth of the opening. Whenever a fire-rated wall or floor is penetrated, fill the space around the duct with a locally approved type of fireproof rope.

2. At firewalls, apply galvanized sheet metal escutcheon plates on both faces of the wall to close the gap between the structure and the sides of the insulated or bare duct.

R. Duct Supports Through Floors

1. Where vertical ducts pass through floor openings, rigidly attach supporting angles to the ducts and anchor with expansion bolts to the floor or curb. Angles shall be of the same material as the duct for metal duct and stainless steel for non metallic ducts, placed on the two long sides of the duct extending 3-in over edge of opening, and shall not be less than the sizes recommended by SMACNA. Remaining open areas shall be filled in with a plate of the same material as the angles.

S. Supporting Outdoor Ducts

1. Provide the ducts installed above roof with angle 316 stainless steel supports. Sizes of angles shall be as shown on the Drawings.

2. The vertical supporting angles shall be continuous full height of the duct and shall be bolted to same. These, together with intermediate supporting angle as required, shall be provided with bottom plates which shall be welded to the vertical angles. Attach the plates with anchor bolts to sleepers, which shall be

placed on scraped roofing. Weld all of these angles together to form a stiff continuous supporting unit for the duct.

3. Slope ducts to shed water.

T. Ductwork at Masonry

1. Where ducts connect to, or terminate at masonry openings, or along the edges of floors where concrete curbs are not being provided, place a continuous 2-1/2-in by 2-1/2-in by 3/16-in angle of the same material as the duct around the ductwork. Then bolt the angle to the construction and make airtight to same by applying caulking compound on the angle before it is drawn down tight to construction.

2. Fasten plenums to concrete curbs with 3-in by 3-in by 1/4-in thick continuous angle. Concrete curbs will be provided under another Division. This angle shall sit on a continuous bead of caulking compound and be anchored to the curb at 16-in centers. Terminate the sheet metal at the curb and bolt to the angle. Seal the sheet metal to the curb with a continuous bead of caulking compound.

3. When exposed ducts pass through finished floors, walls or ceilings, provide angle collars completely covering space around duct.

U. Quality of Ductwork Installation

1. All ductwork shall be free from pulsation, chatter, vibration or objectionable noise. After system is in operation, should these defects appear, correct by removing, replacing or reinforcing the work.

2. The maximum allowable leakage of low pressure system shall be 5 percent of air volume.

V. Plenums

1. Seal fresh air inlet and exhaust air plenums at louvers or otherwise subject to weather entrainment watertight at all bottom joints and seams and up all vertical seams for a minimum of 12-in. After application, remove excess sealant before it sets hard. Where possible, pitch fresh air inlet and exhaust air plenums down towards the louver. Where it is not possible to pitch the plenum, provide a 1-in capped drain connection at the low point of the plenum.

W. Test Ports

1. Where shown on the Drawings and where required for testing and balancing, provide instrument insertion ports. Size and location of ports shall be coordinated with the Contractor performing air balancing. Seal ports with plastic snap lock plugs. When the ductwork will be insulated, extend the port to the face of the insulation and seal the vapor barrier to the port. When the ductwork is lined, extend the port into the duct to the inner surface of the duct liner.

2. In round ductwork provide 2 ports 90 degrees on centers. In rectangular duct-work provide ports are required by AABC or NEBB for a full traverse measurement.

3. As a minimum, ports shall be provided in the following connections:

a. All duct mains.

b. All duct branches unless all connections are diffusers, registers, or grilles and the total can be calculated by summing the readings for all of the connections.

c. All connections to tanks or hoods where there is no other access for taking a measurement.

4. A main duct is defined as one of the following:

a. A duct serving five or more outlets.

b. A duct serving two or more branch ducts.

c. A duct emanating from a fan or plenum.

d. All remaining ducts are considered branch ducts.

X. Piping

1. Pipe and Fittings

a. Install piping in a neat manner with lines straight and parallel or at right angles to walls or column lines and with risers plumb. Run piping so as to avoid passing through ductwork or directly under electric light outlets and/or interference with other lines or extending beyond furring lines as determined by Architectural Drawings. Accomplish all work using the best methods and procedures of recognized pipe fabrication in a good and workmanlike manner in accordance with the latest revision of applicable ANSI Standards, ASME Codes and PFI Standards.

b. Cut pipe square, not upset, undersize or out of round. Carefully ream ends and clean before installing.

c. Bending of pipe shall not be permitted. Use fittings for all changes in direction.

d. Do not remove end caps on pre-cleaned pipe until immediately before assembly. Cap all open ends immediately after completion of installation.

e. Thoroughly clean all piping interiors after installation and keep them clean by approved temporary closures on all openings until the system is put in service. Closures shall be suitable to withstand the hydrostatic test.

2. Soldering (Copper Tubing)

a. After cutting, thoroughly clean all surfaces to be soldered to a metal-bright finish, free from dirt, grease or other material before fluxing and soldering. Perform this cleaning by using emery cloth, sandpaper or steel wool. Clean the outside end of the tubing for a length of 1/2-in greater than the depth of the fitting. Clean the inside of the fittings in a similar manner. Apply non-corrosive flux and assemble the joint. Acid solder or acid flux will not be accepted.

b. Heat the surfaces to be joined slowly and uniformly to the melting point of the solder. Maintain the surface being soldered above the melting point of the solder for sufficient time to draw the solder completely into the joint. When the solder congeals to a plastic state, remove the excess metal with a cloth brush, leaving a fillet around the end of the fitting. Full penetration

of the solder uniformly throughout the entire socket is required. Allow the soldered joints to cool in still air until only warm to the hand, after which the work may be quenched.

c. Any type of crack, pinhole, area of incomplete penetration, or similar defect will not be accepted. Peening for closing up defects shall not be permitted.

d. Use heating torches of sufficient size for heating of large fittings prior to soldering. Multiple tips or ring burners for use on combination torches may be used.

e. Remove all external and internal loose solder and flux after joint cools.

3. Refrigerant Piping

a. Before and during silver soldering refrigerant piping, purge the assembly of pipe and fittings with dry nitrogen, to avoid formation of oxidation scale on inside of pipe during soldering.

b. Where specially prepared, Type R, cleaned or charged refrigerant piping is not available for equipment interconnection, with the Engineer's approval, the following procedure must be completed. Clean the interior of field assembled refrigerant piping after joining in four steps as follows:

1) Draw a clean lintless cloth through the piping to remove coarse dirt and dust.

2) Draw clean lintless trichlorethylene saturated cloth through the piping until cloth is not discolored with dirt.

3) Draw a clean cloth saturated with compressor oil through the piping.

4) Complete cleaning by drawing a clean, dry, lintless cloth through the piping.

c. Pressure test and charge immediately after cleaning.

3.02 FIELD TESTING

A. Testing and Balancing

1. General - Test, adjust and balance all HVAC systems. If required by the Engineer, tests shall be made during the progress of the work to demonstrate the strength, durability and fitness of the installation. Furnish all instruments, ladders, lubricants, test equipment and personnel required for the tests; including manufacturer's representatives for testing and start-up of all Contractor supplied equipment. Before testing and balancing, all systems shall be cleaned as specified. Submit four copies of records of all tests, measurements, settings of throttling devices and nameplate data to the Engineer.

2. Final Tests - Perform tests of all systems as required by the Engineer prior to final acceptance of the systems for the purpose of demonstrating satisfactory functional and operating efficiency as well as adjustment. During this period, check the setting of all automatic controls and take sufficient measurements to ensure that conditions are correct and that capacities are adequate to meet the specified requirements. Systems will not be considered complete until all tests have been concluded to the satisfaction of the Engineer and all other parties having jurisdiction. In event of leakage or defects, repeat tests until all faults are

corrected. Perform the general operating tests under as near design conditions as possible.

3. Perform all testing, adjusting and balancing under the supervision of a qualified heating, ventilating and air conditioning engineer employed by the air balance and testing agency. Reporting forms for testing and balancing shall be as recommended by the [AABC] [NEBB].

4. Coordination of the test shall be the responsibility of the balancing sub-contractor. Access to the site, availability of service representatives, and tenant acquiescence will be considered in the determination of both the testing schedule and the witnessed recheck of the balancing.

B. Piping Pressure Testing

1. Pipe Testing Procedure

a. The equipment to which any piping system is attached shall not be subject to any line tests. Either remove or blank off items which may be damaged by the test pressure. The test pressures apply to the piping materials as specified, but shall not be assumed to apply to piping specialties, accessories, or equipment including safety heads, rupture discs, relief valves, expansion joints, instruments or filters.

b. Prior to pressure testing, take the following precautions:

1) Do not apply insulation over piping prior to completion of testing.

2) Lines containing check valves shall have the source of test pressure located on the upstream side. Set the control valves in the open position for the duration of the test.

3) Block up all piping supported by springs temporarily to a degree sufficient to sustain the test liquid load.

c. Test the piping system at the pressure indicated in the individual pipe material specification section or 1-1/2 times normal working pressure, whichever is greater for the respective systems. Leakage or loss of head will not be acceptable.

2. Condensate Drains Testing

| Test Press. | Medium | Duration | Allowable Loss |
|---|---|---|---|
| 10 Feet Column | Water | 2 hrs | None |
| 10 Inch Mercury | Air | | 15 min. None |

3. Refrigerant Piping Testing

| Test Press. | Medium | Method |
|---|---|---|
| To suit Refrigerant used | Inert gas and refrigerant | Electronic leak detector |

4. Following the completion of acceptable leak testing, evacuate and charge the completed refrigeration system in accordance with the manufacturer's recommendations.

3.03 BALANCING

A. The General Contractor shall notify the Balancing Organization and Engineer when systems become operational and ready for preliminary and final testing, adjusting and balancing.

B. Final balancing shall not begin until system has been installed complete and is capable of normal operation. Provide personnel to assist in rough balance and calibration.

C. All grilles, dampers, fans, coils, pumps, valves and linkages shall be verified to be installed and operating.

D. System shall be capable of operating under control as specified on Drawings and/or contained herein.

E. Visually inspect all fire dampers on branch take-offs to each floor to ensure that they are fully open.

F. Verify with straight edge that fan/pump and motor shafts are parallel and that sheaves are in proper alignment.

G. Verify that belts are properly tensioned when unit is operating with no excessive squeal at startup. If not correct, adjust sheaves or motor base accordingly.

H. Start fans and pumps, verify that rotation is correct. If rotation is incorrect coordinate with electrical contractor to switch power leads such that the motor rotates correctly.

I. Check nameplate voltage on motor, compare to scheduled voltage. Notify the Engineer immediately of any discrepancies. Measure and record actual voltage across all power leads. Notify the Engineer of discrepancies immediately.

J. Check motor nameplates full load amps, measure and record amperage across all power leads. If there are marked discrepancies in amperage draws between legs, notify the Engineer immediately.

K. Measure and record fan/pump and motor rpm. Check that motor rpm agrees with nameplate and scheduled rpm.

L. Systems shall be balanced to be within the following limits of the capacity shown on the Drawings. Limits shall be applied to both individual components and to the system totals.

1. General Systems (plus/minus 10 percent)

2. Laboratory Hoods (plus/minus 5 percent)

3. Odorous Exhaust Systems (plus/minus 5 percent)

M. HVAC Air Systems

1. Balance the supply return and exhaust air systems in accordance with AABC or NEBB Standards by the use of direct reading instruments such as an "anemotherm" or velometer which has been properly calibrated.

2. Temporarily add static pressure to the system, to simulate the effect of dirty filters, by blanking off portions of the filter section, covering filter section with

cheesecloth or other suitable means. Confirm static has been added with new static pressure reading across fan. Remove cheesecloth, etc, after traverses are complete.

3. Adjust fan speeds if results of system capacity tests are not within tolerances specified and repeat Paragraphs 3.04A4c, d and e above, as required.

4. Mark all final balancing damper positions with a permanent marker.

5. For systems which modulate between different flow modes (e.g. minimum outside air to 100 percent outdoor air or 100 percent return air to 100 percent exhaust) measure and report system flow under both extremes of modulation and check for excessive system flow deviation above design, when system is modulating between its end points.

6. Furnish printed data tabulating the following:

    a. Opening number, type, size and design flow rate.

    b. Quantity of air in cfm at each air outlet and inlet.

    c. Dry bulb temperature in each room.

7. Where various combinations of sheaves must be installed on fan systems to achieve the correct air delivery, change the sheaves and continue to take successive readings until the correct combinations are installed.

8. Furnish printed data taken at each air moving device, to include fans, packaged units and air handling units, tabulating the following:

    a. Manufacturers, model number and serial number of units.

    b. All design and manufacturer's rated data.

    c. Total quantity of supply air in cfm.

    d. Total quantity of return air in cfm.

    e. Total quantity of exhaust or relief air in cfm.

    f. Total quantity of outside air in cfm.

    g. Outlet velocity - fpm.

    h. The rpm of each fan or blower.

    i. Maximum tip speed - fpm.

    j. The rpm of each motor.

    k. Voltage and ampere input of each motor (one reading for each phase leg on 3 phase motors).

    l. Pressure in inches w.g. at inlet of each fan or blower.

    m. Pressure in inches w.g. at discharge of each fan or blower.

    n. Pressure drops across system components such as louvers, filters, coils and mixing boxes.

    o. Submit the actual fan operating point on a copy of the fan shop drawing showing operating curve.

    p. List the following data from all fan motors installed.

1) Manufacturer model and size.
2) Motor horsepower, service factor and rpm.
3) Volts, phases, cycles and full load amps.
4) Equipment locations.

N. Standby Equipment

1. Where systems are provided with standby equipment, the system shall be balanced for operation in standby as well as normal operation.

O. Final Acceptance

1. At the time of final inspection, the balancing agency shall recheck, in the presence of the Engineer, specific and random selections of data recorded in the certified test-and-balance report.

2. Points and areas for recheck shall be selected by the Engineer.

3. Selections for recheck, specific plus random, shall not normally exceed 15 percent of the total number tabulated in the report, except where special air systems require a complete recheck for safety reasons.

4. If the specific rechecks are more than 5 percent deviation from the report or specified flows, all of the systems, that require specific recheck, shall be rebalanced. If 5 percent or 5 of the random checks, which ever is less, exceeds a 10 percent deviation from the specified flows, the report shall be rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, a new certified test-and-balance report submitted, and a new inspection test made, all at no additional cost to the Owner.

5. The balancing agency shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The balancing agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

3.04 ADJUSTMENT

A. Start-Up and Temporary Operation

1. Properly maintain and service all equipment and systems until the particular equipment or the system has been accepted by the Owner.

B. Balancing of Rotating Equipment

1. All machines shall be balanced both statically and dynamically by the manufacturer within the limits of best commercial practices. The term machine, as used above, is to be considered as any piece of equipment which contains rotating components. All machines furnished shall have operating speed not exceeding 80 percent of the first critical speed.

C. Painting

1. Repair of all defects, blemishes, holidays and the like apparent in manufacturer's coatings and ensure that materials used for such repair shall match or

be compatible with the manufacturer's standard color, coatings and practices. Do not paint over nameplates.

2. Paint black the louver side of all louver blank off panels and the interiors of unlined plenums and ductwork where connected to louvers.

3.05 CLEANING

A. Leave all piping, ductwork and equipment in a thoroughly cleaned condition. Thoroughly flush all piping to remove all foreign materials prior to any cleaning procedure. All flushing and cleaning shall be to the satisfaction of the Engineer. Furnish, install and remove all temporary piping and equipment used in the cleaning and flushing operations.

B. Maintain all ductwork, fans, coils, air filters, outlets and other parts of the ductwork systems in a clean condition during installation.

C. Clean complete ductwork systems prior to testing and air balancing. Secure cheesecloth over all openings of the ductwork system for entrapment of dirt during the cleaning operation.

END OF SECTION

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# SECTION 15550

# ELECTRIC DOMESTIC WATER HEATERS

## 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. This Section includes the following electric water heaters:

1. Storage electric water heaters.

2. Instantaneous electric water heaters.

3. Water heater accessories.

### 1.03 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Warranty: Special warranty specified in this Section.

### 1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. 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.

D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

### 1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.

b. Faulty operation of controls.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period(s): From date of Substantial Completion:

a. Electric Water Heaters:

1) Storage Tank: Five years.

2) Controls and Other Components: 1 year.

b. Instantaneous Electric Water Heaters: Five years.

## PART 2: PRODUCTS

### 2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.02 ELECTRIC WATER HEATERS

A. Standard, Storage Electric Water Heaters: Comply with UL 174.

1. Manufacturers:

a. American Water Heater Company.

b. Bradford White Corporation.

c. Lochinvar Corporation.

d. Smith, A. O. Water Products Company.

e. State Industries, Inc.

2. Storage-Tank Construction: Steel.

a. Tappings: ASME B1.20.1 pipe thread.

b. Pressure Rating: 150 psig .

c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

3. Factory-Installed Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.

b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.

c. Drain Valve: ASSE 1005.

d. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.

e. Jacket: Steel with enameled finish.

1) Standard: Cylindrical shape.

2) Tabletop: Rectangular shape, with flat-top work surface and raised back.

f. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.

g. Heating Elements: Two; electric, screw-in immersion type with 12 kW or less total, and wired for non-simultaneous operation, unless otherwise indicated.

h. Temperature Control: Adjustable thermostat for each element.

i. Safety Control: High-temperature-limit cutoff device or system.

j. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

B. Thermostat-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.

1. Manufacturers:

a. Chronomite Laboratories, Inc.

b. Eemax, Inc.

c. Stiebel Eltron

2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.

a. Connections: ASME B1.20.1 pipe thread.

b. Pressure Rating: 1035 kPa.

c. Heating Element: Resistance heating system.

d. Temperature Control: Thermostat.

e. Safety Control: High-temperature-limit cutoff device or system.

3. Support: Bracket for wall mounting.

4. Capacity and Characteristics: (Refer to Drawings)

a. Temperature Control: Adjustable thermostat.

b. Electrical Characteristics: (Refer to Drawings)

3.01 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.

C. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 1.

D. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

3.02 SOURCE QUALITY CONTROL

A. Hydrostatically test water heater storage tanks before shipment to minimum of one and one-half times pressure rating.

B. Prepare test reports.

PART 4: EXECUTION

4.01 WATER HEATER INSTALLATION

A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain or acceptable receptor.

C. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.

D. Fill water heaters with water.

4.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 26.

D. Connect wiring according to Division 26.

END OF SECTION

# SECTION 15955

# PIPING LEAKAGE TESTING

## PART 1: GENERAL

### 1.01 REFERENCES

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

1. Chlorine Institute (2001 L Street N.W., Washington D.C. 28036): Pamphlet 6, Piping Systems for Dry Chlorine.

### 1.02 SUBMITTALS

A. Informational Submittals:

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. Provide test plans for gas piping from gas meter to thermal oil system in accordance with manufacturer's O&M Manual and in accordance with any written requirements of the local gas utility.
3. Certifications of Calibration: Testing equipment.
4. Certified Test Report.

## PART 2: PRODUCTS (NOT USED)

## PART 3: EXECUTION

### 3.01 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. Contractor shall provide all equipment and labor required to perform all pipe leakage testing.

C. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.

2. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

3. New Piping Connected to Existing Piping:

   a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.

   b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.

4. Items that do not require testing include: Equipment seal drains, tank overflows to atmospheric vented drains, and tank atmospheric vents.

5. Test Pressure: As indicated on Piping Schedule.

D. Test section may be filled with water and allowed to stand under low pressure prior to testing.

E. Leak testing of natural gas piping shall include soap and water process.

F. 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.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.

2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.

3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.

4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.

5. Examine joints and connections for leakage.

6. Correct visible leakage and retest as specified.

7. Empty pipe of water prior to final cleaning or disinfection.

C. Buried Piping:

1. Test after backfilling has been completed.

2. Expel air from piping system during filling.

3. Apply and maintain specified test pressure with hydraulic force pump.

4. Valve off piping system when test pressure is reached.

5. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.

6. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

7. Maximum Allowable Leakage:

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

where:

L = Allowable leakage, in gallons per hour.

S = Length of pipe tested, in feet.

D = Nominal diameter of pipe, in inches.

P = Test pressure during leakage test, in pounds per square inch.

8. Correct leakage greater than allowable, and retest as specified.

3.03 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallons per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. 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.

D. Exfiltration Test:

1. Hydrostatic Head:

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

b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.

2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

E. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

G. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.04 PNEUMATIC TEST FOR GRAVITY PIPING

A. The Contractor shall provide all labor, equipment, and materials required to Low pressure air testing shall conform to the requirements of UNI-B6-79 "Recommend Practice for Low-Pressure Air Testing of Installed Sewer Pipe," as published by UNI-Bell Plastic Pipe Association.

B. During sewer Construction, all service laterals, stubs, and fittings into the sewer test section shall be properly capped or plugged so as not to allow for air loss that could cause an erroneous air test result. Where necessary, the Contractor shall restrain caps, plugs, or short pipe lengths such that blowouts are prevented.

C. Each test section shall not exceed 400-feet in length and shall be tested between adjacent manholes.

D. Before testing, Contractor shall install monitoring wells at each manhole to determine groundwater level and adjust test pressure accordingly. In no case shall the test pressure exceed 9.0-psig. All pressurizing equipment shall include a regulator or relief valve set no higher than 9.0-psig to avoid over-pressurizing.

E. Low-pressure air shall be slowly introduced into the sealed line until the internal air pressure reaches 4.0-psig greater than the average backpressure of any groundwater above the invert of the pipe, but not greater than 9.0-psig.

F. When temperatures have been equalized and pressure stabilized at 4.0-psig greater than the average groundwater backpressure, the air hose from the control panel to the air supply shall be shut off or disconnected. The continuous monitoring pressure gauge shall then be observed while the pressure is decreased to no less than 3.5-psig greater than the average groundwater backpressure. At a reading of 3.5-psig greater than the average groundwater backpressure, timing shall commence with a stopwatch or other timing device that is at least 99.8% accurate.

G. If the time shown in the table, for the designated pipe size and length, elapses before the air pressure drops 1-psig; the section under-going test shall have passed. The test may be discontinued once the prescribed time has elapsed.

H. If the pressure drops 1-psig before the appropriate time shown in the table has elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test.

I. Should the section fail to meet test requirements, the Contractor shall determine the source or sources of leakage and make all necessary repairs or replacements and shall repeat the test until the test section is within established limits. All corrective work shall be at the Contractor's expense.

**Test Time Table**

| TEST TIME: For sewer diameter between 6 inches and 36 inches inclusive, the pipe shall be tested between adjacent manholes. The test time for the air pressure to drop the specified 1 psig shall be as listed below: | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATION TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP | | | | | | | | | | | |
| 1 Pipe Dia. (in.) | 2 Minimum Time (min:sec) | 3 Length for Minimum Time (ft) | 4 Time for Longer Length (sec) | Feet | | | | | | | |
| | | | | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 |
| 6 | 5:40 | 398 | 0.854 L | 5:40 | 5:40 | 5:40 | 5:40 | 5:40 | 5:40 | 5:42 | 6:24 |
| 8 | 7:34 | 298 | 1.520 L | 7:34 | 7:34 | 7:34 | 7:34 | 7:36 | 8:52 | 10:08 | 11:24 |
| 10 | 9:26 | 239 | 2.374 L | 9:26 | 9:26 | 9:26 | 9:53 | 11:52 | 13:51 | 15:49 | 17:48 |
| 12 | 11:20 | 199 | 3.148 L | 11:20 | 11:20 | 11:24 | 14:15 | 17:05 | 19:56 | 22:47 | 25:38 |
| 15 | 14:10 | 159 | 5.342 L | 14:10 | 14:10 | 17:48 | 22:15 | 26:42 | 31:09 | 35:36 | 40:04 |
| 18 | 17:00 | 133 | 7.692 L | 17:00 | 19:13 | 25:38 | 32:03 | 38:27 | 44:52 | 51:16 | 57:41 |
| 21 | 19:50 | 114 | 10.470 L | 19:50 | 26:10 | 34:54 | 43:37 | 52:21 | 61:00 | 69:48 | 78:31 |
| 24 | 22:40 | 99 | 13.674 L | 22:47 | 34:11 | 45:34 | 56:58 | 68:22 | 79:46 | 91:10 | 102:33 |
| 27 | 25:30 | 88 | 17.306 L | 28:51 | 43:16 | 57:41 | 72:07 | 86:32 | 100:57 | 115:22 | 129:48 |
| 30 | 28:20 | 80 | 21.366 L | 35:37 | 53:26 | 71:13 | 89:02 | 106:50 | 124:38 | 142:26 | 160:15 |
| 36 | 34:00 | 66 | 30.768 L | 51:17 | 76:55 | 102:34 | 128:12 | 153:50 | 179:29 | 205:07 | 230:46 |

## 3.05 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
   a. Leaks (type, location).
   b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION

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# SECTION 16010

# GENERAL ELECTRIC REQUIREMENTS

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section includes materials, installation, and testing of the electrical system.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable Regulatory Agencies and Standards: Installations, materials, equipment, and workmanship shall conform to the provisions of the following agencies:

1. National Electrical Code (NEC)
2. Occupational Safety and Health Act (OSHA)
3. Local authorities having lawful jurisdiction pertaining to the work required.
4. Underwriter's Laboratories, Inc. (UL): Materials, appliances, equipment, and devices shall conform to the applicable UL standards. The label of, or listing by, UL is required wherever applicable.
5. Standards: Where referenced in these specifications or on the drawings, the publications and standards of the following organizations apply:
    a. American Society of Testing and Materials (ASTM)
    b. National Electrical Manufacturers Association (NEMA)
    c. National Fire Protection Association (NFPA)
    d. American National Standards Institute (ANSI)
    e. Institute of Electrical and Electronics Engineers (IEEE)
    f. Insulated Cable Engineers Association (ICEA)

### 1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Submit Operation and Maintenance Manual in accordance with Section 01300.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer.

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

C. Refer to individual Sections for additional spare part requirements.

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with the Special Provisions and the manufacturer's recommendations.

1.06 ELECTRICAL SERVICE CHANGES

A. These specifications and drawings delineate the remodeling of an existing structure, and/or the addition to an existing structure. While the existing structure is occupied, keep the present services intact until the new construction, facilities, or equipment is installed.

B. The contractor shall be responsible for all temporary power required to the facility during construction. The power to the plant, including the emergency generator, shall remain in service until the new service is installed and operational. The plant equipment in operation, as required by the City, shall have two sources of power at all times.

1.07 UTILITY COMPANY COORDINATION

A. The City will make application for electric service. The City will pay utility company fees, cable charges, and added facilities charges related to the design they currently have with Georgia Power. All other fees or costs not associated with the utility design and to be paid by the Contractor and included in the bid price

B. The Contractor shall provide all coordination for service with the utility company including scheduling the service and installation of all utility equipment.

C. Provide and install electric service entrance equipment, conduit, wire, and devices in accordance with the serving utility's requirements for the transformer, secondary feeders, including metering and CT cabinets, if required. Coordinate with the serving utility to ensure timely connection by the utility. Obtain utility company approval of service entrance and metering equipment shop drawings prior to starting fabrication. Not all material, equipment, conduit, and wire required by the utility is shown on the drawings, the Contractor has complete responsibility to provide all equipment and material required by the utility for installation of the new service.

D. Provide all submittals and documentation for switchgear that will be connected to the utility transformers. Georgia power shall provide acceptance of all equipment prior to energization of the new service.

PART 2: PRODUCTS

2.01 GENERAL

A. Similar materials and equipment shall be the product of a single manufacturer. The disconnect switches, motor control center, combination starters, panel boards, and manual motor starters shall be products of one manufacturer.

B. Provide only the products which are new, undamaged, and in the original cartons or containers. Refurbished equipment shall not be provided.

C. Materials and equipment shall be the standard products of manufacturers regularly engaged in the production of such material and shall be the manufacturer's current design.

D. Materials and equipment shall be suitable for storage, installation, and operation in an ambient of 0°C to 40°C except where more stringent conditions are stated in individual equipment specifications.

E. Electrical equipment and panels shall be factory finished with manufacturer's standard primer and enamel topcoats, unless stated otherwise in the individual equipment specifications. Provide 1 pint of the equipment manufacturer's touchup paint per 500 square feet of painted surface for repair of damaged enamel topcoats.

F. Contractor shall verify that overall equipment dimensions of all equipment provided for the project are within the maximum dimensions indicated on the plans. If larger equipment is required, submit a proposed layout showing arrangement of electrical equipment. Provide working clearances in accordance with the NEC. Any costs due to rearrangement of equipment shall be borne by the Contractor with no additional expense to the Owner.

2.02 MANUFACTURERS

A. Refer to specific section for manufacturer.

2.03 HAZARDOUS LOCATIONS

A. Conform with NEC Articles 501 and 502 for areas identified as "Hazardous Areas."

B. Hazardous Class 1, Division 1, areas are identified in Paragraph 2.7, D.

C. Hazardous Class 1, Division 2, areas are identified in Paragraph 2.7, D.

D. Provide equipment with ratings suitable for installation in the hazardous location identified.

E. Conform with NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities, current edition.

2.04 CLASSIFICATIONS OF EQUIPMENT

A. NEMA type Enclosure Classifications

1. NEMA 1G – Dry locations, use only for Motor Control Centers, VFD enclosures and panelboards, located in electrical rooms.

2. NEMA 12 – Dry locations, all other equipment not in Item 1 above, located in electrical rooms.

3. NEMA 4X (316 Stainless Steel) – Wet locations (exterior, process and hose down), and corrosive locations.

4. NEMA 7/9 – Hazardous locations.

B. NEMA Type Panel Device and Component Classifications

All panel devices, instrumentation, and electrical components installed shall satisfy the NEMA type classification of the associated panel:

1. Dry Locations – NEMA 12
2. Wet Locations – NEMA 4X
3. Corrosive Locations – NEMA 4X
4. Hazardous Locations – NEMA 7/9

C. Area Classification Schedule

| Area Description | Hazardous Location[1] | Dry Location | Wet Location | Corrosive Location[2] | Notes |
|---|---|---|---|---|---|
| All Exterior Locations Not Defined | | | X | | |
| Influent Flume | X | | X | | 4 |
| Headworks Facility | X | | X | | 4 |
| Grit Chamber and Facility | X | | X | | 4 |
| Odor Control Facility | X | | X | | 6 |
| Splitter Box | X | | X | | 4 |
| Fine Screen Facility | X | | X | | 4 |
| Magnesium Hydroxide System | | | X | X | |
| Alum Feed Facility | | | X | X | |
| Generator, Switchgear Interior | | X | | | |
| BNR/MBR Electrical Building | | X | | | |
| BNR Basins (1-4) | X | | X | | 4 |
| BNR (Aeration Basin) Blowers | | | X | | |
| Ex. MCC-H | X | | X | | |
| RAS Splitter Box | X | | X | | 4 |
| MBR (Membrane) Facility | X | | X | | 4 |
| MBR Blowers | | | X | | |
| Scum Pumping Station | X | | X | | 4 |
| UV and Post Aeration Facility | | | X | | |
| UV Electrical Building | | X | | | |
| WAS Blowers (Ex. SBR Blowers) | | | X | | |
| WAS Storage Tank | X | | X | | 4 |
| Reuse Pump Station/Wetwell | | | X | | |
| Aerobic Digester Compressors | | | X | | |
| Aerobic Digesters | X | | X | | 4 |
| Aerobic Digester Blowers | X | | X | | 4 |
| Plant Drain Pump Station 1 Wetwell | X | | X | | 4 |
| DW Drain Pump Station Wetwell | X | | X | | 4 |
| Chemical Building | | | X | X | |
| Rotary Drum Thickeners | X | | X | | 5-2 |

| Area Description | Hazardous Location[1] | Dry Location | Wet Location | Corrosive Location[2] | Notes |
|---|---|---|---|---|---|
| Dewater Building Process Area | X | | X | | 8 |
| Dewatering Building Electrical Room | | X | | | |
| Structure Below Grade - Electrical | | | X | | 9 |
| Structure Below Grade - Other | X | | X | X | 7 |

Notes:

1. All Hazardous Areas are Class 1, Group D.
2. "Corrosive" is not an NEC classification, it refers to rooms with chemicals stored in them, or other corrosive environments. Areas Designated as both Wet Location and Hazardous Location shall meet the requirements for both locations.
3. Entire structure including the 36" envelope above the maximum water surface elevation and extending 10' horizontally from the wetted walls of the tank shall be designated a Class 1, Group D, Division 1 Hazardous Location, unless otherwise noted on the drawings. Refer to NFPA 820.
4. Entire structure including the 36" envelope above the maximum water surface elevation and extending 10' horizontally from the wetted walls of the tank shall be designated a Class 1, Group D, Division 2 Hazardous Location, unless otherwise noted on the drawings. Refer to NFPA 820.
5. Note 5-1 is Class 1, Group D, Division 1 building or Equipment. Note 5-2 is Class 1, Group D, Division 2 building or Equipment. 36" Envelope around all Equipment and piping.
6. The 60" envelope around all odor air piping shall be designated a Class 1, Group D, Division 1 Hazardous Location, unless otherwise noted on the drawings. Refer to NFPA 820.
7. Refer to areas above and NFPA 820 and NEC for hazardous classifications in below grade process structures.
8. Process area is unclassified with the exception of the dryer equipment, which is Class 1, Group D, Division 1 Hazardous Location and 36" around the equipment, which is Class 1, Group D, Division 2 Hazardous Location.
9. Other classifications may apply depending on the location of the structure. Provide in accordance with NEC and NFPA 820 requirements.

## 2.05 MOUNTING HARDWARE

A. Provide type 316 stainless steel mounting channel, minimum 1-5/8", stainless steel anchor bolts, and stainless hardware for mounting all equipment, unless otherwise noted.

## 2.06 RUBBER FLOOR MATTING

A. Provide rubber floor matting in front of each new motor control center section, switchboard, switchgear section, panelboard, transformer, and floor mounted control panel located in interior locations, in electrical rooms and process areas. Matting shall be minimum width 30 inch. Rubber matting shall meet ASTM Designation: D178-24 for electrical and physical requirements.

## PART 3: EXECUTION

### 3.01 INSTALLATION

A. The drawings indicate connections for typical equipment only. If the equipment furnished is different from what is shown, provide the modifications necessary for a safe and properly operating installation in accordance with the equipment manufacturer's recommendations.

B. The drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Field determine exact locations based on physical size and arrangement of equipment, finished elevations, and obstructions.

C. Work or equipment not indicated or specified which is necessary for the complete and proper operation of the Electrical systems shall be accomplished without additional cost to the Owner.

D. Review demolition methods with Owner's Representative prior to cutting or removing existing architectural and/or structural items or equipment. Repair damage to match existing and maintain the fire rating of the existing items affected by work.

### 3.02 MANUFACTURER'S SERVICES

A. Comply with Division 1 for requirements of Manufacturer's Representative and Certifications.

B. The Contractor shall refer to Division 1 and individual specification sections for the requirements of the manufacturer services for all equipment provided in Division 16 of the Contract Documents. The services indicated in each technical specification shall be in addition to those indicated in the Division 1 specification sections.

### 3.03 REMOVAL OR RELOCATION OF MATERIAL AND EQUIPMENT

A. Refer to Section 02150.

B. Unless otherwise noted, remove existing electrical materials and equipment from areas indicated for demolition or where equipment is relocated. Remove materials no longer used, such as studs, straps, and conduits. Remove or cut off concealed or embedded conduit, boxes, or other materials and equipment to a point at least ¾ inch below the final finished surface. Remove existing unused wires.

C. Repair affected surfaces to conform to the type, quality, and finish of the surrounding surface.

D. The contractor shall review the existing ductbank system and wiring in detail prior to any demolition. All existing circuit shall be identified from the power source to the equipment. The contractor shall submit a detailed overview of the existing underground system including each raceway in a ductbank, the wiring in each raceway shall be identified, and the routing of all raceways. A riser or block diagram showing the existing underground ductbank system shall be included for all existing ductbanks and raceways. This includes all existing raceways and ductbanks, those which are being demolished and those which are to remaining.

This work shall be performed, submitted, and approved prior to submittal of new ductbanks, or underground work on the project.

3.04 FIELD TESTING

A. Infrared Survey / Testing

1. General

a. Conduct a NETA infrared survey of major electrical and rotating equipment in readings taken should be done with the equipment operating under loaded conditions. Motor starters shall be loaded at the full load ampere rating of the motor. All other equipment, unless indicated otherwise, shall be loaded at 80% of the overcurrent protective device rating ahead of the equipment. All equipment shall be loaded for a minimum of 30 minutes before scanning. A Load Bank, provided by the Contractor, shall be used when the connected equipment cannot provide the required load.

2. Equipment to be Tested

a. Switchgear

b. Switchboards

c. New and Modified Motor Control Centers:

1) Main Breakers.

2) Motor Connections

3) Lighting Panels, Transformers, and other ancillary equipment (under normal station load).

d. Disconnects and Motor Starters

e. Motor connection at all new or rewired motors.

f. HP and LP Standalone Panelboards

g. Vender and OEM Panels and Equipment with voltages exceeding 120 volts.

3. Infrared Scanning of Electrical Equipment

a. Visual Inspection

1) Inspect for physical, electrical, and mechanical condition and bus alignment.

b. Infrared Inspection

1) Perform a qualitative (Level I) infrared inspection on the equipment listed in Paragraph 3.4.B above. The infrared-scanning device used shall meet the requirements contained in Part 4 below.

c. Provide a report indicating the following:

1) Location, equipment, date.

2) Problem area (location of “hot spot”).

3) Indicate temperature of “hot spot” and ambient temperature.

4) Indicate cause of heat rise, if known.

5) Indicate phase unbalance, if present.

6) List of areas scanned.

d. Test Parameters

1) Infrared scanning equipment shall detect 1 degree C rise between subject area and reference at 30 degrees C.

2) Equipment shall detect emitted radiation and convert detected radiation to visual signal.

3) Both identifying photographs and thermographic photos shall be provided of the deficient areas. The thermographic photos shall be seen on the imaging system. The thermographs and identifying photos shall be contained in the report to provide a baseline inventory of the electrical system immediately preceding conditional acceptance.

e. Test Results / Tolerances

1) Per National Electrical Testing Association (NETA), operating temperature shall not exceed manufacturers or listing agency's rating for the equipment or attached conductors. The following temperature tolerances are for equipment temperature ratings of 75 degrees C or above.

a) The following tolerances are applied to temperature gradients/ differences based on comparison between phases on balanced three phase loads:

- Temperature of 15 degrees C or more: Contractor to correct problem immediately and re-test.
- Temperature of 4 degrees C to 15 degrees C: Indicated probably deficiency, Contractor to repair as time permits and re-test.
- Temperature of 1 degrees C to 3 degrees C: Indicated possible deficiency; Contractor to warrant investigation.

b) The following absolute temperature tolerances are applied to all components:

- Temperature of 40 degrees C or more: Contractor to correct problem immediately and re-test.
- Temperature of 21 degrees C: Contractor to monitor until corrective measures can be accomplished.
- Temperature of 11 degrees C to 20 degrees C: Indicated probably deficiency, Contractor to repair as time permits and re-test.
- Temperature of 1 degrees C to 10 degrees C: Indicated possible deficiency, Contractor to warrant investigation.

## 3.05 IDENTIFICATIONS AND SIGNS

A. Mark all electrical devices and panels including, but not limited to, individual panelboard, motor controller, disconnect switch, timer, relay, lighting contactors, control panels, motor control centers, control stations, to identify each item with its respective service or function. Provide nameplates with engraved lettering not less than ¼ inch high. Use black-on-white laminated plastic, attached with rivets or stainless-steel sheet metal screws. Do not use embossed plastic adhesive tape

END OF SECTION

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# SECTION 16011

# PROTECTIVE DEVICE COORDINATION STUDY

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section describes the requirements for furnishing a protective device coordination study.

B. This Section includes general requirements for performing a power system study including short circuit analysis, coordination study, arc flash and testing. The studies shall include all portions of the electrical distribution system from the new Utility transformers and service, new Switchgear SG-Main, new Switchboard SG-OC, and all existing and new MCCs, panelboards and motors.

C. The Contractor shall obtain the services of a single independent Power System Analysis Firm (PSA) who shall be responsible for preparing project specific studies, field information gathering of existing equipment and field testing for all components of the power study as specified herein. The PSA shall be regularly engaged in the business of performing short circuit analysis, coordination studies, arc flash analysis and testing for medium voltage and low voltage power distribution systems.

D. The PSA and Contractor are required to obtain all information from the existing equipment and cabling through field investigation. The information provided herein is for estimating only. The City and Engineer are not responsible to provide any additional information required to complete the study. The PSA and Contractor shall coordinate directly with the power company for all fault and power data required.

### 1.02 QUALITY ASSURANCE

A. References

1. Materials and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein.
    a. Local building codes
    b. National Electrical Code - NEC
    c. Underwriters Laboratories, Inc. - UL
    d. Institute of Electrical and Electronic Engineers - IEEE
    e. Insulated Cable Engineers Association - ICEA
    f. American National Standard Institute - ANSI

### 1.03 SUBMITTALS

A. Submit protective device coordination study in accordance with Section 01300.

B. Submit a qualifications package for the proposed PSA for this project. The qualifications package shall include the following information which shall be organized and formatted as follows:

1. Company Background - Provide a brief company overview detailing PSA's experience, capabilities, and available resources. Description of available resources shall include labor categories, staffing, and testing equipment.

2. Experience in Power Distribution System Evaluations - Provide a list of recent (last 5 years from the bid opening date of this Contract) projects involving Short Circuit, Coordination, Arc Flash Analysis and Testing that the company has successfully performed.

3. Facilities and Equipment - List type and power system analysis software and testing equipment to be used for this project

C. Submittal Coordination with Equipment Manufacturers.

D. The PSA shall obtain specific submittal information pertaining to proposed power distribution equipment from the Contractor. The PSA and Contractor are responsible to obtain all new and existing information required to complete the study. If information is not available, field verification is to be performed by the PSA and Contractor. This shall include as built documents, drawings, manufacturer's catalog information, equipment ratings, and circuit breaker curves. Reports submitted without the information on proposed power distribution equipment will be rejected.

E. The study shall include all equipment, new and existing, that is powered by the new electrical service to Switchgear SG-Main. This will entail the entire plant, new and existing equipment.

F. Power System Study Reports

1. The PSA shall submit Power System Study Reports that shall include the coordination study, short circuit analysis, and final summary and recommendations. Three separate and distinct submittals as specified herein.

2. Preliminary Power System Study Report

a. The Preliminary Power System Study Report shall be based on the following information:

1) Cables and conductors

2) Transformers

3) Panelboards

4) Overcurrent Protective Devices

5) Surge Suppression Equipment

6) Switchgear

7) Switchboard

8) Automatic Transfer Switches

9) Motor Control Centers

3. The Preliminary Power System Study Report shall be submitted prior to, or with the individual equipment submittals as specified in the individual equipment specifications. The report information will be used by the Engineer to review the equipment submittals for overall approval of the shop drawings. Submission of individual equipment submittals without the preliminary report will not be reviewed and will be returned to the Contractor.

4. It is the responsibility of the Contractor to forward the proposed electrical equipment submittal information to the PSA prior to submission of the submittals to the engineer for review.

5. The preliminary report shall consist of the following:

    a. List of proposed power distribution equipment to be provided, with corresponding technical information for equipment pertaining to the study.

    b. Short circuit study evaluation for the proposed power distribution equipment. Provide recommendations for utilization of the proposed equipment based on the adequacy of the short circuit withstand ratings, bus bracing, and overcurrent protective device ratings.

    c. Provide recommendations for mitigating problems with such issues.

6. Draft Final Power System Study Report - Report shall consist of the following.

    a. All information contained in the preliminary report, with Engineer's comments addressed and incorporated.

    b. Final summary and recommendations for power distribution system.

    c. Report shall be submitted upon completion of all measurements and testing. Engineer's comments on the report shall be addressed, and the report resubmitted, until the final report is provided with an "APPROVED" review code by the Engineer.

    d. Electronic Copies

    e. Submit 2 copies of the electronic files for the Power System Study for future updating and reference by the Owner. Files shall be submitted as compact disc in MS Word format.

7. Arc Flash hazard labels

    a. The PSA shall furnish and install warning labels for all electrical equipment associated with this project.

8. Final Power System Study Report – Report shall consist of:

    a. All information contained in the draft final report, and the incorporation of changes, modifications, and adjustments for a final document for use by the Owner.

    b. Report shall be submitted after acceptance of the project.

    c. Electronic Copies

d. Submit 2 copies of the electronic files for the Power System Study for future updating and reference by the Owner. Files shall be submitted as compact disc in MS Word format.

G. The Protective Device Coordination Study submitted as specified shall be signed and sealed by a professional engineer licensed in the state of Maryland.

H. The Protective Device Coordination Study shall be submitted and approved prior to any the engineer reviewing or approving any other power distribution equipment. The contractor shall submit the Study as required in this Specification sections with 30 days of the Notice to proceed for the project. All delays due to the power study approval are the responsibility of the contractor.

1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer.

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with the Special Provisions and the manufacturer’s recommendations.

1.06 RELATED WORK SPECIFED ELSEWHERE

A. General Requirements 16010

PART 2: PRODUCTS

2.01 GENERAL

A. The Power System Study shall be provided to evaluate the power distribution system for equipment interrupting capacity, system coordination, system protection, arc flash and proper operation within the system limits. The Power System Study shall include the following components:

1. Short Circuit Analysis

2. Coordination Study

3. Arc Flash Hazard Analysis

4. Final Summary and Recommendations

B. Power system study to be done using latest version of 1.SKM Power tools or 2. ESA Easy Power program

C. Power Distribution System Information and Data

1. The PSA shall obtain utility source information from Georgia Power.

2. Motor contributions shall be obtained from the new and existing motor loads.

3. Cable and conductor impedances may be obtained from standard libraries for equivalent conductors and cables.

2.02 SHORT CIRCUIT ANALYSIS AND STUDY

A. The short circuit analysis and coordination study shall analyze short circuit occurrence during normal conditions when the utility feeder is available. The Short Circuit Analysis and Coordination Studies shall be performed in accordance with ANSI/IEEE C37.10, ANSI/IEEE C37.13, IEEE Standard 141, IEEE Standard 242, and IEEE Standard 399.

B. Short Circuit Analysis Parameters

1. The short circuit analysis shall be performed to determine the available (worst case) fault level at critical buses on the distribution system. The basis for the analysis shall be that a "three-phase" bolted fault can occur anytime on any bus in the system.

2. Provide calculation methods and assumptions, base per unit quantities selected, one-line diagrams, source impedance data including the normal power supply system characteristics, typical calculations, tabulations of calculated quantities and results.

3. Calculate short-circuit interrupting and momentary (where applicable) duties for an assumed 3-phase bolted fault at the supply switchgear lineup, panelboard, and other significant overcurrent protective device locations throughout the system.

4. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor fault contribution, short circuit kva, and symmetrical and asymmetrical fault currents.

C. Coordination Study Parameters

1. Provide a complete short circuit and system protection coordination study of the electrical distribution system with manufacturer's curves of each protective device indicated on common drawings, to verify proper selectivity and protection for all components of the system obtained. Include all calculations, selected equipment, devices, and recommended settings. The study shall encompass all existing and new devices from the utility connection and the on-site existing generator to all panelboards, and protective devices.

2. Provide time-current curves graphically indicating the coordination proposed for the system. Curves shall be provided on full size, log-log forms. Each curve sheet shall be provided with an appropriate title, one line diagram, and identified components or legend. The study shall include coordination curves showing the proposed settings of protective devices required to assure selective coordination. Specific time-current characteristics of each protective device shall be plotted in such a manner that all upstream devices, including load break interrupter protective devices, will be clearly depicted on a full-size single log paper sheet.

3. Provide a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Provide recommended device tap, time dial, pick-up, instantaneous, and time delay settings in a table format.

4. The curve sheets shall include the load interrupter switch fuse characteristics, low voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, motor, and generator characteristics. Devices shall be shown down to the largest branch and feeder circuit breaker in each panelboard.

5. Provide adjustable settings for ground fault protective devices.

6. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Transformer full load currents, magnetizing inrush, ANSI transformer withstand ratings, and significant symmetrical fault currents shall be included on the curves. Terminate device characteristic curves at a point reflecting the maximum symmetrical fault current to which the device is exposed.

7. Provide phase and ground coordination for the existing generator protective devices. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices.

2.03 REPORT

A. A comprehensive report shall be prepared to document each component of the Power System Study. The report shall be clearly organized and provided with tab dividers to separate logical sections. The report shall include the following information as a minimum.

1. General Description

a. Provide a general description outlining the purpose of the report. The general description shall include a basis and scope for the limits of the study.

2. Short Circuit Analysis

a. Describe the parameters which have an impact on the analysis in explicit detail.

b. Compare the manufacturer's published interrupting, withstand and bus bracing ratings with the calculated available fault levels.

c. Summarize any system deficiencies or shortcomings with the interrupting capability of the proposed distribution equipment.

d. Provide recommendations and solutions for correcting any deficiencies.

3. Coordination Study

a. The study shall include performing time-current analysis of each protective device.

b. The PSA shall provide recommendations for setting and adjusting the protective relay and circuit breaker settings and parameters to assure proper equipment and personnel protection.

c. Provide conclusions based on the compiled information, and recommendations for modifications to equipment or systems to correct any deficiencies

4. Arc Flash Analysis

a. The Report shall include an Incident Energy Study performed in accordance with the IEEE 1584-2004a, “IEEE Guide for Performing Arc Flash Hazard Calculations” as referenced in NFP A 70, “Standard for Electrical Safety in the Workplace”, latest Revision, in order to quantify the hazard selection of personal protective equipment (PPE). Tables that assume fault current levels and clearing time for proper PPE selection are not acceptable.

b. Report shall include incident energy level (calories/cm2) for each equipment location and recommended PPE.

c. The PSA shall optimize the results of the study as it relates to safety and reliable electrical system operation (e.g. overcurrent device settings, working distances, current limiting devices). This includes mitigation, where possible, of incident energy levels that exceed 40 calories/cm2.

5. Existing Equipment Information

a. The preliminary report shall contain information on existing electrical distribution equipment.

6. Final Summary and Recommendations

B. Provide a final summary of all findings, and final recommendations, based on field measurements taken, and analyses performed.

1. Appendices

a. Provide computer input and output databases used in the evaluations.

b. Provide one or more comprehensive one-line diagrams for the power distribution system. Components shall be specifically labeled with tags and values which correlate to referenced items noted in the studies.

c. Provide an equivalent impedance one-line diagram for the power distribution system. Components shall be specifically labeled with tags and impedance values which correlate to referenced items noted in the studies.

d. Provide field data for power measurement values obtained while conducting field measurement surveys.

2.04 ARC FLASH HARD LABELS

A. Based on the results of the incident energy study, the supplier shall produce and install warning labels (orange <40 call/cm2 or danger label red (red >40 call/cm2) for each piece of equipment in accordance with ANSIZ535.4-2002. The label must be readable in both outdoor and indoor environments for at least 3 years and contain the following information.

1. Arc hazard boundary (inches).

2. Working distance (inches).

3. Arc flash incident energy at the working distance (calories/cm2).
4. PPE category and description including the glove rating
5. Voltage rating of the equipment
6. Limited approach distance (inches)
7. Restricted approach distance (inches)
8. Prohibited approach distance (inches)
9. Equipment/bus name
10. Date prepared
11. PSA name and address

PART 3: EXECUTION

3.01 INSTALLATION

A. Power distribution equipment shall not be energized prior to adjusting and setting all of the relay protective devices in accordance with approval of the pre-final Power System Study Report.

3.02 DATA COLLECTION

A. Existing Equipment

Perform a detailed site survey of the existing electrical distribution system in order to collect comprehensive data necessary for the power system study. Obtain field data and equipment nameplate information for the existing equipment which will remain as part of the power distribution system. Obtain type, length, and size information for existing feeders. Survey information shall be submitted as part of the preliminary power system study report. The Contractor and PSA are responsible for obtaining all existing data required for the report from manufacturers and data. The City is not responsible for providing information, but will assist to the extend possible with the information they can provide.

B. Utility Information.

Short-circuit currents or impedances available from the power generation system supplying the new power distribution system, and time-current characteristics and the settings of the utility protective devices on the supply side of the feeders shall be requested from Georgia Power by the PSA.

C. Equipment Submittals and Technical Information

1. The PSA shall obtain equipment submittal information and technical information for the power distribution equipment proposed for the project

D. Field Calibration

1. The PSA shall supervise the performance of the on-site field adjustments for the protective relays, devices, and adjustable circuit breaker settings. The

settings shall be adjusted in accordance with the final Power System Study Report.

2. The on-site field adjustments shall be supervised by a power systems technician who shall be present, on-site, as required to set and calibrate each power distribution unit. This Contractor shall coordinate the number of site trips required for the PSA with the sequencing of the installation and startup of the associated equipment. The technician shall be present on-site for a minimum of 16 hours (excluding travel time) for installation assistance, inspection, and certification of the installation.

E. Measurements and Testing

1. Field measurements shall be performed in the presence of the Engineer's Representative. The PSA shall furnish all materials, labor, and equipment necessary to conduct field measurements. The PSA shall maintain a written record of all measurements, which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and measurement results in the form of an analysis report described below.

2. The PSA shall perform on-site field services and data collection to obtain power measurements (real power, kW, and reactive power kV AR) for the distribution system. Measurements shall be taken at the following busses as a minimum:

   a. Transformers

   b. Switchgear

   c. Motor Control Centers

   d. Panelboards – 480 volt

3. The PSA shall note specific conditions at the time the measurements are taken, including motor status, motor speed, loading levels. Snapshots of measurements shall be taken for VFDs rated 10 Hp and larger. Power measurements shall be compared to values provided by the digital power meters and digital power monitors located on the equipment.

4. The PSA shall coordinate scheduling of the work with the Contractor in order to test the system with all equipment in operation. The Contractor shall make arrangements to schedule all monitoring work in order to not adversely affect the treatment plant operation.

END OF SECTION

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# SECTION 16051

# MISCELLANEOUS ELECTRICAL DEVICES

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section includes materials and installation of miscellaneous electrical devices and equipment, such as disconnect switches, pushbuttons, selector switches, indicating lights, limit switches, and other miscellaneous electrical equipment.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

B. Comply with applicable standards, per Section 16010.

### 1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Submit ratings and characteristics including voltage ratings, continuous current ratings, conduit entry restrictions, and enclosure type and dimensions.

C. Submit Operation and Maintenance Manual in accordance with 01730.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer.

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

### 1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Delivery, handle and store the equipment in accordance with Division 1 and the manufacturer’s instructions.

### 1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Variable Frequency Drive: 16157

C. General Control System Requirements: 16900

## PART 2: PRODUCTS

### 2.01 MANUFACTURERS

A. Disconnect switches shall be Square D, or equal.

B. Provide Allen-Bradley Bulletin 800H; Square D Class 9001, Type SK; or equal for pushbuttons, selector switches, and indicating lights.

C. Provide a Square D, Class 9006, Type C switch or equal, for limit switches.

2.02 DISCONNECT SWITCHES

A. Provide non-fusible or fusible disconnect switches with ampere rating and number of poles as indicated in the drawings. Switches shall be NEMA heavy-duty Type HD. Mechanisms shall have quick-make and quick-break operating handles and provisions for padlocking in the “OFF” position. The switch shall have an interlock to prevent unauthorized opening of the hinged cover when the switch is in the “ON” position and an interlock to prevent closing the switch mechanism with the hinged cover open. Fusible switches shall be equipped with rejection feature. Switch contacts shall be silver or tinned plated. On the front of the enclosure, attach a nameplate that identifies the load per Section 16010.

B. Provide disconnect switches in NEMA 7 enclosures in Class I, Division 1 and Class I, Division 2 hazardous locations.

C. Provide auxiliary contacts for all disconnect switches operating a motor with a variable frequency drive or if shown on the drawings for other applications.

2.03 PUSHBUTTONS, SELECTOR SWITCHES, AND INDICATING LIGHTS

A. Remote-mounted pushbuttons, selector switches, and indicating lights shall be heavy duty, oil tight type, 30.5 mm with NEMA rating as required by Section 16010. Indicating lights shall be push to test type.

B. Install provisions for locking pushbuttons and selector switches in the OFF position wherever lockout provisions are indicated. Stop pushbuttons shall be maintained.

C. Provide control stations in NEMA 7 enclosures in Class I, Division 1 and Class I, Division 2 hazardous locations.

2.04 LIMIT SWITCHES

A. Provide heavy-duty, precision turret head type limit switches with one normally open and one normally closed contact along with an adjustable lever arm with oil-impregnated sintered iron roller, unless otherwise noted. The normal condition of the switch shall be a closed contact.

B. Provide type NEMA 7 limit switches in Class I, Division 1 and Class I, Division 2 hazardous locations.

PART 3: EXECUTION

3.01 INSTALLATION

A. The Contractor shall install all equipment in strict accordance with the manufacturer's recommendations, the contract document and as approved by the Engineer.

3.02 MANUFACTURER’S SERVICES

A. Provide manufacturer’s field services in accordance with Division 1.

B. Manufacturer's field services shall respond to the Owner request for correction of problems during startup and warranty power within four (4) hours.

3.03 FIELD TESTING

A. Operate each disconnect switch under load and verify that all phases of the load are disconnected each time.

B. Operate each push button, selector switch, and limit switch to verify that the equipment controlled operates per the plans or other sections of these specifications.

C. Verify the operation of each pilot light.

3.04 MOUNTING BRACKETS

A. Provide standoff brackets providing a minimum of 1-1/2-inch air space between the device and the mounting surface. Provide 316 stainless steel brackets and concrete anchors in all locations.

END OF SECTION

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# SECTION 16110

# RACEWAYS, BOXES, AND FITTINGS

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section describes materials and installation of raceway systems, whether concealed or exposed, above or below grade.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

### 1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Submit material list for all conduits, fittings, boxes, conduit bodies, mounting hardware, and related accessories.

C. Submit scaled, accurate conduit layout drawings for each building, facility, vault, and for the site. Approval of drawings shall be obtained from the Engineer prior to work commencing in that area.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer.

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

### 1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with SP-13, SP-14, and the manufacturer’s recommendations.

### 1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Cable Tray: 16114

C. Wire and Cables: 16120

## PART 2: PRODUCTS

### 2.01 GENERAL

A. RIGID STEEL CONDUIT AND FITTINGS

1. Use rigid, thick wall, hot-dipped galvanized inside and out, with galvanized threads conforming to ANSI C80.1 and UL-6. Do not use electro galvanizing.

2. Use insulated metallic bushings. Sizes 1 inch and smaller may be non-metallic type.

3. Use hot-dipped galvanized threaded fittings which are compatible with the conduit.

4. Use cast aluminum or hot-dipped galvanized cast-iron conduit bodies equipped with threaded covers or gasketed sheet metal covers secured with at least two captive screws.

B. RIGID NONMETALLIC CONDUIT AND FITTINGS

1. Polyvinyl chloride (PVC) Schedule 40, 90 C rise rating. Conduit shall conform to NEMA TC-2 and UL-651.

C. PVC-COATED CONDUIT AND FITTINGS

1. PVC-coated conduit and fittings shall be rigid galvanized steel with a .040-inch-minimum thickness of PVC coating. Interior coating shall be 2-mil urethane. Conduit and fittings shall be UL listed and shall conform to ANSI C80.1 and to UL-6.

D. LIQUID-TIGHT FLEXIBLE CONDUIT AND CONNECTORS

1. Use single strip steel, hot-dipped galvanized on all four sides prior to conduit fabrication. Conduit shall have overall PVC plastic jacket. Conduit sizes 1-1/4 inches and smaller shall include an integral copper bonding conductor wound spirally in the space between each convolution on the inside of the conduit. Conform to UL-360.

2. Use compression type bushings with steel or malleable iron body and insulated throat and sealing O-ring.

3. All fittings shall be PVC coated.

E. RIGID ALUMINUM CONDUIT

1. Conduit and fittings shall be 6063 aluminum alloy with temper designation T-1. Conduit shall meet all ANSI and UL requirements. Conduit shall be threaded, threadless fittings and not acceptable.

2. Rigid aluminum conduit shall not be installed in concrete or in contact with concrete.

F. FLEXIBLE CONDUIT AND CONNECTORS

1. Use single strip steel, hot-dipped galvanized on all four sides prior to conduit fabrication. Conform to UL-1.

G. OUTLET, JUNCTION, AND PULL BOXES

1. Provide boxes for installation of electrical work, in compliance with codes and regulations.

2. Provide one-piece galvanized pressed steel knockout-type boxes, nominal sizes 4 inches square by 1-1/2 inches in flush-mounted or concealed locations above suspended ceilings unless otherwise indicated. Boxes for

use in concrete shall have square corner tile type covers with ribs or extensions for casting in concrete.

3. Construct pull boxes in flush-mounted or concealed locations that are larger than 4 inches square by 1-1/2 inches of code-gauge sheet steel finished with one coat of metal primer and one coat of primer sealer.

4. Use PVC coated threaded-hub ferrous boxes for surface-mounted or exposed locations. PVC coated cast conduit fittings may be used instead of boxes except where boxes contain devices.

5. Where threaded-hub cast boxes and fittings are not practical, provide NEMA 4X pull boxes constructed of Type 304 stainless steel. Install cover with neoprene gaskets and Type 304 stainless steel bolts. Attach conduit with “Myers” hubs.

H. MANHOLES AND HANDHOLES

1. Manholes shall be precast per ASTM C 478 with 28-day, 3000-psi minimum compressive strength concrete and designed for AASHTO H-20 loading. Manholes shall have minimum interior dimensions as shown on drawings with a concrete throat to the surface. Provide a drainage outlet at the low point of the floor constructed with a cast-iron, slotted or perforated hinged cover, and a 4-inch-minimum outlet and outlet pipe. Set manholes on a crushed rock base 12 inches thick with horizontal dimensions same as bottom of manhole plus 6 inches all around.

2. Handholes shall be electrical-type utility boxes manufactured by Quickset, Brooks Products, or equal. Handhole minimum interior size shall be as shown on drawings. Provide handholes with concrete bolt down covers in unpaved areas and handholes with cast-iron covers with bolt downs and lifting hook in paved areas. Set the handhole on a crushed rock base 6 inches thick with horizontal dimensions same as bottom of handhole plus 6 inches all around. Crushed rock shall be 3/4 inch maximum size.

3. Provide raceway entrances on all four side. For raceways installed under this contract, knockout panels or precast individual raceway openings may be used. On sides where no raceways are installed under this contract, provide 12-inch-high by 24-inch-wide (minimum) knockout panels for future raceway installation.

4. Utilize frames and covers made of cast iron, suitable for street loading. On the upper side of each cover, cast in integral letters not less than 2 inches high appropriate titles, ELECTRIC HV (for above 600 volts), ELECTRIC LV (for 600 volts and below), or CONTROL. Field stamp covers with manhole or handhole numbers indicated on the drawings. Cover shall be minimum 36” diameter.

5. Provide cable racks with adjustable arms and insulators for cables in each manhole. Set adjustable inserts in the concrete walls for the attachment of racks. Do not use bolts or studs embedded in concrete for attaching racks. Set racks and inserts not greater than 3-foot centers around the entire inside perimeter of the manhole, arranged so that spare conduit ends are clear for future cable installation. Provide racks with arms and insulators to

accommodate cables for each conduit entering or leaving the manhole including spares.

6. Provide a pulling iron embedded in the concrete wall or flush with the concrete floor opposite each raceway entrance and one in the floor vertically below the center of the manhole cover. Utilize ¾-inch-round stock securely fastened to the overall steel reinforcement before concrete is poured.

7. Provide an aluminum ladder with square rungs permanently mounted within the manhole. Rungs shall have serrated non-skid tops.

8. Concrete pull boxes, handholes and vaults shall be precast with pull-in irons, hot-dipped galvanized traffic cover with hot-dipped galvanized frame, and two galvanized cable racks with porcelain blocks on each of the two longest sides. Design for AASHTO H-20 loading. Provide bead weld on cover of pull box to indicate services within pull box (electrical, telephone, fire alarm, signal). After cables have been pulled and inspected, seal box between cover and frame with a mastic compound similar to Parmagum, Dukaseal, or equal.

9. Provide barriers and securely fasten conductors of different voltages in manholes and handholes to provide complete separation of the systems.

I. HAZARDOUS LOCATIONS

1. Conform with NEC Articles 501 and 502 for areas identified as “Hazardous Areas” in the specifications and on the drawings.

2. Provide threaded cast boxes and fittings for junction boxes and pull boxes in Class I and Class II areas. Boxes and fittings shall conform with Class I, Groups A, B, C, and D and Class II, Groups E, F, and G requirements.

3. Fixture hangers for pendant-mounted fixtures shall conform with Class I, Division 1 and Class II, Division 1 requirements.

4. Provide conduit seals in Class I, Division 1 and Class I, Division 2 locations within 18 inches of each conduit entering an enclosure containing electrical devices except for hermetically sealed switches and receptacles. Provide a conduit seal for each conduit leaving the hazardous location.

5. Flexible connections to motors and other vibrating equipment in Class I, Division 1 locations shall be made with flexible fittings approved for Class I, Division 1 locations.

J. CONCRETE-ENCASED DUCT BANKS

1. Concrete shall be Class C with red color additive in accordance with Section 03300.

2.02 MANUFACTURERS

A. PVC Coated Conduit and Fittings: Conduit and fittings shall be Permecote Supreme or equivalent product of Occidental or Robroy.

B. Manhole / Handhole Manufacturers: Brooks Products, Inc.; Penn-Cast Products, Inc.; Concrete Conduit Company; Associated Concrete Products, Inc.; or equal.

PART 3: EXECUTION

3.01 INSTALLATION

A. Conduit Usage: Install the following types of raceway in the locations listed, unless otherwise indicated on the drawings.

1. Exterior, Exposed:
    a. PVC-coated rigid galvanized steel conduit. All analog and network circuits shall be installed in PVC Coated Rigid galvanized steel conduit.
    b. Rigid Aluminum Conduit.
2. Interior, Exposed – Process Area:
    a. PVC-coated rigid galvanized steel conduit.
3. Interior, Exposed – Electrical Room:
    a. Rigid Steel Conduit. All analog and network circuits shall be installed in rigid steel conduit.
    b. Rigid Aluminum Conduit
4. Embedded in Concrete or Masonry:
    a. Rigid non-metallic conduit
    b. PVC-coated rigid galvanized steel conduit
5. Underground Direct Burial, or Below Concrete Slabs:
    a. PVC-coated rigid galvanized steel conduit
6. Underground Concrete Encased:
    a. Rigid nonmetallic conduit.
    b. PVC-coated rigid galvanized steel conduit.
7. Provide PVC coated rigid steel conduit long radius elbows for all underground ductbanks for bends exceeding 45 degrees.
8. Final Connections to Motors or Vibrating Equipment: Liquid-tight flexible conduit.
9. Connections to Suspended Lighting Fixtures: Liquid-tight flexible conduit.
10. Conduit Stub-ups: Provide PVC-coated conduit and associated elbows to transition from underground conduit to above ground connections and junction boxes.
11. All fittings for conduit or enclosures which are connected to PVC coated conduit or fittings shall be PVC coated.

B. Conduit Installation

1. Conduit runs are shown schematically. Supports, pull boxes, junction boxes, and other ancillary equipment are not usually shown. Provide pull boxes and junction boxes where shown. In addition, provide pull boxes and junction

boxes to permit pulling of wires without damage to the conductors or insulation.

2. Install exposed conduits parallel to or at right angles to the lines of the building. Make right-angle bends in exposed conduit runs with standard elbows, threaded conduit fittings, or conduit bent to radii not less than those of standard elbows.

3. Route exposed conduit to preserve headroom, access space, and workspace.

4. Conduit in Concrete Slabs: Run conduits 2 inches clear from face of slab and 3 inches clear between other conduits.

5. Do not route conduits below or within concrete footings except to cross footing at 90-degree angles.

6. Conduit in Concrete Walls: Run conduits in center of wall and 4 inches vertical clearance between other conduits.

7. Provide expansion fittings for raceways crossing expansion joints in structures or concrete slabs.

8. Treat threaded joints of rigid steel conduit with T&B “Kopr-Shield” before installing fittings where conduit is in slabs and other damp or corrosive areas.

9. Terminate steel conduits with double locknuts (2) and bushings.

10. When terminating in threaded hubs, screw the conduit or fitting tight into the hub so that the end bears against the fire protection shoulder. When chase nipples are used, install the raceway and coupling square to the box and tighten the chase nipple with no exposed threads.

11. All conduits shall enter exterior pull boxes, control panels, junction boxes, and all other enclosures from the bottom. No top entries allowed without prior approval by the Owner.

12. Provide minimum 12” separation of conduits with twisted shielded pair analog signal wiring and conduits with power circuits.

13. Do not route conduit, conduit fittings, or install junction boxes in sump, containment, or other areas subject to submerging conduits and fittings.

14. All conductors in a common raceway, junction box, or fitting shall have the same voltage rating.

15. Provide stainless steel hardware for connection of all aluminum conduit. Aluminum conduit shall not be in contact with concrete or carbon steel. Provide corrosion protection as recommended by the conduit manufacturer for all final connections of aluminum conduit to equipment.

C. Duct Banks and Concrete Encasements

1. Provide 24-inch-minimum cover for direct burial underground conduit. Provide 4-inch minimum sand above and below conduit. Underground

conduits shall be direct buried unless identified as concrete encased on the drawings, or as specified herein.

2. Provide 30-inch-minimum cover above top of concrete for concrete-encased duct banks. Provide 3.5 inch minimum separation between conduits and 4 inch minimum concrete encasement around the exterior rows and columns of conduits. Extend the concrete encasement under any floor slabs or equipment mounting pads to the point of raceway termination.

3. All conduits installed under traffic areas shall be concrete encased. This includes all asphalt, gravel, concrete, and other areas where vehicular traffic occurs.

4. Where other utility piping systems are encountered or being installed along a raceway route, maintain a 12-inch-minimum separation between raceways and other systems in parallel runs. Do not place raceways over valves or couplings in other piping systems. Refer conflicts with these requirements to the Owner's Representative for instructions before further work is done.

5. Maintain a grade of at least 4 inches per 100 feet either from one manhole or pull box to the next or from a high point between them, depending on the surface contour. Slope ducts from buildings to pull boxes, handholes, or manholes.

6. Changes in direction of over 10 degrees shall be with long sweep bends with minimum radii of 10 feet. Manufactured bends may be used at manholes or pull boxes for runs under 100 feet. Minimum radii of conduit under 3 inches shall be 18 inches. For conduit 3 inches and larger, minimum radii shall be 36 inches.

7. Thoroughly clean conduits before laying. During construction and after completion, the conduit ends shall be kept plugged to prevent water from washing mud into the manholes, handholes, or pull boxes.

8. Terminate conduit in end bells in manholes, handholes, and pull boxes and enter at right angles to the wall.

9. Place separators every 4 feet on center and securely anchor to prevent movement.

D. Conduit Supports

1. Support conduit at intervals and at locations as required by the NEC. Do not use perforated strap or plumbers' tape for conduit supports.

2. Above suspended ceilings, support conduit on or from the structure except that individual conduits of 1 inch or smaller size may be supported from the suspension wires (using "caddy" spring steel fasteners) or from the ceiling channels (using 16-gauge galvanized annealed tie wire). Support conduit attached to the suspension system at maximum 4-foot intervals.

3. Conduit on Concrete or Masonry: Use one-hole malleable iron clamps with pipe spacers (clamp backs) or preformed galvanized steel channels. Anchor with metallic expansion anchors and screws or from preset inserts. Use preset inserts in prestressed concrete. On plaster or stucco, use one-hole

malleable iron straps with toggle bolts. For PVC coated conduit use PVC coated clamps and spacers. For aluminum conduit use 316 stainless steel hardware.

4. Suspended Conduit: Use Type 316 stainless-steel pipe hangers with Type 316 stainless-steel pipe hangers with Type 316 stainless-steel threaded suspension rods sized for the weight to be carried (minimum 3/8 inch diameter); Unistrut, Kin-Line, or equal. For grouped conduits, construct racks with Type 316 stainless-steel rods and 6063-T6 extruded aluminum preformed channel cross members. Construct channel to limit deflection to 1/200 of span. Conduit clamps shall be aluminum. Provide Type 304 stainless-steel bolts and nuts.

5. Supports at Structural Steel members use type 316 stainless-steel beam clamps. Drilling or welding may be used only where indicated on the drawings.

6. Wherever conduit may be affected by dissimilar movements of the supporting structures or medium, provide flexible or expansion devices.

E. Conduit Penetrations

1. Dry-pack with nonshrink grout around raceways that penetrate concrete walls, floors, or ceilings above ground, in addition to paragraphs 2. and 3.

2. Where an underground concrete ductbank enters a structure through a concrete roof or a membrane waterproofed wall or floor, provide a malleable waterproofed wall or floor watertight, entrance sealing device. When there is no raceway concrete encasement specified or indicated, provide such a device having a gland-type sealing assembly at each end with pressure bushings which may be tightened at any time. When there is raceway concrete encasement specified or indicated provide such a device with a gland-type sealing assembly on the accessible side. Securely anchor all such devices into the masonry construction with one or more integral flanges. Secure membrane waterproofing to such devices in a permanently watertight manner.

3. Where an underground raceway without concrete encasement enters a structure through a wall or floor, install a watertight entrance sealing device, such as Linkseal.

F. Warning Tapes

1. Bury warning tapes above all underground direct buried and concrete-encased conduits and duct banks. Align parallel to and within 3 inches of the centerline of the conduit or duct bank. Warning tape should be at locatable type.

2. Plastic tape shall be yellow, 3-inch minimum width. Utilize tape made of material resistant to corrosive soil. Use tape with printed warning that an electric circuit is located below the tape. Manufacturers and types: ITT Blackburn Type YT, Griffolyn Co., Terra-Tape, or equal.

G. Manholes, Handholes, and Pull Boxes

1. Install per Division 3.

2. Install covers flush with finished paved surfaces. In unpaved areas, install the top of manhole or pull box covers 1 inch above finished grade or 6 inches above unfinished grade.

3. Securely support cables on manhole or pull box walls by cable racks, support arms, brackets, and insulators.

4. At inside each manhole, handhole, and pull box, at a convenient location close to a wall, provide a ¾-inch by 10-foot ground rod driven with 6 inches of rod exposed, connect to a copper ground bar in the manhole. Grounding and bonding shall be per Section 16450, and the local code requirements. Ground all conduit, grounding conductors, and metallic portions of the manhole.

5. Excavation, backfilling, and grading shall conform to requirements of Division 2.

6. Use box extension sections where necessary to raise cover to height required depending on grade finish.

H. Damaged Conduit

1. Replace conduit damaged during or after installation. Replace crushed or clogged conduit or any conduit whose inner surface is damaged or not smooth.

2. Repair cuts, nicks, or abrasions, in the zinc coating of galvanized conduit with galvanizing repair stick, Enterprise Galvanizing “Galvabra” or equal.

I. Mandrel

1. For raceways in concrete-encased duct banks, after the concrete envelope has set, pull a mandrel of a diameter approximately ¼ inch less than the raceway inside diameter, through each raceway. Then pull a bristle brush through each raceway to remove debris.

J. Pull Cord

1. Provide 200-pound strength nylon pull cord in all used and empty conduits.

K. Pull Boxes

1. Support wall-mounted pull boxes and panels in all locations with Type 304 stainless-steel preformed channels and Type 304 stainless-steel concrete anchors.

END OF SECTION

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# SECTION 16114

# CABLE TRAY

## PART 1: GENERAL

### 1.01 DESCRIPTION

A. This section describes materials and installation of Cable Trays for installation of overhead wireway and cable tray as shown on the drawings and specified herein.

### 1.02 SUBMITTALS

A. Submit shop drawings in accordance with the Section 01300.

B. Submit material list for cable tray system including dimensions, materials, and finishes, including UL Classification and NEMA/CSA Certification.

C. Submit factory-certified test reports of specified products, complying with NEC, and NEMA VE 1/CSA C22.2 No. 126.1 and manufacturer's certification indicating ISO 9001 quality certified.

D. Submit detailed layout and configuration of cable including weights and loading. Show cable tray as a complete system for each segment.

E. Submit conduit and cable entry methods and details, including drawings.

### 1.03 DESIGN CRITERIA

A. Tray side rails shall be 4 inches high throughout installation.

B. Maximum load capacity on tray is 200 lbs/ft. Structure shall be rated for this load.

C. Minimum turning radius of the tray shall be 12 inches.

D. Cable tray covers shall be solid and fastened to the rail.

## PART 2: PRODUCTS

### 2.01 MANUFACTURERS

A. Cable Tray Systems shall be manufactured by Cooper B, Eaton, Thomas and Betts, or equal.

### 2.02 MATERIALS

A. All material in the scope of supply shall be of Aluminum. Side rails, Rungs, Splice Plates shall conform to 6036-T6 and Trough Bottoms, Covers and Accessories shall meet requirements of 5052-H32.

B. The cable trays shall be manufactured for installation where they may be directly exposed to the sun, be installed or outside a building in cable trenches or in a walk-in cable tunnel, along structures etc, in a power plant or industrial environment.

C. The interiors of all types shall be smooth and free of any projection that might injure cable sheaths and jackets (NEC 318-4). All slice plates should be installed on the outside surface of the supports. Round head bolts, screws, or other fasteners (head inside) are to be used exclusively

D. Length of Straight Sections: Standard manufacturer lengths shall be 12 feet (3.7 m) and 20 feet (6.1 m) not including connectors if attached. Straight section lengths shall be greater than or equal to the support span length. Straight section lengths shall be used such that a maximum of one splice joint is between any two tray supports.

E. Working Allowable Load Capacity: Working load capacity and span shall be in accordance with NEMA Standard VE1 Sections 4.8, 5.2, and Table

1. NEMA Load/Class 12C.
2. NEMA Load/Class 20A.
3. NEMA Load/Class 20B.
4. NEMA Load/Class 20C.

2.03 CABLES

A. Single conductor cable shall be No. 1/0 or larger and shall be of a type listed and marked on the surface for use in cable trays (section 392.10(B) NEC 2011). Where Nos. 1/0 through 4/0 single conductor cables are used, the maximum allowable rung spacing for ladder cable tray is 9 inches.

B. Single conductors used as equipment grounding conductors (EGCs) in cable trays shall be No. 4 or larger insulated, covered, or bare (section 392.10(B)1(C) NEC 2011).

C. All cable used in cable tray shall be rated for this use and allowed by NEC requirements.

PART 3: EXECUTION

3.01 CABLE TRAY SYSTEM INSTALLATION

A. Cable tray wiring systems should be installed with adequate room around the cable tray to allow for the set up of cable pulling equipment. Also, space around the cable tray provides easy access for installation of additional cables or the removal of surplus cables.

B. Supports for cable tray system shall provide strengths and working load capabilities sufficient to meet load requirements of the cable tray wiring system. Consideration should be given to the loads associated with future cable additions or any other additional loads applied to the cable tray system or cable tray support system.

C. Bends in cable trays shall be made with manufacturer’s fittings or equivalent. Mitered vertical bends are permitted on ladder cable supports only. The effective radius must be not less than that allowable for the cables involved. Mitered cuts must be positioned midway between rungs and shall permit not over a 22 ½ degree

directional change per miter or rung. Bends, ells tees and other fittings elbows are available with several radii. The radii of fittings both vertical and horizontal should be suitable to accommodate cables so that they will never be bent, either during installation or in the final arrangement, to lesser radii.

D. Cable tray systems can have mechanically discontinuous segments, and that the mechanically discontinuous segment cannot be greater than 6 feet. A bonding jumper sized per Section 250.102 is necessary to connect across any discontinuous segment. The bonding of the system should be in compliance with Section 250.96.

E. The final cable tray system must be in place before the cables are installed. It does not mean that the cable tray must be 100% mechanically continuous. The electrical bonding of the metallic cable tray system must be complete before any of the circuits in the cable tray system are energized whether the cable tray system is being utilized as the equipment grounding conductor in qualifying installations or if the bonding is being done to satisfy the requirements of Section 250.96.

F. Install full covers on all outdoor installations. Covers shall be attached to the cable trays with heavy duty wrap around clamps instead of standard duty clips due to heavy winds.

G. Seal penetrations through walls and barriers after pulling all cables and installing all accessories

3.02 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. The sum of the diameters (Sd) of all single conductors shall not exceed the inside width of the ventilated cable channel.

C. Section 392.20(D) states that single conductors in ladder or ventilated trough cable tray that are Nos. 1/0 through 4/0, must be installed in a single layer. In addition to the fill information that is in Section 392.20(D), an exception was added which allows the cables in a circuit group to be bound together rather than have the cables installed in a flat layer. The installation practice in the exception is desirable to help balance the reactance’s in the circuit group. This reduces the magnitudes of voltage unbalance in three phase circuits.

D. Maximum Allowable Fill Area for Single-Conductor Cables in Ladder, Ventilated Trough, or Wire Mesh Cable Trays is per Table 392.22(B)(1).

E. The wording of Section 392.80(B)(2)(c) states that a spacing of 2.15 times one conductor diameter is to be maintained between circuits

F. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

G. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

H. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between

cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

I. Cable Routing - Identifies the cable tray sections or runs that a cable will occupy. Cable tray ID tag numbers are to be used to track the routing.

3.03 INSPECTION/TEST

A. The inspection & testing shall be carried out at the manufacturer's works in accordance with the relevant sections of the specification and witnessed by the purchaser prior to the shipment.

END OF SECTION

# SECTION 16120

# WIRES AND CABLES

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section describes materials and installation of wires and cables, including power, control, analog, and variable frequency drive cables.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

### 1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Submit material list for each conductor type. Indicate insulation material, conductor material, voltage rating, manufacturer, and other data pertinent to the specific cable, such as type shielding, number of pairs, and applicable standards.

C. Submit all wire numbers and identification on conduit layout drawings for review and approval.

D. Submit wiring size and type in conduit layout drawings defined in Specification 16110. Provide conduit fill calculations for all conduit with VFD cables.

E. Submit pull calculations for all underground and above ground feeders which exceed 300 feet in length.

F. Submit insulation resistance test reports for all wiring prior to connections and energizing.

G. Submit Control Cable Test reports.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer.

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

### 1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with Division 1 and the manufacturer’s recommendations.

### 1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Raceway, Boxes, and Fittings: 16110

C. Cable Tray: 16114

D. Fiber-Optic Cable: 16125

E. General Control System Requirements: 16900

PART 2: PRODUCTS

2.01 GENERAL

A. Refer to Section 16114 for Cable Tray wiring.

B. Low-voltage Building Wire

1. Conductor material shall be copper.

2. Low-voltage building wire for use at 600 volts or less shall be 600-volt insulated, Type THWN, and rated for continuous operation at 75°C.

3. In underground conduits and ductbanks, utilize type XHHW, 75°C, 600 volt conductors.

4. No. 12 AWG minimum conductor size for power and lighting circuits.

5. No. 14 AWG minimum conductor size for control circuits.

6. All conductors shall be stranded.

C. Instrument Cable

1. Single-pair cables shall be two No.18 AWG stranded tinned-copper conductors individually insulated with fully color-coded PVC rated at 600 volts; insulated conductors twisted together and shielded with a spiral-wound metal foil tape overlapped for 100% shielding. Outer jacket shall be PVC.

2. Multiple-pair cables shall have number of pairs specified with each pair being two No. 18 AWG stranded tinned-copper conductors individually insulated with PVC rated at 600 volts. Conductor pairs shall have insulation pigmented black and white with white conductor numerically printed for group identification. Each pair and its 20 AWG stranded tinned-copper drain wire shall be twisted together and shielded with an aluminum-polyester tape overlapped for 100% shielding. Provide a cable shield of 2.35-mil aluminum-polyester tape overlapped to provide 100% shielding and an 18 AWG copper drain wire. Provide a flame-retardant PVC jacket per UL 13, 105°C temperature rating.

D. Network Cable

1. Provide Category 6 shielded plenum rated network cabling. The cable shall be solid 24 AWG conductor, 4 pair, unshielded type. Provide cable with jacket. Cable shall be suitable for 100 Mbps communications. Provide Belden, or equal.

2. Provide RJ-45 jack outlets for connecting equipment to the Ethernet network. Each jack shall be wired to an 8-position terminal strip for connection of the Category 6 cable.

3. Provide cabling, couplers, end connectors, T-connectors, terminators, junction boxes and all other associated cable connectors as required for supplying a complete and fully integrated system for each of the communication networks, and as required by the manufacturer.

E. Variable Frequency Drive Cables

1. All conductors from VFDs to associated motors shall be VFD cables specifically made for the application. Cable shall be multiconductor, 600 volt, specifically fabricated for use with PWM type VFD inverters. Provide cable with 3 power conductors and overall copper tape shield with XLPE insulation, rated at 90 degrees C, and a PVC jacket. Cable shall be manufactured by Belden, General Cable, or equal.

2. Contract drawing wire sizes shall be used for individual phase and ground conductors, to be installed in a single cable as indicated above.

F. Medium Voltage Cables

1. Provide single conductor copper power cable with 133% insulation level and meets applicable NEMA WC standards, Type MV-90, UL listed.

2. Cable shall consist of conductor, extruded semiconducting thermosetting conductor layer (shield), XLP insulation, copper shield tape with 100% coverage and PVC jacket.

3. Provide cable manufactured by Okonite, Anaconda, or equal.

4. Provide indoor terminations of the factory pre-molded type of an EP rubber material. Make outdoor terminations with preassembled porcelain slip-on type terminators. For all terminations, provide shield termination and grounding. Provide mounting hardware, covers, and connectors. Provide terminators rated in accordance with IEEE No. 48, Pothead Standards.

## PART 3: EXECUTION

### 3.01 INSTALLATION

A. Wire Installation

1. Install wiring and cable in conduit unless otherwise noted.

2. To reduce pulling tension in long runs, coat cables with pulling compound recommended by the cable manufacturer before being pulled into conduits.

3. Remove debris and moisture from the conduits, boxes, and cabinets prior to cable installation.

4. Group conductors No. 1/0 and smaller in panelboards, cabinets, pull boxes, and switchboard wireways; tie with plastic ties; and fan out to terminals. Lace conductors No. 2/0 and larger with marline.

B. Identification

1. Color coding of Low-Voltage Building Wire: Provide color coding throughout the entire network of feeders and circuits (600 volts and below) as follows:

| PHASE | 208/120 Volts | 480/277 Volts | 240 Volts | 240/120 Volts |
|---|---|---|---|---|
| Phase A | Black | Brown | Black | Black |
| Phase B | Red | Orange | Red | Red |
| Phase C | Blue | Yellow | Blue | |
| Neutral | White | Gray | White | White |
| Ground | Green | Green | Green | Green |

2. Conductors No. 10 AWG and smaller shall have factory color coding with solid color insulation. Do not use onsite coloring of ends of conductors or apply colored plastic adhesives in lieu of factory color coding.

3. Conductors No. 8 AWG and larger shall have factory color coding with solid color insulation or shall have black insulation with onsite application of colored plastic adhesives at ends of conductors and at each splice.

4. Control wires shall have colored insulation. Control wiring coloring shall be same as specified in Section 16946.

5. Tagging of Conductors: Tag power and control wires, instrument cables, VFD cables, and network cables in all panels, pull boxes, wireways, and at each control device with adhesive type of marker: Brady, Thomas and Betts, or equal. Tag control wires and instrument cables with same wire numbers as on the interconnect shop drawing submittals from the system integrator. Tag power wires in pull boxes and wireways where there is more than one circuit. Tag power conductors with motor control center or panelboard number and circuit numbers.

C. Low-voltage Wire Splices

1. The contractor shall not splice power or control cables unless specific concurrence is obtained from the Owner's Representative. Splices will only be approved under certain circumstances as defined by the Engineer.

2. Motor Connections: Use T & B "Locktite" connectors, Burndy Versitaps, and heavy-duty connectors, O.Z. solderless connectors, or equal.

3. All other Conductors: Use crimp compression connectors with tools by same manufacturer and/or UL listed for connectors of all stranded conductors.

4. Retighten bolt-type connectors 24 to 48 hours after initial installation and before taping. Tape connections made with non-insulated-type connectors with rubber-type tape, one and one-half times the thickness of the conductor insulation, then cover with Scotch 33 tape.

5. All splices below grade shall use watertight splice kits made specifically for the application.

## 3.02 FIELD TESTING

A. Insulation Resistance Tests

1. Test each complete power and digital control circuit prior to energizing. Insulation resistance between conductors and between each conductor and ground shall not be less than 25 megohms. Repair or replace wires or cables in circuits which do not pass this test and repeat the test.

B. Control Cable Testing

1. Installation: Prior to installing the cable, megger the reel of cable for continuity of each cable pair. Record test results and submit to the Owner's Representative. The intention of these specifications is that the cable shall be installed without splices except as identified on the drawings. Provide sufficient length of continuous cable to permit installation without splices. Protect the cable during and after installation.

2. Testing: After installing the cable, conduct an acceptance test to verify that the cable performs to the specifications. The test shall be for the entire length of the cable. Notify the Owner's Representative three days minimum prior to the scheduled tests.

3. Test each cable for continuity and attenuation. These loop back test values shall be within 10% of the specifications.

4. In the event that the cable should fail to pass the test, ascertain the location of the defects, and replace the cable. Repeat the acceptance test. Repeat this procedure until successful tests are obtained.

5. Communication, instrumentation, and 50 volt (or less) control cables shall be kept separated from all power wiring and cable. The control cable shall be run in separate conduit and shall be kept at least three inches from 120 VAC circuits and proportionately greater distances for higher voltage circuits.

END OF SECTION

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# SECTION 16125

# FIBER-OPTIC CABLE

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section includes materials, installation, and testing a buried multi-mode fiber-optic cable-in-duct system for use in plant control system (PCS) specified in Section 16900. The video system in Section 16792 includes fiber optic cable which is the responsibility of the video installer.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

### 1.03 SUBMITTALS

A. Submit shop drawings and catalog data in accordance with Section 01300 and Section 16900.

B. Submit catalog data on the fiber-optic cable, innerduct, pull boxes, connectors, conduit sealant, closures, enclosures, identification tape, and mounting hardware.

C. Submit catalog data and installation instructions on the splice method, hardware, and splicing equipment.

D. Submit detailed bill of materials.

E. Submit catalog data on the testing equipment. Submit a written test procedure outlining the steps and methods that will be used to test the cable before and after installation. Include a sample copy of the test form that will be used in the test procedure.

F. Provide a cable and duct installation procedure outlining the construction methods that will be used. Identify steps that will be taken to ensure that the cable is not damaged during the installation.

G. Submit complete factory test results for each cable reel stating the signal loss for each fiber in the cable.

H. Submit record drawings indicating the locations of all splices and pull boxes.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer.

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Delivery, handle and store the equipment in accordance with SP-13 and SP-14 and the manufacturer's instructions.

1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Raceways, Boxes, and Fittings: 16110

C. Video Surveillance System: 16792

D. General Control System Requirements: 16900

1.07 QUALIFICATIONS AND RESPONSIBILITY OF INSTALLER

A. The fiber-optic system shall be the unit responsibility of the contractor; however, all coordination shall be through the system supplier as specified in Section 16900.

B. Submit evidence of qualification and experience in installing fiber-optic cables in writing. The qualification evidence shall include the following:

1. Written evidence that the system installer has a minimum of three years' experience with the installation of fiber-optic systems similar to this project.

2. A list of completed installations similar to this project including the name and address of the Owner, the name of the project, and the date or completion.

3. The name and qualifications of the supervisory personnel that will be solely responsible for the installation of the fiber-optic system.

1.08 FIELD CONTROL OF LOCATION AND ARRANGEMENT

A. The drawings diagrammatically indicate the desired location and arrangement of pull boxes, cable runs, and other items. Exact locations shall be determined by the Contractor in the field based on the physical size and arrangement of equipment, finished elevations, and obstructions. Locations shown in the drawings, however, shall be adhered to as closely as possible.

PART 2: PRODUCTS

2.01 MANUFACTURERS

A. Provide fiber optic cable manufacturer by Corning, Belden, or equal as follows:

1. For exterior and duct bank installation, provide loose tube double jacket armored fiber optic cable. Tight buffered cable shall not be acceptable for exterior or underground use.

2. For indoor installation, provide loose tube single jacket plenum Fiber Optic Cable.

B. Fiber optic patch cable and panel shall be manufactured by Corning, Belden, or equal.

C. Fiber Optic Distribution Box shall be Corning or equal.

D. Innerduct shall be ARNCO Starburst Type 11, or equal.

2.02 FIBER-OPTIC CABLE

A. The fiber-optic cable shall be a multi-mode cable suitable for use with both 850 and 1,300 nm transmission equipment. The cable sheathing shall be medium-density polyethylene (MDPE). The cable shall be all dielectric.

B. Each fiber shall consist of:

1. 50-micron core with a 125-micro cladding material.

2. The maximum individual fiber loss 3.5 dB/km at 850 nm and 1.5db/km at 1,300 nm.

3. Color-coded.

4. 6-pair per fiber-optic cable, unless otherwise specified.

5. -40°C to 80° C operating Temperature range.

6. 250-lb./inch minimum crush resistance.

C. Crush resistance shall be 220N/cm minimum.

D. The fiber-optic cable shall have a tensile load rating of 600 pounds minimum.

E. Provide cable sheathing medium-density polyethylene (MDPE). Provide all dielectric cable.

F. Continuous outer jackets of the cable, free from holes, splits, blisters, or inclusions. The same requirement holds for any inner jackets within a given cable structure as well as fiber coatings. Design, manufacture, and test panels in accordance with the latest applicable standards of NEMA, IEEE and ANSI.

G. Provide all of the fiber-optic cable from the same manufacturer.

H. Provide loose-tube type cable construction.

I. All of the fiber-optic cable shall be supplied from one manufacturer, exterior cable construction shall be the loose-tube gel-filled type as manufactured by Belden, Corning, or equal.

J. Fiber-optic cable shall transition from interior to exterior cable in a fiber distribution box within 50 feet from entry into the facility.

2.03 FIBER-OPTIC ACCESSORIES

A. Provide fiber optic patch panel connector LC type for each fiber to match fiber optic equipment.

B. Install the connectors after the fiber-optic cables are pulled and run to their desired location.

C. Provide fiber optic cable connectors LC type pre-polished.

D. Provide heavy wall rigid galvanized steel raceways for fiber optic cable.

E. Provide all other raceways, fittings, boxes, and terminal cabinets in accordance specification 16110.

2.04 FIBER-OPTIC DISTRIBUTION BOX (FOD)

A. Provide a fiber optic distribution box to enclose indoor/outdoor fiber optic cables connections. Provide, as a minimum, one FOD for each area as indicated on drawings.

B. Locate the FOD enclosure as close as possible to PLC or equipment enclosure.

C. Meet fiber optic cable recommendation for fiber optic cable connections in FOD enclosures.

D. Provide LC connectors and connect all fiber optic strands to FOD rack.

E. Provide an enclosure with the following characteristics:

1. Constructed of a Low Zero halogen Material.
    a. Easy to punch, drill, file or saw.
    b. Provide brackets for wall mounting.
    c. Provide hardware grounding kit.
2. Provide (2) 6-fiber panels for 12 fibers total capacity, as a minimum or 125% of fiber optic capacity.
3. Provide NEMA 4X enclosure in damp, wet, corrosive, or exterior locations.

2.05 INNER DUCT

A. Innerduct shall be polyethylene plastic duct manufactured from high density, premium grade P34, polyethylene resin in accordance with ASTM standard D-1248. Resin shall be UV stabilized for protection during shipping and outside storage. Color shall be orange.

B. Innerduct shall incorporate internal longitudinal ribs for reducing surface contact and minimizing drag during cable pull.

C. Innerduct shall be provided with pre-installed pull tape.

2.06 FIBER-OPTIC SPLICES

A. Fiber-optic splices shall be fusion or mechanical with a 0.2 dB maximum loss per splice. Install splices in splice tray organizers specifically designed for the type of splice being used. The splice trays shall be suitable for use with loose tube cables. Splices shall only be allowed by prior written consent of the Owner.

2.07 FIBER-OPTIC SPLICE CLOSURE ASSEMBLY

A. Install fiber-optic splices in pull boxes in a re-enterable splice closure assembly with removable splice organizer trays. The splice closure assembly shall consist of individually accessible splice trays and an inner and outer closure. Fill the outer closure with an encapsulant to provide a moisture proof seal. Provide AT&T UCB1 with a Type 2000 outer closure, or equal.

2.08 CONDUIT SEALANT

A. Seal open ends of buried conduit and conduit entrances into the pull boxes with waterproof putty duct seal LHD-5 by Doltie or equal.

2.09 FIBER-OPTIC PULL BOXES AND HANDHOLES

A. Provide precast concrete pull boxes and handholes for cable installation. The pull boxes shall be traffic bearing and designed for H-20 bridge loading. Covers shall be galvanized steel with Communications bead welded on the upper surface. Knockouts in the wall shall permit underground conduit Penetrations. Embed 1-5/8-inch by 2-foot galvanized steel channel inserts on each side of the interior of the pull box for attachment of the cable supports. Refer to Section 16110 for handhole dimensions. Accessories shall include angle iron and pulling eyes. Provide Brooks Type 200FPB, or equal.

2.10 SUPPORTS

A. Support the fiber-optic cable on porcelain saddles attached to 1-5/8-inch structural channel on the inside of the fiber-optic pull boxes. Secure the cable to the porcelain saddles with cable tie wraps or approved PVC saddles/brackets designed specifically for use in electrical manholes.

PART 3: EXECUTION

3.01 FIELD TESTING

A. Install connectors on each fiber to perform the field tests. Test fibers for breaks, abnormalities, and overall attenuation characteristics to ensure that the installed cable adheres to the required optical parameters. Provide written certification of the dB loss at each splice point and test location.

B. Perform attenuation tests at the following times:

1. After delivery to the site, before the cable is removed from the reel.

2. Before a splice is made.

3. Final test at each end of the cable after all the splices have been made.

C. Remove, replace, and retest any cable section that exceeds the allowable attenuation. After the field test has been successfully completed, remove the connectors at the splice locations and install the splices.

D. The Owner’s Representative will witness the testing and final checkout of the fiber-optic system to determine if the system complies with the contract documents.

3.02 CABLE PACKAGING

A. Permanently mark the cable to identify the manufacturer, date manufactured, length of cable, product identification code, and UL messages when appropriate. The marking shall be printed at regular intervals of not more than 1 meter apart.

B. Package the cable and duct on a reel with inner hub diameter greater than the recommended minimum bending diameter of the cable. The anchor holes on the

reels shall admit a 63.5-mm (2.5-inch) diameter spindle without binding. The package shall be sturdy enough to endure reasonable handling in the process of shipping and storage.

C. The following information shall be securely attached to the reel (as a tag) or clearly and permanently stenciled or labeled on each reel: customer order number, customer job number, customer reel number, termination, ship date, manufacturer's name, factory reel number, manufacturer's cable code (type and fiber count), length of cable, weight of cable and reel, and defect tag.

D. Seal the ends of all cable and duct to prevent the escape of filling compound and to prevent the entry of moisture during shipping, handling, storage, and installation.

3.03 FIBER-OPTIC CABLE INSTALLATION

A. The installation of the fiber-optic cable and inner duct shall be performed by workers skilled in fiber optic installations. Install the fiber optic cable in ducts as shown on the drawings, with an identification tape installed 12 inches above it.

B. Do not place the cable in tension during installation. Minimum cable bending radius shall be as required per manufacturer.

C. During installation, do not kink the cable and inner duct as it comes off the spool. Do not allow vehicular or pedestrian traffic to run over the duct or cable. Use dynamometers or break-away pulling swings to ensure the pulling line tension does not exceed the installation tension values specified by the manufacturer. The maximum pulling tension for each pull shall be recorded and submitted after the installation is complete.

3.04 FIBER-OPTIC ACSSESORIES

A. Provide fiber optic patch panel connector LC type for each fiber to match fiber optic equipment.

B. Install the connectors after the fiber-optic cables are pulled and run to their desired location.

C. Provide fiber optic cable connectors LC type pre-polished.

D. Fiber optic patch cable and panel shall be manufactured by Corning or equal.

E. Provide heavy wall rigid galvanized steel raceways for fiber optic cable.

F. Provide all other raceways, fittings, boxes, and terminal cabinets in accordance specification 16110.

3.05 FIBER OPTIC DISTRIBUTION BOX (FOD)

A. Provide a fiber optic distribution box to enclose indoor/outdoor fiber optic cables connections. Provide, as a minimum, one FOD for each area as indicated on drawings.

B. Locate the FOD enclosure close to RIO enclosure.

C. Meet fiber optic cable recommendation for fiber optic cable connections in FOD enclosures.

D. Provide ST connectors and connect all fiber optic strands to FOD rack.

E. Provide an enclosure with the following characteristics:

1. Constructed of a Low Zero halogen Material
    a. Easy to punch, drill, file or saw.
    b. Provide brackets for wall mounting.
    c. Provide hardware grounding kit.
2. Provide (2) 6-fiber panels for 24 fibers total capacity.
3. Provide NEMA 4X.

F. Provide FOD Manufacturer by Corning or equal

3.06 SPLICING

A. Do not splice the fiber-optic cable except in the locations shown in the drawings. Provide cable runs and required loops in one continuous length. Additional splices, if required, shall be submitted prior to installation. Do not perform additional splicing unless authorized in writing by the Owner.

3.07 CONDUIT INSTALLATION

A. Pull a mandrel through the conduit to check the inside diameter and verify that the conduit is free from obstructions. If the mandrel will not pass through the conduit, replace, or repair the conduit at the obstruction point.

3.08 INNERDUCT

A. Innerduct shall be installed in all underground conduits and ductbanks for the installation of fiber optic cable. Ductbank conduits shall be rodded, slugged, and if required, flushed to remove silt and foreign material and to determine the location of collapsed sections.

B. Innerduct shall be routed through handholes and manholes to protect fiber optic cable. Secure innerduct to racks inside manholes.

C. The maximum pulling strength limits of the innerduct during installation shall not be exceeded. Innerduct pull tensions shall be monitored at all times during installation.

D. To reduce friction and minimize pulling forces during installation, a polymer based, water soluble lubricant shall be used when pulling innerduct.

E. Within manholes, innerduct shall be cut to allow sufficient duct protruding from the ductbank conduit for joining corrugated slit duct.

3.09 TEST RESULTS

A. Furnish written certification of all tests conducted for each fiber at each splice point and at the end of each fiber-optic cable run. Certification shall clearly label the test type, the fiber identification as shown on contract document, fiber number, fiber color, test location, test date, wavelength, index of refraction, and a diagrammatic identification of the tested fiber.

B. Overall distance and distances to each and every splice location on an individual fiber.

C. Overall attenuation with a comparison to the allowable overall attenuation characteristics specified herein and attenuation of each span of cable between two adjacent splice locations.

D. Individual Splice Loss: Splice loss measurements shall be arrived at by averaging the splice losses at each individual splice from both directions of the splice by use of an OTDR. Each splice measurement shall have written documentation of the OTDR trace.

3.10 TRAINING OF OWNER'S PERSONNEL

A. Provide the Owner's operating personnel and/or the Owner's Representative with one day of formal instruction in the maintenance and operations of the fiber-optic system provided under this contract. The training shall cover overall system theory, hardware splicing, connectors, diagnostics, and troubleshooting.

B. Provide the training sessions at the Owner's facilities and on the equipment furnished under this contract. The education and instruction of operating personnel shall be by a qualified instructor familiar with the requirements for this project. Each training session shall be for eight hours of formal instruction. Session dates shall be directed by the Owner.

END OF SECTION

# SECTION 16140

# SWITCHES AND RECEPTACLES

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section describes materials and installation of light switches and receptacles.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

### 1.03 SUBMITTALS

A. Submit shop drawings and catalog data in accordance with Section 01300.

B. Submit material list for each type of switch, receptacle, and cover plate. Indicate type, ratings, material, color, and manufacturer.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer.

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

### 1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with the Special Provisions and the manufacturer’s recommendations.

### 1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

## PART 2: PRODUCTS

### 2.01 GENERAL

A. Provide switches and receptacles that are listed by Underwriter’s Laboratories, Inc.

### 2.02 RECEPTACLES

A. Provide corrosion-resistant receptacles, unless otherwise noted. Provide gray melamine, duplex receptacle, Hubbell 53CM62GY or equal.

B. Ground Fault Interrupter Duplex Receptacles: Receptacles shall be rated 20 amperes and comply with UL-943, Class A. Provide Leviton 6198-I, 3M GFI-2701, or equal.

C. Explosion-Proof Receptacles: Provide explosion-proof receptacles for areas identified as “Hazardous Area” or where receptacle is labeled “explosion proof.” Provide explosion-proof outlet of the cast malleable iron type with sealing chamber to house receptacle. Unit shall be of dead front design with spring-loaded cover utilizing receptacle outlet as indicated. Provide watertight self-adjusting matching plug capable of securely locking to outlet with no danger of being accidentally withdrawn. Receptacle outlet shall be activated only after plug is inserted and rotated manually. Receptacle shall comply with NEC Class I, Division I, Groups F and G. Provide Appleton “U-Line” series, Crouse-Hinds ENR series, or equal.

2.03 SWITCHES

A. Switches shall be molded composition, brown, specification grade, single pole, three- way and four-way as shown on the drawings.

B. 120- or 277-Volt Lighting: Provide switches rated 20 amperes, 120/277-volt AC. Provide quiet operation, toggle type switches.

C. Explosion-Proof Switches: Provide explosion-proof switches for areas identified as “Hazardous Area” in Section 15140. Provide factory-sealed tumbler switches, 20 amperes, 120/277-volt a-c. Comply with NEC Class I, Division I, Groups C and D and Class II, Division I, Groups E, F, and G. Provide Appleton EDS series, Crouse-Hinds EDS series, or equal.

2.04 COVERPLATES

A. Outside, or where indicated, use individually gasketed weatherproof metallic cover plates. Provide in use covers as required.

B. Provide satin stainless 302 plates in all remaining locations.

PART 3: EXECUTION

3.01 FIELD TESTING

A. Operate each switch and verify that the load is turned on and off.

B. Test each receptacle with a circuit tester that checks voltage, polarity, and grounded conditions. Repair or replace defective receptacles and repeat the test.

3.02 GROUNDING

A. Provide a bonding jumper between the grounded outlet box and the receptacle ground terminal.

END OF SECTION

# SECTION 16155

# LOW VOLTAGE MOTOR CONTROLS

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section includes materials, installation, and testing of low-voltage motor control equipment.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

### 1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Submit manufacturer's descriptive data including bill of material, ratings (short circuit current rating, voltage, continuous current), circuit diagrams, dimensional data, nameplate schedule, conduit entry restrictions, and overload relay ratings.

C. Submit Layout, one line and Wiring Diagrams for new and modified motor control centers.

D. Provide Manufacturer's Equipment Certification for motor controls and power monitors in accordance with Division 1.

E. Manufacturer's installation instruction.

F. Submit dimensional layout drawings and detailed wiring diagrams for installation of all motor controls in existing equipment. Contractor is responsible to verify all dimensions and equipment configuration, layout, and wiring. Drawings shall include those of modified motor control centers.

G. Before MCC shipment, submit final as-built drawings per item A thru F above that incorporate all changes made during the manufacturing process.

H. Submit Operations and Maintenance Manuals in accordance with Section 01730.

I. Submit Manufacturer's Certificate in accordance with Division 1 specifications.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. Spare Parts

1. The Contractor shall furnish to the representative of the Owner all necessary spare parts of components required to maintain the system. Prior to final acceptance of work, the system supplier shall provide a spare parts listing of all necessary spare parts and quantities for review of the representative of the Owner. Minimum spare parts to be provided shall include:

    a. Twenty (20) fuses of each type provided

    b. Five (5) lamps of each type pilot light provided

c. One (1) current transformers of each type provided

d. One (1) circuit breaker of each current rating and type provided

e. One (1) NEMA size motor starter of each rating and type provided

f. Twelve (12) Overload Element of each rating and type provided.

g. Five (5) control relays for each type provider.

h. Five (5) time delay relays for each type provider.

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with the Division 1 specifications and the manufacturer's recommendations.

1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Coordination Study: 16011

C. Variable Frequency Drives: 16157

D. Panelboards: 16160

E. Transformers: 16460

F. Surge Suppression: 16670

G. General Control System Requirements: 16900

1.07 RATINGS

A. Motor horsepower ratings and enclosures shown are minimum expected. This does not limit the equipment size. When motors and other equipment furnished differ from the minimum ratings indicated, make the necessary adjustments to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate the motors actually installed, at no additional cost to the Owner.

PART 2: PRODUCTS

2.01 GENERAL

A. EQUIPMENT

1. MOTOR CONTROL CENTERS

a. Motor control centers shall be dead front, dead rear, floor standing, and front accessible NEMA 1 gasketed construction, except for sections with VFD and solid-state controllers which shall be NEMA 1 construction, unless otherwise noted. The voltage and ampere rating and physical dimensions shall be as indicated on the drawings. Wiring shall be NEMA

Class I, Type B. Tag control wiring from field within 2 inches of termination at each device and terminal board. Schematics shall also show terminal numbers and interior and field wire numbers. Obtain instrument wire numbers from instrument system supplier.

b. Provide channel iron sills and removable lifting angles. Motor control centers shall be constructed of minimum 14-gauge sheet metal.

c. Provide a separate vertical wiring compartment for each motor control center section. Provide cable supports and a hinged door separate from the unit starters.

d. Provide individual compartments separated by steel barriers and with separate hinged doors for each starter, circuit breaker, or other unit. Locate equipment to enable termination of field wiring from front without equipment removal. Motor control center shall have a 12-inch bottom wireway and a 6 inch top wireway.

e. Mechanically interlock starter and circuit breaker doors so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access while starter or circuit breaker is energized. Provide provisions for padlocking external disconnect handles in the OFF position.

f. Bus bars shall be tin plated copper and braced to withstand minimum symmetrical short circuit current, as shown on drawings. Provide full horizontal bus rating for entire length of the motor control center. Do not taper the bus.

g. Provide a continuous, frontal accessible 300-ampere-minimum ground bus extended the full length of the motor control center.

h. Feeder circuit breakers shall be molded-case type and lockable in the on and off positions, unless otherwise noted. Provide quick make and quick break toggle mechanism, inverse-time trip characteristics, and trip-free operation on overload or short circuit. Automatic tripping shall be indicated by a handle position between the manual OFF and ON position. Provide trip ratings and number of poles as indicated on the drawings. Provide breakers with fault current interrupting ratings equal to or greater than the motor control center short-circuits current rating. If necessary, to comply with this provision, breakers shall be equipped with current-limiting fusing.

i. Main circuit breakers shall be as described above for feeder circuit breakers except without the inverse - time trip characteristics.

j. Combination starters shall be as described in “Combination Magnetic Motor Starters” in this section.

k. Each compartment shall have nameplates made from phenolic material with 1/4” white lettering on a black background, as specified in Section 16010.

l. Motor control centers shall comply with applicable NEMA, UL, and ANSI standards for industrial control.

m. Motor control centers shall be factory finished with ANSI 61 medium gray paint.

n. Verify that overall equipment dimensions are within the maximum dimensions indicated on the plans. If larger equipment is required, submit a proposed layout showing arrangement of electrical equipment. Provide working clearances in accordance with the NEC. Any costs due to rearrangement of equipment shall be borne by the Contractor with no additional expense to the Owner.

2. COMBINATION MAGNETIC MOTOR STARTERS

a. Comply with NEMA ICS, Class A, and with NEC Article 430.

b. Combination motor starters shall be thermal trip circuit-breaker type, with ratings as noted on the drawings. If ratings are not shown on the drawings provide circuit breakers and motor starters as required by the NEC and as recommended by the manufacturer for the connected load. The short-circuit rating shall be equal to or greater than the bus bracing rating for the MCC as shown on drawings, but not less than 42,000 A for enclosed or open-type combination starters. Where indicated short-circuit duty exceeds the starter's rating, provide current-limiting type breakers or circuit breakers with current limiters of type and rating required to comply with indicated main bus rating.

c. Provide motor starter overload relays for each motor starter. The overload shall be the same manufacturer as the motor starter and include a manual reset. The manufacturer shall verify the motor ratings and coordinate the overloads with the actual horsepower ratings of the motors installed.

d. Provide indicator lights, selector switches, push buttons, etc., as shown in the wiring diagrams and single line diagrams. Mount on the front panel of the control panel.

e. Provide externally operable overload relay reset buttons and disconnect operators.

f. Provide control relays within the starter enclosure as shown in the schematic wiring diagrams.

g. Control switches shall be round, heavy duty, oil tight type, 30.5mm complete with legend plates and quantity of contact blocks required for the control function.

h. Indicating lights shall be round, heavy duty, oil tight type, 30.5mm complete with color of lens indicated on drawings and legend plate. Lamps shall be 120-volt a-c. Indicating lights shall be LED cluster type with a life cycle of over 100,000 hours. Indicating lights shall be push-to-test type.

i. Elapsed time meters shall be synchronous motor driven, 0 to 99,999.9-hour range, non-reset type, suitable for semi-flush, panel mounting.

j. Starters and each unit compartment door shall have engraved nameplates made from black on white laminated plastic with 1/4" white lettering on a black background. Refer to Section 16010. Attach nameplates with rivets. Nameplate descriptions shall have full names and approved as part of the shop drawing submittal.

k. Auxiliary contacts shall be provided as indicated on drawings, include a minimum of one spare normally open and one spare normally closed contact.

l. Provide terminal blocks in each starter where external controls or indicators are required. A schematic diagram shall be provided inside the cover of each starter. This diagram shall show terminal block identifications for each external connection.

m. Enclosed combination starters shall be panel mounted in an enclosure designated for the area. All panel devices shall have NEMA rating and type as required by Specification 16010.

n. Time-delay relays shall be UL listed with contacts rated 10-ampere noninductive load, 120 volts, with coil voltage, number of poles, pole arrangement, and maximum timing adjustment as indicated on the drawings. Relays with maximum timing adjustment 180 seconds or shorter shall be plug-in, solid-state type with timing knob adjustment. Provide Potter Brumfield, Square D Class 9050, Type FS, or equal.

o. Control devices shall be same as those specified in Section 16946.

p. In Class 1, Division 1 and Class 1, Division 2 hazardous locations provide combination or standalone starters in NEMA 7 enclosures.

3. MANUAL MOTOR STARTERS

a. Provide number of poles and size of thermal overload heaters for the motor being controlled. All panel devices shall have NEMA rating and type as required by Specification 16010.

b. Starters shall have provisions for padlocking in the off position and shall be UL listed.

c. Starters shall be the heavy-duty type with toggle or push-button operation. Arrow Hart Type LL, Allen-Bradley Bulletin 609, or equal.

d. In Class 1, Division 1 and Class 1, Division 2 hazardous locations provide manual motor starters in NEMA 7 enclosures.

4. REDUCED VOLTAGE SOFT STARTERS

a. The solid-state starter shall be a 6-SCR device fully rated for continuous operation for 40° C ambient. The control section shall be digital micro-processor based.

b. The controller shall comply with the following requirements:

- Dielectric withstand per UL-508.
- Noise and RF immunity per NEMA ICS-2-230 and IEEE STD 47

c. Provide the following functions:

- Soft Start with Selectable Kickstart
- Current Limit
- Full Voltage Start
- Soft Stop
- Pump Control

d. The acceleration ramp time shall be selectable from 2 to 30-seconds.

e. The initial torque shall be adjustable from 5% to 90% of locked rotor torque.

f. Kickstart function shall provide an adjustable time pulse of current prior to the normal start mode. The current shall be held at 500% of full load for an adjustable time. This feature shall be field defeatable.

g. Provide the following protection during “starting” and “running” modes. When these conditions are detected, starting of the controller shall be inhibited or the controller shall be shut down if it is operating:

- Start Fault
- Line Fault
- Temperature Fault
- Stalled Motor

h. Provide LED indicators for advisory status and fault annunciation. The LEDs shall be color coded for distinct annunciation and shall consist of:

- Control Voltage Present (Green)
- Starting (Amber)
- Running (Red)
- Stopping (Amber)
- Fault (Red)

i. The controller shall contain a latch circuit for three-wire control. It shall also be provided with two-wire control circuit.

j. The controller shall have a Form C auxiliary contact for customer use. The contacts shall change state instantaneously on a start command and when the logic completes the ramp-down feature. It shall be possible to reconfigure the system via a switch such that the contacts change state when the controller has determined that the motor is “up-to-speed” and when the motor starts to decelerate.

k. The controller shall have an ethernet connection (RJ-45) provided for future use in connection of the RVSS to the plant control system. The Ethernet connection shall allow all drive control and monitoring parameters to be accessed by the plant control system. Demonstrate the capability of the connection during testing.

l. Soft Stop: The deceleration ramp time shall be selectable with settings from 2 to 60-seconds. This feature shall be field defeatable.

m. Pump Control: This function shall reduce surges in a pumping system during starting or stopping of a centrifugal pump by smoothly accelerating and decelerating the motor. Pump starting shall also be accomplished via soft start, current limit, or full voltage. Starting and stopping time shall be adjustable.

n. Equip the controller with heatsink assemblies.

o. Provide ground provisions for the controller-mounting flange.

p. The controller shall incorporate integral (fan(s) for forced air ventilation.

q. Provide metal oxide varistors for transient protection.

r. Equip controller with lugs to accept the wire sizes indicated in the drawings.

s. The controller shall be capable of:

- 600% Current Rating for 10 seconds
- 450% Current Rating for 30 seconds

t. The controller shall operate properly at the temperature, humidity, and altitude of the project.

u. Provide 3-phase motor thermal overload relay.

v. Provide internal shorting contactor across starter to energize when controller is at 100%. The schematic on the drawings do not provide the detail required for this connection. The manufacturer shall provide all required contactors, relays, and wiring required for this operation.

5. SURGE PROTECTION

a. Provide surge protection as shown on the drawings for motor control centers. (Refer to Section 16670.)

6. POWER MONITOR (PM)

a. Power Monitor (PM) shall be a panel-mounted, 3-phase microprocessor-based monitoring device that provides complete electrical metering, displaying and remote monitoring of electrical parameters as listed herein and as shown on the drawings.

b. The PM shall be UL listed. The PM shall support 3 and 4 wire Wye, 3 wire Delta and single-phase systems as shown on the Drawings and as specified herein. The PM shall accept input from standard 5A secondary instrument transformers.

c. Voltage monitoring range shall be up to 300 VAC phase-to-phase for 120/208-volt system or 300 VAC phase-to-neutral and 600 VAC phase-to-phase for 277/480 volt system.

d. PM shall measure True RMS voltage, phase-to-phase, phase-to-neutral, current per phase and neutral, real power, reactive power, and power factor. PM shall monitor total accumulated energy, total accumulated reactive energy, and total apparent energy.

e. PM shall calculate average, max/min demand values for all readings. A time/date stamp must be recorded when a max or min is detected.

f. The accuracy shall be a minimum ±0.2% of full scale for current and voltage readings and ±0.4% for power, energy and ±1.0% for power factor readings. Accuracy shall be maintained from 10 to 115% of nominal for voltage, 3 to 140% of nominal for current and from –0.50 to 1.00 to +0.50 power factor. The resolution for current, voltage and power parameters shall be 0.1% and for power factor 1.0%.

g. The PM display shall have a standard switchboard instrument size footprint with mounting per ANSI C39.1. Where PMs are installed in existing switchboards and motor control centers, new mounting plates

shall be furnished and installed with coating to match existing panel finish. The PM shall have high intensity LEDs or LCD of at least 5/16-inch-high letters. Displayed power measurements shall include Volts, Amps, Watts, VARs, KWH and Power Factor. The totalized power readings shall be displayed in Five-digit resolution minimum. Provide a listing of the register locations in the PM where the collected data is accessible, via the communication port.

h. The power monitors shall have the following characteristics:

Current Input Range (for each channel): 5A at full scale

Overload withstand: surge 10X for 3 seconds

Surge withstanding: per IEEE C37.90.1

Frequency Range: 0-75Hz, 60Hz – Nominal

Temperature: -4°F to 150°F

i. Fused potential transformers shall be incorporated into the Monitoring system. Provide split core window type, current transformers, fuses, disconnects, lugs, wiring, potential taps, and accessories with ratios suitable for service voltage and current rating of system being monitored. Current transformers shall be capable of carrying full load continuous primary current without damage to transformer insulation. Voltage and current transducers shall be self-powered, solid state device, AC input, DC output insensitive to load variations from 0 up to 19,000 ohm; with multiturn adjustable potentiometer accessible through a siding access port providing a 0-1 mA DC output. Transducers shall be Scientific Columbus Model VT110A2 (voltage) and CT510A2 (current), or equal.

j. Power monitor shall communicate through Allen Bradley TCP Ethernet Communications to the plant control system programmable logic controller (PLC) for gathering data , as shown on drawings. Provide all hardware, configuration, and software for interfacing to the Plant PLC.

k. All current transformers, control transformers, fusing, disconnects, installation, wiring, identification of space in the equipment, MCC buckets and doors, shall be performed by the Contractor.

2.02 MANUFACTURERS

A. Motor control center shall be manufactured by Eaton, Square D, or Siemens.

PART 3: EXECUTION

3.01 FACTORY TESTING

A. The Owner and Engineer reserve the right to witness all factory test. Provide (3) weeks written notice to the Owner prior to schedule factory testing.

B. Perform testing as required by the latest NEMA and UL standard.

C. Submit the final factory inspection tests report to the Engineer/Owner.

D. Provide two weeks written notice to the Owner

3.02 INSTALLATION

A. Motor Control Centers shall be shipped to the site in one continuous section with all bus connections and line side power wiring to the compartments complete, if possible, for the installation. In the event the Motor Control Center is to be disassembled, or shipped in sections, for installation in a building or area, a representative from the Motor Control Center manufacturer shall perform the reassembly of the MCC bus and internal power connections. The Contractor shall not perform this work. The drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Field determine exact locations based on physical size and arrangement of equipment, finished elevations, and obstructions.

B. Secure motor control enclosures rigidly to floors or mounting pads with 316 stainless steel anchor bolts or concrete wedge anchors. Provide new concrete housekeeping pads for all motor control centers, or extend existing pads as required for new motor control centers.

C. Install motor controls at locations as shown on the drawings. The Contractor shall provide and install all terminations, hubs, connectors, and conduit fittings required for connection of new conduit and wiring to the motor controllers and motor control center. Provide wire identification for all wiring.

D. For motor control equipment which is installed in existing cabinets or motor control centers provide new doors, buckets, operating mechanisms, control transformers and other required equipment.

E. Install power monitors in new motor control centers, switchboards, and other enclosures at locations shown on the drawings. Contractor shall provide all lugs and connectors required for power monitor current and voltage connections. Wiring and equipment shall be protected as required by the NEC.

3.03 MANUFACTURER'S SERVICES

A. Provide equipment manufacturer's services at the jobsite for the minimum man-days listed below, travel time excluded:

1. Five man-days to check the installation, supervise start up, and supervise testing of each MCC for each process area to be energized.

2. One man-day to instruct the Owner's personnel in the operation and maintenance of the equipment, at the site during a time approved by the Owner.

3.04 FIELD TESTING

A. Test the operation of each interlock and control circuit to verify that the interlock performs its function.

B. Set adjustable trip circuit breakers two settings above the setting that causes the breaker to trip during motor starting. Do not adjust the setting above 1,300% of the motor nameplate current rating.

C. Set protective relaying, main and feeder circuit breaker adjustable set points, and time delays in accordance with the manufacturer's recommended values.

D. Test operation of power monitoring unit and set all parameters for this application. Provide coordination with the system supplier for connection of the equipment to the PCS and PLC hardware. Testing shall include transfer of data between the power monitor and the new programmable logic controller as shown on drawings. Refer to Section 16900.

E. Perform complete testing in accordance with Section 01650.

F. Infrared testing shall be performed on all Motor Control Centers and Motor Control Devices in accordance with Specification Section 16010.

3.05 TRAINING

A. Provide at least two 8-hour days to instruct the representative of the Owner and Engineer.

B. The training shall include the following:

1. General electrical operation and maintenance of the MCC and its associated devices such as circuit breaker, starters, power monitor, and accessories.

2. Power Monitor configuration/programming, operation, and troubleshooting.

3.06 EXISTING MOTOR CONTROL CENTER MODFICATIONS

A. Existing Motor Control Centers MCC-A in the existing Administration Building and MCC-H an existing outdoor MCC require modifications as shown on the drawings. The contractor shall coordinate with the MCC manufacturer to provide modifications as indicated. Not all components shown are standard equipment. The contractor shall provide special and optional equipment as required to retrofit the motor control centers.

B. The contractor shall submit all modifications required to the MCCs in the same manner as a new MCC. Final as built, as fabricated drawings shall be provided for all modifications. The City has some existing drawings; however, it is the contractor’s responsibility to obtain all drawings and required details from the manufacturer for this work.

C. The contractor shall provide all additional wiring, bussing, doors, backpanels, equipment, and devices to make to provide a complete system.

END OF SECTION

# SECTION 16157

# VARIABLE FREQUENCY DRIVES

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section describes materials, testing, and installation of variable frequency drives (VFDs). The application will utilize a variable or constant torque VFD rated for the specified horsepower. Coordinate the type of torque rating for the VFD with the specific application as defined in the contract documents.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

### 1.03 SUBMITTALS

A. Submit shop drawings and catalog data in accordance with Section 01300.

B. Submit shall include the following:

1. Manufacturer's descriptive data including ratings, circuit diagrams, dimensional data, conduit entry restrictions, and heat dissipation to ambient. Clearly identify part number of the equipment to be provided.

2. Layout and Wiring Diagrams.

3. Submit dimensional layout drawings and detailed wiring diagrams for installation of variable frequency drives in existing equipment. Contractor is responsible to verify all dimensions and equipment configuration, layout, and wiring.

4. Submit a report with all parameters set at each VFD. The report shall include as a minimum the following data per each parameter: ID, Name, description, value, default, unit, minimum value, and maximum value.

5. Submit in writing that each supplied VFD is be compatible with the equipment to which is connected. VFD supplier shall obtain all required parameters from the equipment manufacturers and submit in writing that the each VFD is sized correctly and full compatible with the equipment to be connected to. Each VFD shall be sized in accordance with the equipment's motor maximum current requirements under peak torque demands.

6. Submit in writing that the VFD supplier reviewed and checked each motor lead length restriction. Motor, cable type, cable length, conduit type and all other motor length constrains shall be reviewed/checked by the VFD supplier to ensure the VFD is acceptable to be installed as shown on drawings.

7. Submit in writing that the VFD supplier verified each of the VFDs with the application and final equipment manufacturer to provide a constant torque or variable torque VFD. Any changes to the VFD after design and fabrication will be at no cost to the owner.

C. Submit Manufacturer's Equipment Certification in accordance with Division 1 specifications.

D. Submit Manufacturer's Certificate in accordance with Division 1 specifications.

E. Submit Operation and Maintenance Manuals in accordance with Section 01730. Include the following:

1. Programming/Parameter – User Manual

2. Final VFD parameter setting in an electronic file. The file can be used by the Owner to download the drive configuration at the field. Provide the associated configuration software to be installed in a laptop computer for parameter visualization.

1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide one complete VFD unit, as specified herein, less the enclosure. Deliver to locations as requested by the Owner

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with the Division 1 specifications and the manufacturer's recommendations.

1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Low voltage motor control: 16155

C. General Control System Requirements: 16900

D. Division 11

E. Division 15

F. Variable frequency drives shall consist of variable frequency controllers, bypass starters, as indicated, and controls. Each drive shall operate as a simplex unit with no interaction with other drives. Horsepower rating of each drive shall be sufficient to drive the motor as shown on the drawings under the specified operating conditions.

G. Design equipment to operate under the following conditions:

1. Altitude to 3,300 feet above sea level.

2. Ambient 10 C to 40 C.

3. Noncondensing relative humidity to 95%.

H. Equipment shall comply with the requirements of ANSI, IEEE, and NEMA. The electrical equipment, design, and construction shall comply with the provisions of the NEC.

I. The complete VFD assembly shall be "Integrally Equipment Rated" in accordance with UL requirements and shall be suitable for connection of a minimum available

fault of 65,000 RMS symmetrical amperes. The VFD circuit breaker shall conform to Specification 16155 for feeder circuit breakers.

J. The pump and blower manufacturer shall be responsible for the coordination of the VFD operation with the specific pump and motor requirements.

K. Variable frequency drives shall be manufactured by, Eaton, Square D, or Siemens.

L. The VFD shall comply with IEEE 519-2014 for Harmonic Currents and voltage distortion limits for this application, it is the Contractor's responsibility to provide adequate equipment, including but not limited to input isolation transformers, input line reactors, DC bus reactors and harmonic filters, as required. The maximum Short Circuit Current (ISC) versus maximum Demand Load Current (IL) ratio (ISC/IL) is less than 20 for this facility. The total demand distortion at the point of common coupling (main switchgear) allowed for this application is 5%.

## PART 2: PRODUCTS

### 2.01 ENCLOSURES

A. As indicated on the drawings, provide, and install a separate enclosure for each variable frequency drives, or provide the drives in the Motor Control Center sections.

B. Verify that overall equipment dimensions are within the maximum dimensions indicated on the plans. If larger equipment is required, submit a proposed room layout showing arrangement of electrical equipment. Provide working clearances in accordance with the NEC. Any costs due to rearrangement of equipment shall be borne by the Contractor with no additional expense to the Owner.

C. Enclosure shall be floor standing, completely front accessible, ventilated NEMA 1 gasketed. Enclosures shall be suitable for mounting against a wall or back-to-back with other equipment.

D. Provide fan cooling for all VFD cabinets. Maximum temperature inside cabinet shall be less than 95°F. All components and wiring inside the enclosure for the fan cooling shall be provided by the manufacturer. Provide a 480:120 volt transformer to power the fan.

### 2.02 VARIABLE FREQUENCY CONTROLLERS

A. Controller shall consist of a power conversion bridge and inverter.

B. Controller shall be pulse width modulated (PWM) design.

C. Controller shall be variable voltage/variable frequency (constant volts per hertz).

D. The controller shall include the following features:

1. 460-volt a-c, 3-phase, 3 wire, 60-Hz input power.

2. 460 volt a-c, 3-phase, 3-wire, ungrounded output power.

3. Input fusing, fast acting.

4. Input power surge protector, for transient protection up to 10 KV and 250 Joules. (Refer to Section 16670.)
5. 0 to 650 Hz continuous operating range with 0.01 Hz frequency resolution.
6. Output current limit, 0% to 250% adjustable, minimum. Limits motor inrush current during startup.
7. Regulation +/-3% of base speed.
8. Adjustable acceleration and deceleration rates.
9. Maximum and minimum speed adjustments.
10. Frequency skip adjustment (3 minimum).
11. 115-volt a-c control power for run/stop circuits.
12. Blower cooled with thermal switch cutout and filters for all intake and exhaust openings.
13. Minimum 5% line reactor on input of VFD
14. Line reactor on VFD output for motor leads greater than 100 feet in length.

E. The controller shall include protective circuitry that initiates an orderly shutdown of the inverter without component failure. The controller shall shut down and require manual reset for the following fault conditions.

1. Overload
2. Instantaneous overcurrent
3. Inverter fault
4. Over frequency
5. D-C link overvoltage
6. Cabinet overtemperature

F. The controller shall shut down for the following fault conditions. The controller shall automatically restart upon a cleared fault condition.

1. Incorrect phase sequence
2. Loss of an input phase
3. Input undervoltage

G. Provide a common failure contact for remote indication of fault conditions previously listed.

2.03 CONTROLS

A. The following data shall be accessible via a digital display mounted on the control cabinet door and interfaced to the variable frequency drive.

1. Control power on.

2. Drive run.

3. Drive fault.

4. Drive speed indication, 0% to 100% rpm and 0-60 Hz.

5. Elapsed time meter, six digits, reading in hours and tenths.

6. Drive output current and voltage.

7. Manual speed adjustment, 0% to 100% rpm and 0-60 Hz.

8. Drive, start/stop (local mode).

9. As indicated on the drawings.

B. The following operation shall be provided.

1. With system mode in AUTOMATIC, the motor shall automatically vary in speed proportional to an ungrounded 4- to 20-mA input signal from the PLC.

2. With system mode in HAND, the motor shall vary in speed in response to the manual speed adjustment.

C. Drive shall have automatic restart following a power failure.

D. Provide minimum five digital inputs, two relay output contacts, and one 4-20 mA analog input and one 4-20 mA analog output. The digital input and relay output shall be programmable. The analog input shall increase the VFD output proportional to the signal.

E. The VFD shall be capable of setting a minimum speed for operation. This setting shall be configured by the Contractor during system testing and startup, with a value indicative of the system hydraulics and operation.

F. The VFD shall be configured to ramp to a preset speed when an input is energized in the VFD. The preset speed setting shall be configured by the Contractor and coordinated with the System Integrator during system testing and startup, with a value indicative of the system hydraulics and operation.

G. Provide pilot devices which meet the requirements specified in Section 16155.2.2.

H. The drive shall have an ethernet connection (RJ-45) provided for future use in connection of the VFD to the plant control system. The Ethernet connection shall allow all drive control and monitoring parameters to be accessed by the plant control system. Demonstrate the capability of the connection during testing.

2.04 FACTORY TESTING

A. The Owner and Engineer reserve the right to witness all factory test. Provide (3) weeks written notice to the Owner prior to schedule factory testing.

B. Subject the variable frequency drives to a rated motor load operational test prior to shipment. Provide written certification of completed and approved factory test.

2.05 SOFTWARE

A. Provide all configuration software and cables for connection of each type of drive to a laptop computer for setting the drive parameters. The software shall operate Windows 10 operating system. Provide all cabling and accessories for direct connection to a Laptop. A manufacturer's representative shall configure all drive parameters to operate as specified. The software and license will then be provided to the Owner after project completion. The software shall be licensed to City of Canton, Georgia, Wastewater Maintenance Superintendent, Department of Public Works.

PART 3: EXECUTION

3.01 INSTALLATION

A. Drives shall be installed in standalone NEMA rated enclosures or motor control centers at locations as shown on the drawings. Mount drive with the recommended clearances per the manufacturer and local codes.

B. Secure drive enclosure to floor, wall or install MCC with stainless steel hardware. Provide access of digital display and all pilot devices on front of drive.

C. Provide filters as required on the load connection of the VFD for motor cables exceeding 100 feet in length. Obtain the VFD manufacturer and motor manufacturer approval on the filter application.

3.02 MANUFACTURER'S SERVICES

A. Provide equipment manufacturer's services at the jobsite for the minimum man-days listed below, travel time excluded:

1. Three man-day per VFD installed to check the installation, calibrate the drives, supervise start up, and supervise testing of the drives for each process area to be energized.

2. Three man-day to instruct the Owner's personnel in the operation and maintenance of the equipment, at the site during a time approved by the Owner.

3.03 FIELD TESTING

A. Test the operation of each interlock to verify that the interlock performs its function.

B. The variable speed drive system shall be tested to check correct operation of each drive in the manual variable speed mode and automatic variable speed mode during the testing of the plant control system (PCS). The VFD testing shall not be approved until the VFD and motor are tested with the PCS.

C. Verify minimum and maximum speed and analog input settings to correspond with the system integrator PLC connections.

D. Test the total demand distortion and odd harmonic distortion of the system at the point of common coupling. The Contractor shall provide all equipment required to test the system. A certified test report shall be submitted by the Contractor for review and approval by the Owner. If the maximum harmonic limits, as required by

IEEE 519-2014, for this application, are not satisfied the Contractor shall include additional equipment to meet these requirements at no additional cost to the Owner.

E. MCC-MBR shall be coordinated with the MBR manufacturer, Suez, for all startup and configuration. The contractor shall be responsible to provide coordination with Suez equipment, operation, and testing.

3.04 FACTORY TRAINING

A. The contractor shall provide a factory-training course to a minimum of six Owner personnel. The training shall include, as a minimum, the following:

1. Theory of Operation
2. Maintenance
3. Overhaul Instructions
4. Troubleshooting Techniques
5. Programming/Configuration

B. The training shall be performed by a qualified factory representative at a location within a 50-mile radius of the site, and be a minimum of two man-days, for a maximum of six Owner personnel.

3.05 TRAINING

A. Provide at least two-8 hour days to instruct the representative of the Owner and Engineer.

B. The training shall include the following:

1. Operation and maintenance of the drive and its accessories.
2. Configuration and troubleshooting.

END OF SECTION

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# SECTION 16160

# PANELBOARDS

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section describes materials, testing, and installation of panelboards as standalone surface mounted enclosures and installed in Motor Control Centers.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

### 1.03 SUBMITTALS

A. Submit Shop's Drawings in accordance with Section 01300.

B. Show ratings and characteristics including voltage ratings, bussing arrangement, continuous current ratings, fault current withstand ratings, neutral bus rating, enclosure type, ratings and arrangement of over-current protective devices, and mounting provisions.

C. Submit outline and dimensional drawings and conduit entry restrictions.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer. At a minimum, provide one (1) complete set of the following:

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

### 1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with requirement sin Division 1 and the manufacturer's recommendations.

### 1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Power System Study and Testing: 16011

C. Low Voltage Motor Controls: 16155

D. Surge Suppression: 16670

## PART 2: PRODUCTS

### 2.01 LOW-VOLTAGE PANEL BOARD

A. Provide dead front, safety-type panelboards with voltage ratings as scheduled. Panelboards shall be circuit breaker type and suitable for a minimum short circuit

rating of 22,000 AICS, unless otherwise indicated on the drawings, or defined in the power study.

2.02 CABINETS

A. Install panelboard in a flush mount cabinet, or in motor control centers, as shown on the drawings with hinged front doors, catches, and locks. Provide holder for the directory on the inside of the door.

2.03 BREAKERS

A. Molded-case breakers.

1. Provide quick-make and quick-break toggle mechanism, inverse-time trip characteristics, and trip-free operation on overload or short circuit. Automatic tripping shall be indicated by a handle position between the manual OFF and ON position. Provide trip ratings as indicated in the panelboard. Provide lock-on or lock-off devices where indicated on the drawings.

2. Single-pole breakers shall be full module size; two poles shall not be installed in a single module. Multiple circuit breakers shall be of the common-trip type having a single operating handle.

3. For existing panelboards provide circuit breakers with same characteristics as is existing, with ratings as shown on the drawings, or as required by NEC.

4. Circuit breakers minimum interrupting current rating shall be 22,000 AICS, minimum. Provide breakers with same interrupting current as panelboard if panelboard rating is greater than 22,000 AICS.

2.04 BREAKER CONNECTIONS

A. Circuit breaker current-carrying connections to the bus shall be bolted type.

2.05 BUS BARS

A. Bus bars shall be copper. Provide a copper ground bus bar installed on the panelboard frame, bonded to the box, and containing at least 10 terminal screws.

2.06 MINI-POWER ZONE TRANSFORMER

A. Furnish and install mini-power zone transformer as indicated on drawings.

B. Transformer shall be rated for 480 – 240/120 volts as indicated, unless otherwise noted.

C. Transformer shall have a minimum of 2.5% full capacity primary taps below normal and shall be rated 115 deg C temperature rise above 40 deg C maximum ambient.

D. Insulating materials are to be in accordance with current ANSI C89.2 and NEMA ST20 standards for a 185 deg C UL component recognized insulation system.

E. Transformer shall be encapsulated using sand-epoxy resin mixture to provide maximum protection against moisture, dust, and corrosive environments.

F. Enclosure shall be phosphatized and electronically powder coated with ASA 49 color.

G. Packaged power supply shall include integrally mounted and wired primary and secondary mail circuit breaker in accordance with NEC requirements.

H. Branch circuit breakers shall be Square D type QO QWIK-GARD or approved equal.

I. A hinged access door shall be provided which maintains itself in the open position when desired, and which has padlock provisions to prevent unauthorized entry.

J. All live parts ate to be fully enclosed for personnel protection when installation is completed.

K. The transformer and panelboard shall be constructed with separate enclosures capable of being assembled or disassembled as independent units.

L. Mini-power zone transformer shall UL listed and shall be Square D, model MPZ, or equal.

2.07 SPACE ONLY

A. Where “space only” is noted on the drawings, provide connectors, mounting brackets, etc., for the future insertion of an overcurrent device of the size indicated.

2.08 DIRECTORIES

A. Provide typed circuit directories on the inside face of the door of each panel on medium weight card stock. Do not provide handwritten directories.

2.09 NAMEPLATES

A. Provide nameplates as specified in Section 16010. Designate the identifying nomenclature, voltage and phase of the panel as shown on the drawing; for example, “PANEL A, 208Y/120V, 3-phase, 4-wire, 100-ampere bus.”

2.10 SURGE PROTECTION

A. Provide surge protection at panelboards, as indicated on the drawings. Provide all circuit breakers, wiring, and equipment required for surge protection.

2.11 ENCLOSURES

A. For circuit breakers and panelboards in standalone enclosures, provide NEMA rated enclosure as indicated in specification Section 16010 and as shown on the drawings.

B. NEMA 4X enclosures shall be provided with ample space required for heat dissipation.

PART 3: EXECUTION

3.01 INSTALLATION

A. Mount the panelboard in locations as shown on the drawings.

B. For wall mounting, secure panelboards with stainless steel hardware and ¼" spacing behind panel.

C. Install circuit breakers in existing panelboards as shown on the drawings.

D. Install surge protection as indicated on the drawings and refer to Section 16670.

E. Provide typed panel schedule for all new panelboards with final circuits. Update existing panel schedule for modified existing panels.

F. Power all circuits on panel for balancing the phases. The contractor shall relocate breakers in the panel to balance the phases as required.

3.02 FIELD TESTING

A. Operate each circuit breaker and verify that all phases of each load are disconnected.

B. Verify panel has balanced loads on each phase. Relocate feeder circuit breakers within the panel, if required to provide balanced phases.

END OF SECTION

# SECTION 16161

# SWITCHBOARD

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section describes materials and installation of the outdoor switchboards to be installed in a NEMA 3R protected non walk-in pre-engineered metal clad electrical enclosure.

B. Provide buses, insulated and molded case circuit breakers, instrumentation and associated transformers, relays, fuses, wiring and appurtenances as shown on Contract Drawings and specified herein.

C. This section includes equipment and work for the Odor Control Switchboard (SG-OC).

### 1.02 QUALITY ASSURANCE

A. The switchboard assemblies and power circuit breakers shall comply with the codes and standards as indicated. Copies of certified design tests shall be furnished if requested to confirm compliance.

1. ANSI/IEEE C37.13 – Low-Voltage AC Power Circuit Breakers Used in Enclosures.

2. NEMA AB 1 – Molded Case Circuit Breakers and Switches

3. NEMA PB 1 – Deadfront Distribution Switchboards

4. NEMA PB 2 – Proper Handling, Installation, Operation and Maintenance of Dead front Switchboards Rated 600 volts or less

5. NEMA SG 3 – Low-Voltage Power Circuit Breakers.

### 1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Submit ratings and characteristics including voltage ratings, bussing arrangement, continuous current ratings, fault current withstand ratings, enclosure type, ratings, and arrangement of all over correct protective devices.

C. Submit shop drawings, layout drawings showing physical details, dimensions, clearances, conduit entry restrictions, mounting elevation, sections, and nameplates.

D. Submit electrical control schematics, wiring diagram including terminals for all equipment connections, internal interconnection diagrams and connections to equipment external to switchboard.

E. Submit ground fault protection system field test results.

F. Outline drawings for NEMA 3R assembly.

G. Lighting and utility transformer locations and operation.

H. Sequence of Operation and Key interlock diagrams.

I. Programmable controller Input/output table and wiring diagrams.

J. Submit factory acceptance test report.

K. Submit Operation and Maintenance Manual in accordance with Section 01730.

L. Provide Manufacturer's Equipment Certification and Certificate in accordance with Division 1

M. Submit Manufacturer's Certificate of proper installation.

1.04 SPECIAL TOOLS AND SPARE PARTS

A. The Contractor shall furnish to the Owner all necessary spare parts of components required to maintain the switchboard prior to final acceptance of work. The Contractor shall provide a spare parts listing of all necessary spare parts and quantities for review by the Owner. As a minimum the Contractor shall provide a minimum of ten (10) of each type of fuses, light bulbs, and contact kits for the switchboard; two (2) current transformers for each type and rating, two (2) potential transformer for each type and rating, One (1) circuit breaker rating plug for each size furnished and (1) sensor trip unit for each size furnished

B. The Contractor shall deliver to the Owner all the required spare parts upon conditional acceptance of the work. The spare parts shall not be used as replacement parts during the guarantee or startup period.

C. Provide as a minimum the following tools – fuse handling tool, racking handle, motor driven remote racking operator for racking breaker in and out of cubicle, portable circuit breaker lift truck, circuit test set, and secondary test coupler.

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with the Division 1 and the manufacturer's recommendations.

1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Power System Study and Testing: 16011

PART 2: PRODUCTS

2.01 GENERAL

A. The equipment to be supplied shall be metal enclosed low-voltage power circuit breaker switchboard with insulated case main breakers and molded case feeder circuit breakers. All circuit breakers and assemblies shall be produced by a single manufacturer and shall be designed, tested, and manufactured in accordance with the standards referenced in this specification.

B. Provide a complete switchboard, busses, circuit breaker, instruments and related transformer, relays, fuses and, wiring suitable for installation in the pre-engineered NEMA 3R electrical enclosure.

C. Limit the maximum switchboard dimensions to the space provided as shown on the drawings.

2.02 MANUFACTURERS

A. Switchboard shall be manufactured by Eaton, Square D, Siemens, or Equal.

2.03 ASSEMBLY

A. The switchboard housing and assembly shall be integrally designed and produced by the same manufacturer as the switchboard to ensure a completely and coordinated design.

B. The switchboard housing and assembly shall be in a NEMA 3R enclosure.

C. Main bus shall be tin-plated copper, fully insulated.

D. Provide barriers for individual cell compartments for each breaker or space.

E. Provide metal barrier between main buss and users feeder connection compartment.

F. Provide solid copper ground bus mounted near bottom of enclosure.

2.04 BUS

A. Main bus shall be three-phase, 4-wire, 4000-ampere copper silver-plated connection points. Neutral bus rating shall be 100% of the main bus current rating and shall be located centrally in the structure for ease of terminating cables whether entering from above or below. 600 volt clearances shall be maintained in all horizontal and vertical buses such that insulation is not required. The main horizontal bus shall be run in a vertical, edge-to-edge arrangement for high short circuit strength. Access to the rear cable termination area shall be possible without reaching over the main and vertical bus. Bus bracing shall be as shown on the drawings. A 0.25 inch by 2.00 inch copper ground bus will be provided. Barriers shall be provided which isolate the rear cable termination compartment from the adjacent vertical section.

2.05 MAIN DISCONNECT (BREAKER)

A. Main disconnect device shall be insulated case circuit breaker with rating as indicated on the drawings. Device shall be capable of being padlocked in the off position. Provide zero-sequence ground fault protection by solid state relays, field adjustable, with continuous time adjustments. Provide reset and test functions by means of pushbuttons and pilot light or mechanical target to indicate that a ground fault has occurred from a fused 120-volt a-c control source within the main disconnect compartment.

B. Provide phase monitoring relay to protect against single-phase voltage and incorrect phase rotation.

C. Provide Ground Fault protection for each main breaker.

## 2.06 CIRCUIT BREAKERS

A. Circuit breakers shall be molded case type. Minimum interrupting ratings will be equivalent to the bus rating as shown on the drawings and in accordance with the power study.

B. Circuit breakers are to be 100% ampere rating, 600 volt class with nominal ratings as dictated by the system voltage. Circuit breakers shall be rated as indicated on the drawings.

C. Provide trip units that comply with the following:

1. Overcurrent, short circuit, and integral ground fault protection
2. Adjustable long delay pickups and time.
3. Adjustable short delay pickups and time.
4. Adjustable instantaneous pickup.
5. Adjustable ground fault current pickup and time.
6. Final setting as recommended by the final approved Power System study.

D. Provide mechanical position indicator visible from the front of the unit to indicate whether the breaker is open or closed.

E. Equipment each breaker with a mechanical trip button accessible from the front of the door to allow tripping of the breaker.

## 2.07 ACCESSORIES

A. The following accessories are to be provided:

1. Power Monitoring system as Specified in Section 16155.
2. Portable lifting device circuit breakers.
3. Container of touch-up paint.
4. Portable test set.
5. Spare Surge Protection Device

## 2.08 NAMEPLATES

A. Provide nameplates as specified in Section 16010. Provide a nameplate for each circuit breaker or fusible switch and automatic transfer switch to indicate feeder and load served. The main nameplate shall give the switchboard designation in 1/2 inch-high letters. A second line in 1/4-inch-high letters shall indicate the voltage and phases.

## 2.09 SURGE PROTECTION

A. Provide service entrance surge protection as indicated on the drawings, and as specified in Section 16670.

PART 3: EXECUTION

3.01 FACTORY ACCEPTANCE TEST

A. The Owner has the right to witness the factory test, Contractor shall notify 10 days prior to schedule the factory test.

B. Submit the factory approval test report to the Owner.

C. Factory test shall include all tests required by ANSY, NEMA and IEEE including the following:

1. Visual and Mechanical inspection
    a. Inspect for physical damage
        1) If visual inspection reveals damage, conduct internal inspections and test as necessary to locate the damage
        2) Submit a detailed report to the Owner. Identify the damage, cause of damage, and corrective measures taken to assure the Owner of the quality of the low voltage switchboard.
    b. Compare equipment nameplate information with latest one-line diagram and record/report discrepancies.
    c. Verify proper auxiliary device operation such as indicators and auxiliar contacts.
    d. Mechanical Open/Close operation.
    e. Grounding of instrument transformer cases.
2. Electrical tests:
    a. Check closing operation and trip from all protective relays (trip units)
    b. Check open and closing operation and trip from all remote terminals.
    c. Perform insulation-resistance tests at 1000V DC for 1 minute.
        1) Across the contacts of each pole breaker open
        2) From pole-to-pole and from each pole-to ground with the control wiring connected to the line and load side of breaker.
        3) Where applicable, remove solid-state relays.
        4) Minimum acceptable values shall be in accordance with NETA.
    d. Verify control wiring.
    e. Verify operation of ground fault sensing unit.
    f. Perform insulation-resistance test at 1,000V dc for 1 minute on all control circuit wiring and electromechanical components. Minimum acceptance values shall be in accordance with NETA.

3.02 INSTALLATION

A. Secure switchboards rigidly to floors or mounting pads with anchor bolts or Phillips Drill Company concrete anchors. Anchor Bolts or concrete anchors shall be Type

316 stainless steel. Coordinate pad dimensions and loading with the Contractor prior to installation.

B. Coordinate all conduit entries, underground and overhead, with the contractor prior to fabrication. Provide additional sections or portions of the switchboard to allow all cables and raceways to be installed in the switchboard as indicated on the contract documents.

C. Set protective relaying, main and feeder circuit breaker adjustable set points, and time delays in accordance with recommended values from the Protective Device Coordination Study in Section 16011.

D. Verify that overall equipment dimensions are within the maximum dimensions indicated on the plans. If larger equipment is required, submit a proposed layout showing arrangement of electrical equipment. Provide working clearances in accordance with the NEC. Any costs due to rearrangement of equipment shall be borne by the Contractor with no additional expense to the Owner.

E. Set and calibrate breaker trip setting in accordance with the final approved power coordination study per Section 16011, Power System Study.

F. Provide all grating, landings, stairs required for ingress and egress to the walk in switchboard. Additionally, rear access is required for maintenance which shall be accessible without the use of portable steps or ladders.

G. Refer to the contract documents for control of the feeder breaker to MCC-A.

3.03 MANUFACTURER'S SERVICES

A. Provide equipment manufacturer's services at the jobsite for the minimum man-days listed below, travel time excluded:

1. Five man-days to check the installation, supervise start up, and supervise testing of each Switchboard.

2. One man-day to instruct the Owner's personnel in the operation and maintenance of the equipment, at the site during a time approved by the Owner.

3.04 FIELD TESTING

A. Ground Fault Protective Equipment: The ground-fault protection system shall be performance tested after installation in accordance with NEC 230-95C. Submit a written record of the test to the Owner's Representative. Record current pickup level and time delay settings to which the equipment was finally adjusted. Measure and record relay pickup current and the relay time delay at two values above pickup. Test or correct system operation at 57% rated voltage. If relay pickup current is not within 10% of the manufacturer's calibration marks or fixed setting or relay timing does not conform with manufacturer's published time-current characteristic curves, repair or replace equipment and repeat test.

B. Voltage: When the installation is essentially complete and the plant is in operation, check the voltage at the point of termination of the power company supply system to the project. Check voltage amplitude and balance between phases for loaded and unloaded conditions.

If the unbalance (as defined by NEMA) exceed 1%, or if the voltage varies throughout the day and from loaded to unloaded conditions more than +/-5% of nominal, make a written request to the power company that the condition be corrected. If corrections are not made, request from a responsible power company official a written statement that the voltage variations and/or unbalance are within their normal standards.

C. Operate each switch, circuit breaker and automatic transfer switch at least three times, demonstrating satisfactory operation each time.

D. Provide coordination with the Power System Study in Section 16011.

E. Infrared testing shall be performed on the switchboard in accordance with Specification 16010.

3.05 TRAINING

A. Provide at least one 8-hour day OF instructs to either or all the Owner, Contractor, Engineer, or responsible party.

B. The training shall include the following:

1. General electrical operation and maintenance of the Switchboard and its associated devices such as circuit breaker, PLC-ATCS, and accessories.

2. Protective devices, sequence of operation troubleshooting, fault indications and clearing faults.

3. Normal operating procedures

    a. Operating breaker electrically and manually

    b. Tie breaker operation

4. Emergency operating procedure

    a. Restoring after a power loss and lockout of main breaker

5. Maintenance procedures, frequency of maintenance:

    a. Removing breakers

    b. Voltage testing

    c. Lockout/tagout

    d. Use of testing devices

    e. Use of grounding devices

    f. Use of special tools

    g. Use of breaker lifting module

3.06 PAINTING

A. Clean and shop prime all non-galvanized, non-stainless steel metal surfaces.

B. Use manufacturer final exterior color for the low voltage switchboard touch-up.

END OF SECTION

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# SECTION 16165

# SWITCHGEAR

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section describes materials and installation of the main switchgear capable to be installed in a NEMA 3R protected aisle walk-in pre-engineered metal clad electrical enclosure.

B. Provide buses, draw-out circuit breakers, instrumentation and associated transformers, relays, fuses, wiring and appurtenances as shown on Contract Drawings and specified herein.

C. This section includes equipment and work for the Main Switchgear (SG-Main).

### 1.02 QUALITY ASSURANCE

A. The switchgear assemblies and power circuit breakers shall comply with the codes and standards as indicated. Copies of certified design tests shall be furnished if requested to confirm compliance.

1. ANSI/IEEE C37.13 – Low-Voltage AC Power Circuit Breakers Used in Enclosures.
2. ANSI C37.16 – Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors – Preferred Ratings, Related Requirements, and Application Recommendations.
3. ANSI C37.17 – Trip Devices for AC and General Purpose DC Low-Voltage Power Circuit Breakers.
4. ANSI/IEEE C37.20.1 – Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear.
5. ANSI C37.50 – Standard Test Procedures for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
6. ANSI C37.51 – Standard Conformance Test Procedures for Metal Enclosed Low-Voltage AC Power Circuit-Breaker Switchgear Assemblies.
7. ANSI/NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
8. NEMA SG 3 – Low-Voltage Power Circuit Breakers.
9. NEMA SG 5 – Power Switchgear Assemblies.
10. UL 1066 – Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.
11. UL 1558 – Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Submit ratings and characteristics including voltage ratings, bussing arrangement, continuous current ratings, fault current withstand ratings, enclosure type, ratings, and arrangement of all over correct protective devices.

C. Submit shop drawings, layout drawings showing physical details, dimensions, clearances, conduit entry restrictions, mounting elevation, sections, and nameplates.

D. Submit electrical control schematics, wiring diagram including terminals for all equipment connections, internal interconnection diagrams and connections to equipment external to switchgear.

E. Submit ground fault protection system field test results.

F. Outline drawings for NEMA 3R assembly.

G. Lighting and utility transformer locations and operation.

H. Sequence of Operation and Key interlock diagrams.

I. Programmable controller Input/Output table and wiring diagrams.

J. Submit factory acceptance test report.

K. Submit Operation and Maintenance Manual in accordance with Section 01730.

L. Provide Manufacturer’s Equipment Certification and Certificate in accordance with Division 1

M. Submit Manufacturer’s Certificate of proper installation.

1.04 SPECIAL TOOLS AND SPARE PARTS

A. The Contractor shall furnish to the Owner all necessary spare parts of components required to maintain the switchgear prior to final acceptance of work. The Contractor shall provide a spare parts listing of all necessary spare parts and quantities for review by the Owner. As a minimum the Contractor shall provide a minimum of ten (10) of each type of fuses, light bulbs, and contact kits for the switchgear; two (2) current transformers for each type and rating, two (2) potential transformer for each type and rating, One (1) circuit breaker rating plug for each size furnished and (1) sensor trip unit for each size furnished

B. The Contractor shall deliver to the Owner all the required spare parts upon conditional acceptance of the work. The spare parts shall not be used as replacement parts during the guarantee or startup period.

C. Provide as a minimum the following tools – fuse handling tool, racking handle, motor driven remote racking operator for racking breaker in and out of cubicle, circuit breaker lift truck, circuit test set, and secondary test coupler.

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with the Division 1 and the manufacturer's recommendations.

1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Power System Study and Testing: 16011

PART 2: PRODUCTS

2.01 GENERAL

A. The equipment to be supplied shall be metal enclosed low-voltage power circuit breaker switchgear with draw-out circuit breaker elements. All power circuit breakers and assemblies shall be produced by a single manufacturer and shall be designed, tested, and manufactured in accordance with the standards referenced in this specification.

B. Provide a complete switchgear, busses, draw-out circuit breaker, instruments and related transformer, relays, fuses and, wiring suitable for installation in the pre-engineered electrical enclosure.

C. Limit the maximum switchgear dimensions to the space provided as shown on the drawings.

2.02 MANUFACTURERS

A. Switchgear shall be manufactured by Eaton, Square D, or Siemens.

2.03 ASSEMBLY

A. The switchgear housing and assembly shall be integrally designed and produced by the same manufacturer as the switchgear to ensure a completely and coordinated design.

B. The switchgear housing and assembly shall be in a NEMA 3R walk-in enclosure.

C. The switchgear and be constructed of multiple, metal-enclosed, ventilated sections. The front of each vertical section is to contain compartments with 14-gauge steel side sheets and compartment barriers of 11-gauge steel. A double thickness of 14-gauge steel is to be provided between vertical sections. The side sheets shall be full height and depth to provide a full metal barrier separating the rear cable compartments between sections. End sections shall include provisions for main bus extension and installation of future vertical sections. The design shall incorporate preformed steel channels, angles, and side sheets bolted together and reinforced to form a rigid, self-supporting, compact assembly.

D. Horizontal barriers are to be provided to form individual circuit breakers, automatic transfer switch and metering compartments. Circuit breaker compartments are to be barriered from the bus compartments through a primary disconnect assembly. Each circuit breaker, PLC-ATCS, control or metering compartment shall be provided with a hinged front door secured with rotary latches requiring no tools to operate.

E. Circuit breaker compartments shall include stationary primary contact disconnects. The primary disconnects shall be copper, silver-plated at connection points and shall be of one piece construction. The upper set of disconnects shall bolt directly to the main bus and, for feeder circuit breakers, the lower set shall extend to the rear cable area and shall be insulated where they pass through the main bus compartment. Primary disconnects shall be sized for the maximum continuous current of the circuit breaker which will be located in the compartment. Interlocks shall be provided which will prevent a circuit breaker element of the incorrect frame size or interrupting rating from being inserted into the compartment. A stationary circuit breaker frame grounding contact shall be provided which shall be visible with the circuit breaker installed in any position.

Secondary control contacts, when required, shall be located in the circuit breaker compartment and shall be of the sliding contact, silver-plated copper design. Barriers shall be provided between terminal points. The secondary control contacts shall engage the draw-out circuit breaker element in the connected and test positions.

F. Control circuit fuses for electrically operated circuit breakers shall be located on the side of the circuit breaker compartment and shall be contained in a dead-front, pull-out fuse block with a clear cover. Withdrawing the cover from the fuse block shall automatically remove the control circuit fuses and hold them captive. The fuse block cover shall include provisions for being installed in the reverse position in order to maintain the open control circuit for testing or maintenance purposes while continuing to hold the fuses captive.

G. All control wiring within the assembly shall be continuous and shall terminate on each end at a suitable terminal block. Control wiring shall be gauge 14, stranded, type SIS, and shall be labeled at each end with sleeve type wire markers. Wire markers shall be machine imprinted with the wire name as indicated on the wiring diagrams. Wrap on wire markers will not be accepted. Terminals shall be insulated locking fork or ring tongue type except where connecting to components that do not accept these terminations. Control wiring for external connections shall be terminated in the rear cable area for ease of access. Metal covers shall be provided over terminal blocks located in the power cable termination area.

2.04 BUS

A. Main bus shall be three-phase, 4-wire, 5000-ampere copper silver-plated connection points. Neutral bus rating shall be 100% of the main bus current rating and shall be located centrally in the structure for ease of terminating cables whether entering from above or below. 600 volt clearances shall be maintained in all horizontal and vertical buses such that insulation is not required. The main horizontal bus shall be run in a vertical, edge-to-edge arrangement for high short circuit strength. Access to the rear cable termination area shall be possible without reaching over the main and vertical bus. Bus bracing shall be as shown on the drawings. A 0.25 inch by 2.00 inch copper ground bus will be provided. Barriers shall be provided which isolate the rear cable termination compartment from the adjacent vertical section.

2.05 MAIN DISCONNECT (BREAKER)

A. Main disconnect device shall be as indicated on the drawings. Device shall be capable of being padlocked in the off position. Provide zero-sequence ground fault

protection by solid state relays, field adjustable, with continuous time adjustments. Provide reset and test functions by means of pushbuttons and pilot light or mechanical target to indicate that a ground fault has occurred from a fused 120-volt a-c control source within the main disconnect compartment.

B. Provide phase monitoring relay to protect against single-phase voltage and incorrect phase rotation.

C. Provide Ground Fault protection for each main breaker.

2.06 MICROPROCESSOR TYPE AUTOMATIC TRANSFER CONTROL SYSTEM.

A. The mains and tie breakers shall be controlled under normal operating conditions by a programmable logic controller (PLC) based automatic transfer control system and described herein for the Main Switchgear (SG-Main).

B. The PLC shall be provided by the switchgear manufacturer. controller and other components needed for the automatic transfer scheme shall be installed as part of the switchgear.

C. Provide a UPS to power the PLC and transfer system. The UPS shall meet the following requirements:

1. Input and Output: 120VAC, 1 phase
2. Surge Protection 240 Jules
3. Automatic voltage regulator
4. Maintenance-free sealed lead-acid battery
5. Recharged time: 5 minutes
6. Ambient temperature 0 to 40 C
7. Minimum battery backup of 30 min at full load

D. Furnish a door-mounted 2-position selector switch to select Automatic and Manual operation.

E. Sequence of Operation (Open Transition):

1. Normal Operation: Main A (source 1 power) NC, Main B (source 2 power) NC, Tie NO
2. In case of loss of source 1 power, Main Breaker A open, Tie will close,
3. If Source 1 power is restored, Tie will open, Main Breaker A closes.
4. Same Scenario for loss of Source 2 power.
5. Only two breakers can be closed at the same time.
6. Adjustable delays for opening and closing the breakers will be input during startup and commissioning.
7. All automatic transfer control shall be performed automatically by the transfer controller as specified above when the Auto/manual selector switch is in Auto

position and manually at the switchgear door control devices and generator when the selector switch is in Manual position.

2.07 CIRCUIT BREAKERS

A. Circuit breakers shall be power type either electrically or manually operated as indicated on the drawings. Minimum interrupting ratings will be equivalent to the bus rating and shall meet or exceed the interrupting ratings as defined by ANSI standards.

B. Circuit breakers are to be 100% ampere rating, 600 volt class with nominal ratings as dictated by the system voltage. Circuit breakers shall be three-pole, single-throw, operated by a stored energy mechanism, with arc quenchers, main and arcing contact structure, a three-phase solid state trip overcurrent trip unit, trip actuator, three single ratio trip sensors, and primary disconnecting devices. In addition, the circuit breaker element shall have connected, test, and disconnected position indicators, spring charged/discharged indicators, and circuit breaker open or closed indicators all of which shall be visible to the operator with the compartment door closed. It shall be possible to rack the circuit breaker element from disconnect to the connected position with the compartment door closed. Interlocks will be provided that prevent racking a circuit breaker unless the circuit breaker is open and that prevent closing a circuit breaker unless it is in the connected or test position.

C. Trip units shall be interchangeable so that any trip unit can be used with any frame size circuit breaker. The basic trip unit shall be a self-powered, micro-processor based device that measures true RMS currents. Long time, short circuit or ground fault trip indication shall be maintained for a minimum of 48 hours without the need for a separate battery or relay. Peak sensing devices will not be accepted. All adjustment setting switches shall be digitally encoded type with gold contacts.

D. Provide trip units that comply with the following:

1. Overcurrent, short circuit, and integral ground fault protection

2. Adjustable long delay pickups and time.

3. Adjustable short delay pickups and time.

4. Adjustable instantaneous pickup.

5. Adjustable ground fault current pickup and time.

6. Final setting as recommended by the final approved Power System study.

E. Provide mechanical position indicator visible from the front of the unit to indicate whether the breaker is open or closed.

F. Equipment each breaker with a mechanical trip button accessible from the front of the door to allow tripping of the breaker.

G. Provide electrically operated breakers with the following features:

1. 120 VAC coils,

2. control switch.

3. Red and green pilot lights to indicated breaker on close and Open position, respectively.

4. Amber pilot light to indicated breaker trip.

5. Pilot lights shall be LED and push to test type.

2.08 INFRARED SCANNING WINDOWS

A. Provide scanning windows on the vertical section for the main circuit breakers and tie breakers.

B. Provide scanning windows that are UL listed for use with the electrical assembly and that will not affect the UL rating of the electrical assembly

C. Provide scanning windows thar are compatible with all makes and models focusable infrared camera including cameras with dual visual digital and infrared capabilities.

2.09 ACCESSORIES

A. The following accessories are to be provided:

1. Rail system for racking circuit breakers.

2. Lifting yoke for circuit breakers.

3. Container of touch-up paint.

4. Portable test set.

2.10 NAMEPLATES

A. Provide nameplates as specified in Section 16010. Provide a nameplate for each circuit breaker or fusible switch and automatic transfer switch to indicate feeder and load served. The main nameplate shall give the switchgear designation in 1/2 inch-high letters. A second line in 1/4-inch-high letters shall indicate the voltage and phases.

2.11 SURGE PROTECTION AND POWER MONITOR

A. Provide service entrance surge protection as indicated on the drawings, and as specified in Section 16670.

B. Provide power monitor for each main circuit breaker as indicated on the drawings and as specified in Section 16155.

2.12 WALK IN SWITCHGEAR

A. Provide metal enclosure walk in switchgear with minimum two doors for ingress and egress. Enclosure shall be standard equipment from the manufacturer.

B. Provide 120-volt power in the enclosure for lighting and two convenience receptacles.

C. Provide rear access to the buss bar and cable terminations.

D. Provide lifting and removal mechanism in the switchgear for all breakers and equipment. Mechanism shall be permanently mounted and installed in the walk in enclosure.

E. Walk in enclosure shall be rated NEMA 3R and be coated with manufacturers standard paint system in ANSI gray.

F. Provide a panelboard in the switchgear for power of exterior lighting and other equipment. Refer to drawings for panelboard ratings and circuits.

PART 3: EXECUTION

3.01 FACTORY ACCEPTANCE TEST

A. The Owner has the right to witness the factory test, Contractor shall notify 10 days prior to schedule the factory test.

B. Submit the factory approval test report to the Owner.

C. Factory test shall include all tests required by ANSY, NEMA and IEEE including the following:

1. Visual and Mechanical inspection
    a. Inspect for physical damage
        1) If visual inspection reveals damage, conduct internal inspections and test as necessary to locate the damage
        2) Submit a detailed report to the Owner. Identify the damage, cause of damage, and corrective measures taken to assure the Owner of the quality of the low voltage switchgear.
    b. Compare equipment nameplate information with latest one-line diagram and record/report discrepancies.
    c. Verify proper auxiliary device operation such as indicators and auxiliar contacts.
    d. Mechanical Open/Close operation.
    e. Grounding of instrument transformer cases.
2. Electrical tests:
    a. Check closing operation and trip from all protective relays (trip units)
    b. Check open and closing operation and trip from all remote terminals.
    c. Perform insulation-resistance tests at 1000V DC for 1 minute.
        1) Across the contacts of each pole breaker open
        2) From pole-to-pole and from each pole-to ground with the control wiring connected to the line and load side of breaker.
        3) Where applicable, remove solid-state relays.
        4) Minimum acceptable values shall be in accordance with NETA.
    d. Verify control wiring.

e. Verify operation of ground fault sensing unit.

f. Perform insulation-resistance test at 1,000V dc for 1 minute on all control circuit wiring and electromechanical components. Minimum acceptance values shall be in accordance with NETA.

3.02 INSTALLATION

A. Secure switchgears rigidly to floors or mounting pads with anchor bolts or Phillips Drill Company concrete anchors. Anchor Bolts or concrete anchors shall be Type 316 stainless steel. Coordinate pad dimensions and loading with the Contractor prior to installation.

B. Coordinate all conduit entries, underground and overhead, with the contractor prior to fabrication. Provide additional sections or portions of the switchgear to allow all cables and raceways to be installed in the switchgear as indicated on the contract documents.

C. Set protective relaying, main and feeder circuit breaker adjustable set points, and time delays in accordance with recommended values from the Protective Device Coordination Study in Section 16011.

D. Verify that overall equipment dimensions are within the maximum dimensions indicated on the plans. If larger equipment is required, submit a proposed layout showing arrangement of electrical equipment. Provide working clearances in accordance with the NEC. Any costs due to rearrangement of equipment shall be borne by the Contractor with no additional expense to the Owner.

E. Set and calibrate breaker trip setting in accordance with the final approved power coordination study per Section 16011, Power System Study.

F. Provide all grating, landings, stairs required for ingress and egress to the walk in switchgear. Additionally, rear access is required for maintenance which shall be accessible without the use of portable steps or ladders.

3.03 MANUFACTURER'S SERVICES

A. Provide equipment manufacturer's services at the jobsite for the minimum man-days listed below, travel time excluded:

1. Five man-days to check the installation, supervise start up, and supervise testing of each Switchgear.

2. One man-day to instruct the Owner's personnel in the operation and maintenance of the equipment, at the site during a time approved by the Owner.

3.04 FIELD TESTING

A. Ground Fault Protective Equipment: The ground-fault protection system shall be performance tested after installation in accordance with NEC 230-95C. Submit a written record of the test to the Owner's Representative. Record current pickup level and time delay settings to which the equipment was finally adjusted. Measure and record relay pickup current and the relay time delay at two values above pickup. Test or correct system operation at 57% rated voltage. If relay pickup current is not within 10% of the manufacturer's calibration marks or fixed setting or

relay timing does not conform with manufacturer's published time-current characteristic curves, repair or replace equipment and repeat test.

B. Voltage: When the installation is essentially complete and the plant is in operation, check the voltage at the point of termination of the power company supply system to the project. Check voltage amplitude and balance between phases for loaded and unloaded conditions.

If the unbalance (as defined by NEMA) exceed 1%, or if the voltage varies throughout the day and from loaded to unloaded conditions more than +/-5% of nominal, make a written request to the power company that the condition be corrected. If corrections are not made, request from a responsible power company official a written statement that the voltage variations and/or unbalance are within their normal standards.

C. Operate each switch, circuit breaker and automatic transfer switch at least three times, demonstrating satisfactory operation each time.

D. Provide coordination with the Power System Study in Section 16011.

E. Infrared testing shall be performed on the switchgear in accordance with Specification 16010.

3.05 TRAINING

A. Provide at least one 8-hour day OF instructs to either or all the Owner, Contractor, Engineer, or responsible party.

B. The training shall include the following:

1. General electrical operation and maintenance of the Switchgear and its associated devices such as circuit breaker, PLC-ATCS, and accessories.

2. Protective devices, sequence of operation troubleshooting, fault indications and clearing faults.

3. Normal operating procedures

    a. Operating breaker electrically and manually

    b. Tie breaker operation

4. Emergency operating procedure

    a. Restoring after a power loss and lockout of main breaker

5. Microprocessor Automatic Transfer Control system

    a. Sequence of operation

    b. Automatic operation

    c. Manual operation

    d. Maintenance

6. Maintenance procedures, frequency of maintenance:

    a. Removing breakers

    b. Voltage testing

c. Lockout/tagout
d. Use of testing devices
e. Use of grounding devices
f. Use of special tools
g. Use of breaker lifting module

3.06 PAINTING

A. Clean and shop prime all non-galvanized, non-stainless steel metal surfaces.

B. Use manufacturer final exterior color for the low voltage switchgear touch-up.

END OF SECTION

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# SECTION 16220

# ELECTRIC MOTORS

## PART 1: GENERAL

### 1.01 DESCRIPTION

A. This section describes materials, installation, and testing of induction motors and applies to motors which are provided as part of equipment specified in other sections. When it applies, this section is referenced in these other sections.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. General electrical requirements: 16010.

B. Low-voltage motor control: 16155.

C. Variable-frequency drives: 16157.

D. Division 11 and 15.

### 1.03 SUBMITTALS

A. Submit SHOP DRAWINGS in accordance with Section 01300.

B. Show complete nameplate data, ratings, characteristics, mounting arrangements, size and location of conduit entry, location and size of grounding lug, and coatings.

C. For high efficiency motors, provide percent efficiency data at full, 75%, and 50% load.

D. Submit factory test results for each motor.

### 1.04 FACTORY TESTS

A. For each integral hp motor provide routine (short commercial) test data. Tests shall comply with NEMA MG 1-12.51 and MG 1-23.46.

B. Test thermally protected motors in accordance with NEMA MG 1 winding temperature and trip current tests.

### 1.05 CONTROLLER COORDINATION

A. Where motor controller, other than a standard across-the-line type, is specified, furnish reviewed shop drawings to the controller manufacturer for coordination and sizing of the controller.

B. Contractor shall coordinate all motor types and sizes with other equipment provided.

### 1.06 QUALITY CONTROL

A. NEMA Compliance: Unless otherwise indicated, comply with NEMA MG 1.

B. UL Listing: Motors for applications in hazardous locations shall bear the UL label listing its use in accordance with the NEC.

PART 2: MATERIALS

2.01 GENERAL MOTOR DESIGN REQUIREMENTS

A. Unless otherwise specified or specifically required by the manufacturer of the equipment to be driven, a-c motors shall be single speed, squirrel cage induction motors, NEMA Design B. Motors 15 hp and larger shall be NEMA Starting Code F or G. Motors smaller than 15 hp may be manufacturer's standard starting characteristics.

B. Two-speed motors shall be two-winding type.

C. Stator windings shall be copper.

D. If motors are subjected to overhanging loads, they shall be designed for such loads. The magnitude of the overhanging load shall not exceed the recommendations of the motor manufacturer.

E. The connected load (maximum hp required) of each motor shall not exceed its nameplate hp rating (exclusive of service factor) under any operating condition.

F. Motors shall be sized to start and accelerate the design load of the driven equipment without exceeding any of the specified design requirements. Replace any motor failing these requirements with a motor that will meet the specifications and requirements at no additional cost to the Owner.

G. Connection box shall be cast metal with gaskets between the box and housing and between the box and cover. Provide a grounding terminal in the connection box.

H. Open drip proof and weather-protected motors shall have a service factor of 1.15, and totally enclosed motors shall have a service factor of 1.0, unless a higher service factor is standard for the operating duty.

I. Unless otherwise noted, motors shall be rated for continuous duty at an ambient temperature of 40C and at an altitude of 3,300 feet.

J. Open drip proof and weather-protected motors 7.5 hp and larger shall have stainless-steel screens over openings.

K. Motors 7.5 hp and larger shall have cast-iron frames. Do not provide aluminum frames.

L. For motors controlled by VFDs, use a motor whose critical vibration frequency is not within the operating range of the VFD.

2.02 BEARINGS

A. Horizontal Motors

1. Bearings for motors up to 1 hp shall be sealed, permanently lubricated ball bearings.

2. Bearings for motors 1 hp and larger shall be shielded open-type ball bearings installed in labyrinth sealed end bells with pipe plugs. Bearings shall be regreasable and have provisions for purging old grease.

B. Vertical Motors:

1. Vertical motors shall be designed for vertical operation and shall have thrust bearings with a rated B-10 life of 40,000 hours as defined by Anti-Friction Bearing Manufacturers Association (AFBMA).

2. Thrust bearings for motors 75 hp and larger shall be oil lubricated. Guide bearings may be antifriction, grease lubricated, or oil lubricated.

3. Equip grease lubricated bearings with fittings in each bearing housing. Fittings shall be accessible without removal of any covers or guards. Provide drains to prevent over lubrication.

2.03 INSULATION AND TEMPERATURE RISE

A. Unless otherwise noted, provide Class F insulation with Class B rise at unity service factor.

2.04 VOLTAGE

A. Unless otherwise noted, provide a-c motors 1/3 hp and smaller at 115 volts, single phase, 60 Hz, and motors 1/2 hp and larger at 460 volts, 3 phase, 60 Hz.

2.05 COATING

A. Do not coat cast aluminum frame motors.

B. Motors housed within equipment enclosures, such as exhaust fans, air handling units, and air conditioners, may have factory's standard prime and finish coats.

C. Coat cast-iron frame motors. Apply prime coat at the factory which shall be compatible with field-applied finish coat(s).

D. Field apply finish coat(s) specified in the applicable equipment section.

2.06 MOTOR TYPES

A. Motor types are defined below and shall be identified in each of the specification sections.

1. Vertical weather protected Type 1, NEMA WP-1.

2. Horizontal or vertical weather protected Type 2, NEMA WP-2.

3. Horizontal, open drip proof.

4. Totally enclosed, fan cooled.

5. Totally enclosed, nonventilated.

6. Horizontal, heavy duty, totally enclosed, fan cooled and shall have the following features:

a. Nonhygroscopic insulation.

b. Extra dips and bakes of insulating varnish for moisture protection of windings.

c. Gasket cast-iron conduit box halves and moisture seal between conduit box and motor frame.

d. Weep holes to vent enclosure and drain condensation.

e. Chemically inert fan.

7. Totally enclosed, explosion proof, suitable for use in Class 1, Division 1, Group D hazardous locations, with UL label.

8. Totally enclosed, fan cooled, nonventilated, d-c, for application on a variable speed drive system. D-C armature voltage shall be compatible with variable speed controller. Motors 3/4 hp and larger shall have d-c field supply voltage compatible with variable speed controller. Motors 1/2 hp and smaller may have permanent magnets or windings for d-c field. Equip with a thermostat with one NC contact securely attached to interpole to provide protection for motor overheating.

2.07 MOTOR REQUIREMENTS

The following requirements shall be identified in each of the equipment specifications and as indicated below.

1. Motor shall be rated for continuous duty at an ambient temperature of 65C with temperature rise as indicated in other specifications.

2. Provide complete initial test for motors 100 HP and above. Include actual data specified for the routine test, plus as follows:

   a. Full-load heat run.

   b. Percent slip.

   c. Efficiency and power factor at 100%, 75%, and 50% of full load.

3. Unless otherwise noted, motors shall have minimum guaranteed full load efficiencies in accordance with NEMA MG 1-12.55. The efficiency shall be determined by IEEE 112 Method B [using sine wave power] for motors up to 300 hp and Method F for motors above 300 hp. Efficiency shall be listed on the nameplate in accordance with NEMA MG 1-12.54.2.

4. Motor shall have 120-volt heating elements as indicated in other specifications.

5. Motor windings shall be moisture sealed as indicated in other specifications. Motors with form-wound coils shall have vacuum-pressure impregnated windings. Critical mechanical parts of the motor shall be plated or treated with a paint primer to provide additional protection in corrosive atmospheres. Provide with stainless steel nameplates.

6. Provide motor with a guaranteed maximum noise level of 72 dBA, measured at 5 feet from the motor surface per IEEE 85, when running at no-load connected to sine wave power as indicated in other specifications.

7. In addition to nameplate information required by NEMA MG 1-10.37 through 39, show on the nameplate the bearing numbers for both bearings, efficiency, and power factor at full load.

8. Motors so specified shall be equipped with a nonreversing ratchet.

9. Motors so specified shall be equipped with thermal protection in accordance with NEMA MG 1. Control leads shall be color-coded, brought out to the motor conduit box or a separate terminal box for connection. Provide one of the following three types and coordinate with the motor control system and contract drawing schematics.
    a. Provide three series connected, normally closed switches, one in each winding.
    b. Provide three positive temperature coefficient thermistors installed in stator winding (one per phase) and a solid-state encapsulated electronic control module mounted in a separate motor outlet box.
    c. Provide 120-ohm resistance-temperature detectors (RTD), with two RTDs in each winding and one RTD in each bearing, for a total of eight. The RTDs shall be designed to function in two temperature steps: the first to indicate an alarm and the second to stop the motor.
10. Motor controller via a variable frequency drive shall be suitable for use with a variable frequency drive with nonfiltered output if recommended by the manufacturer. Design the motor to limit temperature rise to within the specified requirement when powered from the drive. Provide a nameplate designating inverter duty use.

## PART 3: EXECUTION

### 3.01 STORAGE

A. Protect motors from exposure of elements for which they are not designed. Install and energize temporary electrical service to motors with electrical heaters as required.

B. Unless protected by manufacturer’s packing, upon delivery, carefully wrap each motor in three layers of 8-mil-minimum polyethylene. Secure the wrap with adhesive tape to minimize the entrance of moisture. For base-mounted motors, wrap the entire assembly.

### 3.02 VIBRATION TESTS

A. Where indicated, conduct a vibration test in the field after the installation has been completed. The test shall be conducted for each motor when specifically noted or when ordered by the Owner in cases of discernible abnormal vibration. Vibration shall not exceed 5 in/sec.

B. For horizontal motors, measure N-S and E-W vibration at top and bottom of front and rear housing.

C. For vertical motors, measure N-S and E-W vibration at front and rear of upper and lower bearing housing.

END OF SECTION

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# SECTION 16446

# LIGHTNING PROTECTION SYSTEM

## PART 1: GENERAL

### 1.01 DESCRIPTION

A. SCOPE:

1. Contractor shall provide the lightning protection systems design by a qualified Lightning Protection System (LPS) firm registered to design lightning protection systems.
2. Contractor shall furnish and install a complete lightning protection system for the following facilities and structures:
   a. New Administration Building
   b. BNR Basin 1-3
   c. BNR Basin 4
   d. BNR/MBR Electrical Building
   e. MBR Facility
   f. WAS Holding Tank/Reuse Wetwell
   g. Aerobic Digesters 1 and 2
   h. Solids Handling Building
   i. UVPA Facility
3. Contractor shall test and certify that the lightning protection system design, installation, and testing comply with the lightning protection industry standards as applied to the project facilities and structures.
4. Contractor shall provide the LPS firm with the plant or facilities drawings that indicate the equipment, buildings, structures, and HVAC equipment as the basis for their design work.
5. Contractor shall submit the design drawing to the Design Review Agency for approval and to the Engineer for reference.

B. COORDINATION

1. Lightning Protection Systems design shall be arranged in accordance with the class of structure to be protected.
2. Coordinate arrangement and connections with roof system proposed for use and roof mounted equipment. Refer to the structural and architectural drawings.
3. Coordinate with building grounding systems for interconnection.

C. RELATED SECTIONS

Contractor shall coordinate the requirements of the Work in this Section along with the requirements of the sections listed:

1. Section 16010 – Electrical
2. Section 16110 – Raceways, Boxes and Supports
3. Section 16450 - Grounding Systems.

1.02 QUALITY ASSURANCE

A. GENERAL

1. Lightning protection system materials shall be the standard product of a manufacturer regularly engaged in the production of lightning protection systems.
2. Materials shall comply in weight, size, and composition for the class of structure to be protected.
3. Lightning protection systems shall be installed under the direct supervision of a Lighting Protection System Certified Master Installer.

B. CERTIFICATION REQUIREMENTS

1. Provide and submit Master Installer Certified forms for the following:
   a. Form LP1-175A - Jobsite Witness of Grounding Connections.
   b. Form LP1-175B - Post-Installation Inspection.
   c. UL Master Label

C. QUALITY CONTROL

Provide the system in accordance with the following standards and specifications:

| Reference | Title |
|---|---|
| ANSI/IEEE C62.1 | Surge Arresters for AC Power Circuits |
| ANSI/IEEE C62.11 | Metal-Oxide Surge Arresters for Alternating Current Power Circuits |
| LP1-174 | Lightning Protection Institute Installation Code |
| LP1-175 | Lightning Protection Institute Standard of Practice |

NEC National Electrical Code (NEC):

Article 230 – Services

Article 250 – Grounding

Article 280 – Surge Arrestors

Article 501 – Class I Locations

Article 502 – Class II Locations

Article 800 – Communications Circuits

NFPA-780 Lightning Protection Code

UL Standard No. 96 Lightning Protection Components

UL Standard No. 96A Master Label Provisions

1.03 SUBMITTALS

A. SHOP DRAWINGS:

The following submittals shall be provided in accordance with Section 01300:

1. Manufacturers technical information for materials proposed for use.
2. Complete scaled drawings identifying the system arrangement and equipment connections for each building.
3. Drawings shall include equipment connection details, down-lead details, routing of system conductors, and locations of air terminals.

B. MASTER LABEL CERTIFICATES:

1. Submit certificates for LP1 Code Compliance together with UL Master Label C certificates.

PART 2: PRODUCTS

2.01 MATERIALS

A. MATERIALS:

1. GENERAL: System materials shall be copper and high copper-content bronze castings.
   a. Fittings, except cable holders, shall be heavy-duty type made from bronze castings.
   b. Terminal rods, bolts, screws, and related type hardware shall be copper clad steel or brass to prevent galvanic corrosion.
2. COMPONENTS: The system shall consist of the necessary equipment as required to provide a complete and coordinated system. Cable and air terminals used shall bear the UL Label. The components shall consist of, but not limited to, the following:
   a. Cables
   b. Air terminals
   c. Mounting bases
   d. Fittings

e. Couplings

f. Connectors g. Fasteners

g. Conduit

h. Pitch pads and weatherproof seals.

2.02 MANUFACTURERS

The Owner and Engineer believe the following candidate firms are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section.

The candidate detailed design, product manufacturer, and installation firm shall be one of the following or accepted equal:

1. Thompson Lightning Protection Inc.
2. AC Lighting Security
3. Or Approved and Qualified Equal.

PART 3: EXECUTION

3.01 INSTALLATION

1. Verify field measurements as indicated on the drawings and as specified elsewhere herein.
2. Conceal system conductors as much as possible. Main down-leads and roof risers shall be concealed within the building walls or columns.
3. Allow six foot minimum clearances as required by the NEC from:
   a. Lightning rod conductors to non-current-carrying metal parts of electrical equipment unless they are bonded to the rods;
   b. Lightning conductors to open conductors of communications systems;
   c. Lightning protection grounding electrodes to electrodes of other grounding systems.
4. Do not use lightning protection rods and electrodes in place of the grounding electrodes for electrical equipment.
5. Run leads in conduits as specified in 16110. Down conductors shall be concealed in the building structure.
6. Terminate upper end above floor ceiling, utilize through-roof connectors for cable roof penetrations. Conduit terminations at lower end to be 6- inch above finished ground level, to pinpoint locations during future inspections.
7. Bond metallic objects and systems at roof level.
8. Primary bonds using appropriate fittings and full-size conductor:

a. Roof intake and exhaust fans, HVAC units, ductwork, piping, ladders, skylights, stacks, vents, etc.

b. Down-leads to steel column or major framing member at every down-lead position.

9. Secondary bond using secondary cable and fittings:

a. Metal bodies of inductance located within six feet of a conductor

b. Equipment with primary bond.

10. Connect to structure ground grid system using exothermic welds.

11. Ensure installation of air terminals to withstand wind force equivalent to 100 miles per hour with a gust factor of 1.3 without structural damage and without damage to the integrity of the lightning protection system.

12. Interconnect the Lightning Protection System to the building grounding grid at one location. Suggest the design indicate the interconnection be on opposite side of the building's service entrance location.

END OF SECTION

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# SECTION 16450

# GROUNDING

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section includes materials, testing, and installation of electrical grounding system around all new structures, for equipment grounding, and utility service.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

### 1.03 SUBMITTALS

A. Submit shop drawings and catalog data in accordance with the Section 01300.

B. Submit material list for all grounding materials and equipment. Indicate size, material, and manufacturer.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer.

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

### 1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with the Special Provisions and the manufacturer’s recommendations.

### 1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

## PART 2: PRODUCTS

### 2.01 GROUND RODS

A. Ground rods shall be copper-clad steel, 3/4 inch diameter, minimum 10 feet long, with hardened steel points.

### 2.02 GROUND CLAMPS

A. Ground clamps shall be bronze.

### 2.03 GROUND RESISTANCE TESTER

A. The ground resistance tester shall be an instrument specifically designed for ground resistance testing.

## PART 3: EXECUTION

### 3.01 MANUFACTURER'S SERVICES

A. Provide Service of Manufacturer's Representative per Division 1 specifications.

B. The Contractor shall refer to the individual specification sections for the requirements of the manufacturer services for all equipment provided in Division 16 of the Contract Documents. The services indicated in the Division 1 specifications shall be in addition to those indicated in the specification sections.

### 3.02 FIELD TESTING

A. Before making connections to the ground electrode, measure the resistance of the electrode to ground using a ground resistance tester. Perform the test not less than two days after the most recent rainfall, and in the afternoon after any ground condensation (dew) has evaporated. If a resistance of 5 ohms or less is not obtained, provide ground rods driven 6 inches below grade and connect to ground test well with No. 4/0 AWG bare copper wire and repeat the test. If the resistance is still above 5 ohms, inform the Owner.

### 3.03 GROUND ELECTRODE

A. Install a bare copper ground loop for all new structures and as shown on the drawings. Bring the loop to the ground at the motors, distribution transformers, ground main service disconnect bus, or motor control centers. Buried or concealed joints or terminations are not permitted. Protect wires with rigid steel conduit where wires stub up through slab at motor control center.

B. Install ground rods 6" below grade at each corner of new structures. Connect to ground loop with exothermic weld.

C. Equipment Grounding

1. Connect the ground buses of the distribution transformer to the ground bus within the panel with a grounding conductor.

2. Ground raceways and noncurrent carrying parts of electrical equipment in accordance with NEC Article 250. Use the metallic conduit system for equipment and enclosure grounding. Grounding through the conduit system shall be in excess of any ground conductors shown on the drawings.

3. Circuits in all conduits shall carry one ground conductor for equipment grounding.

4. All above ground metallic equipment shall be effectively bonded to the earth ground electrode system, i.e., stairways, handrails, ladders, elevated platform motors.

D. Provide and install #4 AWG bare copper grounding conductors to all motor bases, connect to ground loop.

E. Provide and install service grounding as shown on the drawings and as required by the local codes and utility.

END OF SECTION

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# SECTION 16460

# DRY TYPE TRANSFORMERS

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section includes materials and installation of low-voltage (600V or less) transformers.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

### 1.03 SUBMITTALS

A. Submit shop drawings and catalog data in accordance with Section 01300.

B. Submit ratings and characteristics including voltage, phases, connections, enclosure type and dimensions, and conduit entry restrictions.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer.

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

### 1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with the Special Provisions and the manufacturer’s recommendations.

### 1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Low Voltage Motor Control: 16155

C. Panelboards: 16160

## PART 2: PRODUCTS

### 2.01 GENERAL

A. KVA size, voltage, and phase of the transformers are indicated on the drawings.

B. Transformers to be UL listed and labeled where listing applies.

C. Transformers shall be rated for continuous operation in a 40°C maximum ambient temperature.

2.02 DRY-TYPE TRANSFORMERS (25 KVA AND BELOW)

A. Construct transformers in accordance with ANSI C89.2, NEMA ST-20, and UL listed under the requirements of Standard 506.

B. Transformers 5 KVA and larger shall have two 5% FCBN taps on the primary side.

C. Transformers rated 250 VA and below shall have 55°C rise, 105°C insulation system. Transformers rated 0.5 KVA through 25 KVA shall have 115°C rise, 180 C insulation system.

D. Encapsulate core and coil in an insulating resin of the class equal to the temperature rise. They shall be embedded in a resin and filler system to attenuate the sound level.

E. Transformers shall be Square D, Eaton, or equal.

2.03 DRY-TYPE TRANSFORMERS (30 KVA AND ABOVE)

A. Construct transformers in accordance with ANSI C89.2, NEMA TR-27, NEMA ST-20, and UL listed under the requirements of Standard 506.

B. Transformers shall have two 2-/2% FCAN and FCBN taps on the primary side.

C. Transformers shall have 150 C rise, 220 C insulation system.

D. Sound levels shall be within the requirements of ANSI C89.1-2.7.2

E. Transformers shall be ventilated type.

F. Transformers shall be Square D Company “Quiet Quality,” General Electric Company “QL,” or equal.

PART 3: EXECUTION

3.01 INSTALLATION

A. Set taps under load conditions for correct voltages as shown on the drawings.

B. Install transformers such that no metal-to-metal, concrete, plaster, or wood contact exists between the transformer and structural members.

C. Install transformer on equipment pads, on wall supports, in control panels, or in motor control centers in locations as indicated on drawings.

3.02 MANUFACTURER’S SERVICES

A. Comply with Division 1 for Service of Manufacturer’s Representative.

B. The Contractor shall refer to division 1 and individual specification sections for the requirements of the manufacturer services for all equipment provided in Division 16 of the Contract Documents. The services indicated in the Division 1 shall be in addition to those indicated in the specification sections.

3.03 FIELD TESTING

A. Transformers shall have insulation resistance tests made on the windings prior to being connected. The measurements shall be from primary and secondary windings to ground and between primary and secondary windings. The minimum value shall be 10 megohms.

B. Demonstrate secondary voltage is within 5% of rated voltage at full and no load conditions.

END OF SECTION

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# SECTION 16500

# LIGHTING

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section includes materials and installation of lighting fixtures as indicated in accordance with Contract Documents.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

### 1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300, submittal shall include the following:

1. Manufacturer’s catalog data including complete catalog number, photometric data, and descriptive literature.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer.

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

C. Provide minimum of 1 type of each fixture for spare part.

### 1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle and store the equipment in accordance with the Special Provisions and the manufacturer’s recommendations.

### 1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Lighting Schedule: Contract Drawings.

## PART 2: PRODUCTS

### 2.01 GENERAL

A. Furnish lighting fixtures of the type indicated on the drawings, complete with lamps, sockets, wiring, and mounting hardware.

B. The use of a manufacturer’s name and model or catalog number in the drawings is for the purpose of establishing the standard of quality, photometrics, and general appearance desired only. Products of other manufacturers will be considered in accordance with the Division 1 requirements.

2.02 MANUFACTURERS

A. Fixtures as indicated on the drawings.

B. Ballasts: Advance, General Electric, Jefferson, Universal, or equal.

2.03 LAMPS

A. Include lamps in each fixture to provide the lumens/foot candles as indicated in the Lighting schedule.

2.04 BALLASTS/DRIVERS

A. Provide solid state ballasts and drivers for all fixtures as recommended by the manufacturer for the fixtures identified.

2.05 FIXTURE TYPES

A. Fixture types are identified on the drawings in the Lighting Schedule. The schedule specifies fixtures which were utilized for the design, substitutions shall have similar lighting specifications, and materials used in fabrication shall be similar to that specified.

2.06 POLES

A. Pole shaft shall consist of round extruded 6063-T6 aluminum alloy with finish to match fixture. Height of pole shall be as shown on drawings.

B. Design poles, including handholes and luminaries, for a minimum yield safety factory of 1.5 when subjected to a sustained wind velocity of 100 MPH and wind gusts of 130 MPH. In addition, limit the deflection to 5% of pole length under these conditions.

C. Equip with handhole of sufficient size to permit the pulling and splicing of wires and grounding of the pole. Provide a grounding lug accessible through the handhole to accept a ½-inch-diameter copper conductor. Equip handhole with a cover.

2.07 HAZARDOUS AREAS

A. Lighting fixtures and equipment installed in hazardous and classified areas shall be suitable and rated for installation in such areas. Provide fixtures with equivalent characteristics as those noted in the Luminaire schedule on the drawings, except rated for the applicable hazardous location.

PART 3: EXECUTION

3.01 INSTALLATION

A. Install lighting fixtures as close as possible to the locations shown on the drawings, making adjustments only for the purpose of avoiding interferences.

B. Install lighting fixtures plumb and level, with fixture surfaces parallel and perpendicular to walls and other major structures.

C. Aim exterior adjustable lighting fixtures after dark. Notify Engineer at least three days in advance of aiming fixture. After final adjustment, drill and install self-tapping stainless steel screws to lock adjustment brackets into place.

D. Provide mounting and anchoring of fixtures in accordance with the manufacturer's requirements.

E. Install continuous rows of fixtures straight and true and equip with necessary parts, such as joining straps, couplings, and nipples.

F. Support fixtures with a length of 18" or greater at two points minimum from structural elements which are capable of carrying the total weight. Mount fixtures rigidly with no rocking action. Where fixtures are mounted in or on a suspended grid-type ceiling, support fixtures at two points in addition to support from the ceiling grid.

G. Emergency lighting units shall be arranged to provide the required illumination automatically in the event of any interruption of normal lighting such as failure of public utility or outside electrical power supply, opening of a circuit breaker or fuse or any manual act(s) including accidental opening of a switch controlling normal lighting facilities. Provide all the required components for a complete operation.

H. Provide pendant stem-mounted fixtures with swivel hangers. Stem shall be one piece without coupling and shall be finished the same color as the canopy and the fixture, unless otherwise noted.

I. Not all conduit and wire is shown on the drawings for the lighting fixture power feeds. Provide all wiring for a complete system to power the light fixtures through the switches and contactors as indicated.

3.02 FIELD TESTING

A. Operate each fixture, demonstrating that all lamps and fixtures are fully operational.

B. Aim fixtures at night to provide lighting to all proposed areas as recommended by the engineer.

C. Verify all contactors and controls operate including photocells.

D. Replace all lamps and ballasts which are not operational at time of acceptance.

END OF SECTION

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# SECTION 16670

# SURGE SUPPRESSION

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section describes the materials and installation requirements for Surge Protective Devices (SPD) for the protection of AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.

### 1.02 QUALITY ASSURANCE

A. The following standards and publications are referenced for use in various sections of this specification.

1. ANSI/IEEE C62.41, Guide for Surge Voltages in Low Voltage AC Power Circuits. For purposes of this specification, Category C shall assume a maximum voltage amplitude of ten kilovolts and a maximum current amplitude of twenty kiloamperes.

2. ANSI/IEEE C62.1, Standard for Surge Arrestors for AC Power Circuits.

3. ANSI/IEEE C62.33, Standard for Test Specifications for Varistor Surge Protection Devices.

4. NEMA LS-1--Low Voltage Surge Protective Devices.

5. Underwriters Laboratories, UL 1449, Standard for Safety, Transient Voltage Surge Suppressors, Latest edition.

### 1.03 SUBMITTALS

A. Shop Drawings:

1. Provide product data for each suppressor type in accordance with Section 01300.

2. The submittals shall include.

a. Dimensional drawing of each suppressor type indicating the following:

1) Line-to-neutral, line-to-ground, and neutral-to-ground suppression paths

3. UL Standard 1449 Listing, Standard for Safety, Surge Protective Device.

4. UL Standard 1283 Listing, Electromagnetic Interference Filters, documentation

5. IEEE C62.41 Category C3 (20kV-1.2/50, 10kA-8/20μs waveform) let through voltage test results.

6. Conductor size, rating, and type for connection of surge protection.

B. Submit Operational and Maintenance Manuals in accordance with GP-5.04 and SP-10.

1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide minimum two of each complete type of SPD provided, in addition to those required in other specification sections.

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver, handle, and store the equipment in accordance with the Special Provisions and the manufacturer's recommendations.

1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Low Voltage Motor Control: 16155

C. Panelboards: 16160

D. Switchboards: 16161

E. Switchgear: 16165

F. Grounding: 16450

G. General Control Requirements: 16900

1.07 MANUFACTURER'S QUALIFICATIONS

A. All surge suppression devices shall be manufactured by a company normally engaged in the design, development, and manufacture of such devices for the protection of electrical circuits and electronic equipment.

B. The surge suppressor manufacturer shall provide factory repair service for all nonencapsulated assemblies and replacement parts for all encapsulated units.

1.08 WARRANTIES

A. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.

B. Should the suppressor fail for any reason, a one-time replacement shall be provided during the warranty period at no cost to the Owner.

PART 2: PRODUCTS

2.01 MANUFACTURERS

A. SPD shall be provided by the same manufacturer. Provide protection manufactured by Current Technology, Innovative Technologies, or equal

B. The low voltage signal surge protection equipment for devices shall be provided by Innovative Technologies, or equal.

2.02 PANELBOARD AND MOTOR CONTROL CENTER SURGE PROTECTIVE DEVICE (SPD) OR TVSS (AS NOTED ON THE DRAWINGS)

A. SPD shall be UL Listed to UL 1449, Standard for Safety, Transient Voltage Surge Suppressors, and UL 1283, Electromagnetic Interference Filters.

B. SPD shall be designed for integral installation in each panelboard. The mounting position of the SPD shall permit a straight and short lead length connection between the SPD and the point of connection to the panelboard.

C. SPD shall provide suppression components between each phase conductor and neutral, between each phase conductor and ground and between the neutral Conductor and ground.

D. All encapsulated SPD's shall utilize an encapsulant that is UL listed and holds a 94-V2 fire retardant rating. No encapsulant compounds that incorporate epoxy shall be allowed.

E. SPD shall meet or exceed the following criteria:

1. 1. Maximum single impulse current rating shall be 80 kA per phase. (40 kA L-N, 40 kA L-G)

2. Pulse life test: Capable of protecting against and surviving 2000 ANSI/IEEE C62.41 Category C3 transients without failure or degradation of UL 1449 suppression voltage ratings by more than 10%.

3. The UL 1449 suppression voltage ratings shall not exceed the following:

| VOLTAGE | L-G | L-N | N-G |
|---|---|---|---|
| 120/208 V | 500 V | 500 V | 500 V |
| 277/480 V | 1000 V | 1000 V | 1000v |

F. SPD shall be made of solid-state components and operate bidirectionally.

G. SPD shall have a response time no greater than one nanosecond for any of the individual protection modes.

H. SPD shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.

I. Visible indication of proper SPD connection and operation shall be provided. Visual indication shall be by means of solid state status indicator lights on the front of the SPD.

2.03 LOW VOLTAGE SIGNAL PROTECTION

A. Surge suppression for all control cabinets, PLC cabinets, and instrumentation shall be furnished and installed by the system supplier.

B. Suppressor Performance Criteria

1. Maximum single impulse current withstand, conductor to ground or conductor to conductor: 10,000 amperes (8 X 20 us - waveform).
2. Pulse life rating: 3,000 amperes (8 X 20 us - waveform): 2,000 occurrences
3. Suppressors shall have turn-on and turn-off times of less than one nanosecond.
4. Maximum clamping voltage at 10,000 amperes, 8 x 20 us current waveform, shall not exceed the peak of the normal applied signal voltage by 200%.
5. Suppressors shall be a hybrid design with a minimum of three (3) stages utilizing solid-state componentry and shall operate bidirectionally.
6. Suppressors shall be housed in an enclosure that is compatible with the system being protected.

PART 3: EXECUTION

3.01 FIELD TESTING

A. Provide factory certified test reports for each model of suppressor supplied, including test methods and equipment.

3.02 PANELBOARD/MOTOR CONTROL CENTER INSTALLATION

A. Install SPD at each panelboard and motor control center (MCC), as indicated on the drawings.

B. SPD shall be mounted adjacent to or integral with the panelboard. SPD shall be mounted in the MCC as shown on the drawings.

C. Neutral and ground shall not be bonded together at the panelboard locations.

D. Provide overcurrent protection as required by the NEC for the SPD.

E. Suppressors shall be close-nippled to the device being protected. The mounting position of the suppressor shall permit a straight and short lead length connection between the suppressor and the point of connection.

F. Securely mount surge suppressor to wall, or panel with stainless steel hardware.

G. Conductors for connection of surge suppression shall be as recommended by the manufacturer for this application and shall be wrapped together the full length of the conductors.

END OF SECTION

# SECTION 16720

# SECURITY ACCESS MANAGEMENT SYSTEM

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section includes the requirements for integrated Security Access Management System (SAMS) with all related controls and accessories. The gate operators shall be compatible with Card Reader Access Systems installed in the future. Video Surveillance System is provided per the requirements of 16792 Video Surveillance System.

B. The SAMS shall be provided by a Security Systems Integrator (SSI). The SSI is a qualified subcontractor who shall be responsible for the coordination and integration of the SAMS for this Contract. The Security Systems Integrator shall have the total responsibility for the design, fabrication, installation, configuration, programming, testing, and start-up, and implementation of the complete Security Access Management System.

### 1.02 SECURITY SYSTEMS INTEGRATOR

A. The Security Systems Integrator shall be regularly engaged in the business of security systems. Components shall be provided by companies specializing in manufacturing the Products specified in this Section with minimum of (5) five years documented experience. The Security Systems Integrator shall have maintenance facilities and service personnel within 100 miles of the Project Site.

B. SAMS Security Systems Integrator shall provide all materials, products, services as required to obtain an operable system. The Security Systems Integrator shall have total responsibility for the system performance and conformance to assure proper interfacing and reliable operation of all components of the system. The Security Systems Integrator shall be totally and solely responsible for the quality and proper functioning of all supplied components.

C. The Security Systems Integrator shall be capable of providing on-site maintenance services within 24 hours following a maintenance request, and emergency service within eight hours following an emergency service request. Normal and emergency maintenance service shall be made available 24 hours every day on a call request basis for the one-year warranty period.

D. The Security Systems Integrator shall assume full responsibility for ensuring the proper testing functionality of the system and shall provide all coordination as required to provide a complete functioning system.

E. The Security Systems Integrator shall provide training services as specified herein.

1.03 REFERENCES

| | |
|---|---|
| NFPA 70 | National Electrical Code |
| NFPA 72G | Notification Appliances for Protective Signaling Systems |
| NFPA 72H | Guide for Test Procedures for Protective Signaling Systems |
| NFPA 72-1993 | National Fire Alarm Code |
| NFPA 101 | Life Safety Code |
| IBC | Chapter 10 of the International Building Code |

1.04 SYSTEM DESCRIPTION

A. The Security Access Management System shall consist of a modular computer based integrated platform, which shall include and perform the following functions as a minimum:

1. Provide security access, and intercom communications, at designated computer workstations.

2. Provide automatic gate controls at the front gate. The gate operator shall be compatible with card reader that will be installed in the future.

1.05 DESIGN REQUIREMENTS

A. The requirements included herein provide minimum performance criteria for the Security Access Management System. The Security Systems Integrator shall provide an integrated, turn-key solution for incorporating the functionality and operational parameters for a complete system.

B. The Security Systems Integrator shall design the system architecture and configuration of the complete network to establish connectivity of the SAMS components. This shall include computer workstations, gate operators, gate keypads with intercoms, future card readers, etc.

C. The Security Systems Integrator shall conduct a site survey of the proposed facility to locate the proposed equipment locations. The Security Systems Integrator shall include all materials and accessories required to furnish, install, test and startup the systems for the proposed locations. The locations include:

1. Gate security access points.

2. PC Workstation Location.

3. Identify power supply connection points.

4. Determine layout and routing of duct bank, conduit, and wiring systems.

5. Coordination with Camera locations

D. The Security Systems Integrator shall develop a project delivery plan which outlines a timeline and task description for how the project will be implemented, including equipment procurement, installation, programming, testing, demonstration, and training components.

1.06 SUBMITTALS

A. Shop Drawings shall include the following information:

1. Shop drawings submittals shall include:
   a. All product descriptive data
   b. Performance characteristics
   c. Materials specifications
   d. Recommended spare parts list
   e. Drawings
   f. Wiring schematics
   g. Interconnecting wiring diagrams
   h. Shop drawings shall be complete and accurate to indicate item-by-item compliance with the specification.
2. All catalog cuts, manufacturer's specifications, drawings, and written sequence of operation and control descriptions shall be clearly marked to allow identification of the specific products used.
3. If the submittal deviates from the requirements of the Specifications in any way, it shall be clearly marked in the submittal with the justifying reason stated for evaluation by the Owner.
4. Electrical submittals shall include a written description of the control functions, instrumentation, alarm points, alarm sequences, interconnection wiring diagrams, full schematics, and any other specific features.
5. Provide point-to-point loop wiring diagrams for all components, including field devices, control panels, workstation and server computers, and controllers. Diagrams shall depict wiring connections for all components specified herein, and all connections to existing equipment. Pin-out connections for cables shall be included.

B. System Testing Plan – Submit a testing plan indicating the sequence of the testing and demonstration of the system.

C. Test Reports - Indicate satisfactory completion of required tests and inspections.

D. Submittal Procedures

1. Submit shop drawings in accordance with Section 01300.

1.07 MAINTENANCE SERVICE

A. Furnish service and maintenance agreement of the complete Security Access Management System for a one year period starting from the Date of Substantial Completion of this project.

1.08 INSTALLATION CERTIFICATION

A. Upon completion of the Security System Integrator installation services, submit certification that the system installed meets the requirements of the manufacturer

and conforms to or exceeds specified requirements. Include reports of all tests conducted with certification.

## PART 2: PRODUCTS

### 2.01 GENERAL

A. All system components shall be UL listed and labeled.

B. Equipment located outside or in the process areas shall be rated NEMA 4X and UL listed for Wet Locations.

C. Provide all required software licensing and agreements as required to register the software packages in the Owner's name.

### 2.02 SECURITY ACCESS MANAGEMENT SYSTEM (SAMS)

A. The SAMS system shall be provided as an integrated facility security access system furnished, installed, and commissioned by the Security Systems Integrator. The foundation of the SAMS shall be based on an open software package which can incorporate the operations and functionality of several sub-systems including:

1. Gate Operator.
2. Intercom with Keypad.
3. Intercom with Remote Gate Access Control.
4. Future Card Reader Gate Access System. (System shall be compatible with card reader, but card readers will not be installed until later in the future.)

B. The SAMS system shall be operated and controlled at the SAMS computer workstation. The software package shall be Microsoft Windows based system, providing an operator interface to each sub-system through graphical displays.

C. The software shall be designed with a modular architecture to accommodate the sub-system configurations. Modules shall be provided to accommodate the building access system database, control and access to the CCTV digital surveillance system, and monitoring and recording of the plant alarms and fire alarms.

### 2.03 SAMS COMPUTER WORKSTATIONS

A. The following SAMS computer workstations shall be provided for the SAMS network:

1. Administration/Control Building Control Room – Security Workstation

B. Each PC workstation shall be provided with the following minimum hardware requirements:

| | | |
|---|---|---|
| 1. | Voltage: | 120 VAC, 1 Phase, 60 Hz. |
| 2. | Processor: | Intel Core i3-9100 |
| 3. | Primary Hard Drive: | 500GB SATA IDE, 3.5” inch (7200 RPM) |
| 4. | Memory: | 4GB 1x4GB DDR4 2666MHz non-ECC Memory |
| 5. | Graphics Card: | Intel Integrated Graphics |
| 6. | Modem: | Not Required |
| 7. | Network Adapter: | Integrated 3COM 10/100Mbps 3C905C network controller |
| 8. | Operating System: | Windows 10 Pro 64bit |
| 9. | Services: | 3-years On-Site, NBD Service after Remote Diagnosis |
| 10. | Speakers: | Internal Speaker |
| 11. | Keyboard: | Dell Multimedia English Keyboard - KB216 |
| 12. | Mouse: | Dell MS116 Wired Mouse |
| 13. | Manufacturer: | Dell |
| 14. | Model: | Precision 3630 Tower Workstation |

C. Monitor

| | | |
|---|---|---|
| 1. | General: | Flat Panel Monitor (LCD Screen) |
| 2. | Size: | 24” Monitor |
| 3. | Optimal Resolution: | 1920 x 1080 @60Hz |
| 4. | Pixel Pitch: | 0.275 x 0.275 mm |
| 5. | Response Time: | 8 ms (normal); 5 ms (fast) |
| 6. | Brightness: | 250 cd/$m^2$ |
| 7. | Contrast Ratio: | 1000:1 |
| 8. | Manufacturer: | Dell |
| 9. | Model: | P2419H |

## 2.04 PROXIMITY CARD READER STATIONS AND CONTROLLERS

A. Card reader stations shall be provided at access gates in the future so the security workstation and gate controller shall be compatible with future card readers.

## 2.05 SURVEILLANCE SYSTEM

A. Work under this Section shall be coordinated with the Surveillance System subcontractor providing equipment under Section 16792, Video Surveillance System.

## 2.06 INTERCOM

A. Provide an IP-based intercom with keypad at the gates and the operator’s console as indicated on the Contract Drawings.

B. Intercom units shall include speaker, microphone, dry contact control output for gate control, dry contact input for remote activation of gate, and push-to-talk

control. The intercom with keypad at the gates shall contain programmable keypad codes and shall allow for activation of gate. The intercom with keypad at the gates shall be mounted on a pedestal.

C. Include all software required for configuration on operation. Software shall be installed on the SAMS computer workstation.

D. Provide Intercom power supply in the nearest Communications/Gate panel. Power and signal cables between Communications/Gate Panels and the intercoms with keypads shall be provided by the Security Systems Integrator. Conduit shall be installed by the Contractor.

E. The intercom with keypad units shall be connected to a multi gate controller that shall connect to the SAMS computer workstation.

F. Manufacturers/Models:

1. The intercom with keypad shall be model 12-000I as manufactured by “Security Brands Inc.” or Equal.

2. The intercom with gate activation buttons shall be model LEM-3 as manufactured by “AIPhone” or Equal.

3. The multi gate controller shall be model ProAccess 200 as manufactured by “Security Brands Inc.” or Equal.

4. The pedestal for mounting the intercom with keypad shall be model 18-012 as manufactured by “Security Brands Inc.” or Equal.

2.07 GATE OPERATOR

A. Operation shall be by means of a metal rail passing between a pair of reinforced composite wheels with polyurethane treads. Operator motors shall be hydraulic, roller type, and system shall not include belts, gears, pulleys, roller chains or sprockets to transfer power from operator to gate panel. The operator shall generate a minimum horizontal pull of 300 lb. (136 kg) without the drive wheels slipping and without distortion of supporting arms. Operator shall be capable of handling gates weighing up to 4,000 lb. (1,814 kg). Gate panel velocity shall not be less than 1 ft/s (304 mm/s) and shall be stopped gradually to prevent shock loads to the gate and operator assembly. The “soft-stop” feature of the gate operator shall be controlled by two adjustable hydraulic brake valves (one for each direction).

B. Minimum standard mechanical components:

1. Supporting arms: Cast aluminum channel. Arms shall incorporate a fully bushed, 1 1/2" (38 mm) bronze bearing surface, acting on arm pivot pins. (item 2 below)

2. Arm pivot pins: 3/4" (19 mm) diameter, stainless steel, with integral tabs for ease of removal.

3. Tension spring: 2 1/2" (63 mm) heavy duty, 800 lb. (363 kg) capacity.

4. Tension adjustment: Finger tightened nut, not requiring the use of tools.

5. Drive release: Must instantly release tension on both drive wheels and disengage them from contact with drive rail in a single motion, for manual operation.
6. Limit switches: Fully adjustable, toggle types, with plug connection to control panel.
7. Chassis: 1/4" (6 mm) steel base plate, and 12 Ga. (3 mm) sides and back welded and ground smooth.
8. Cover: 16 Ga. (1 mm) zinc plated steel with textured TGIC polyester powder coat finish. All joints welded, filled, and ground smooth. Finished corners square and true with no visible joints.
9. Finish: Zinc plated steel with textured TGIC polyester powder coat finish, proven to withstand 1,000 hour salt spray test.
10. Drive wheels: Two 6" diam (152 mm) AdvanceDrive wheels. High-strength composite hub with polyurethane over mold.
11. Drive rail: Shall be extruded 6061 T6, not less than 1/8" (3 mm) thick. Drive rail shall incorporate alignment pins for ease of replacement or splicing. Pins shall enable a perfect butt splice.
12. Hydraulic hose: Shall be 1/4" (6 mm) synthetic, rated to 3,000 psi (20.6 MPa).
13. Hydraulic valves: Shall be individually replaceable cartridge type, in an integrated hydraulic manifold.
14. Hose fittings: At manifold shall be quick-disconnect type, others shall be swivel type.
15. Hydraulic fluid: High performance type with a viscosity index greater than 375 and temperature range -40° F to 158° F (-40° C to 70° C).
16. A zero to 2,000 psi (13.7 MPa) pressure gauge, mounted on the manifold for diagnostics, shall be a standard component.
17. The hydraulic fluid reservoir shall be formed from a single piece of metal, non-welded, and shall be powder painted on the inside and the outside, to prevent fluid contamination.

C. Minimum standard electrical components

1. Motor: 1 hp, 480 volt, 3 phase, 3450 RPM, 56C, TEFC.
2. All components shall have overload protection.
3. Electrical enclosure: Type 3R, metal, with hinged lid gasketed for protection from intrusion of foreign objects.
4. Controls: Smart Touch Controller Board containing:
    a. inherent entrapment sensor.
    b. built in audible “warn before operate” system.
    c. built in timer to close.

d. 32 character OLED display for reporting of functions and codes.

e. multiple programmable output relay options.

f. anti-tailgate mode.

g. built-in power surge/lightning strike protection.

h. menu configuration, event logging and system diagnostics easily accessible with a PC and HySecurity's free Smart Touch Analyze and Retrieve Tool.

i. RS-232 port for connection to laptop or other computer peripheral and RS-485 connection for network interface.

j. dual gate communication connection for bi-parting, sally port, or sequenced gates.

k. electromechanical and solid state relays.

l. radio option outputs.

m. 21 inputs for site specific configurations.

5. Transformer: 75 VA, non-jumpered taps, for all common voltages.

6. Control circuit: 24 VDC.

D. Required external sensors: Installer shall ensure that the automated gate system conforms to the latest revisions of UL 325 and ASTM F2200.

1. Provide two sets of through beam photo eyes to be install no further than 5 inches from the face of the gate and between 21 and 27.5 inches from grade. One set shall protect the open direction of gate travel and the other for the close direction.

2. Provide gate edge sensors to mitigate any entrapment zones inherent in the gate system.

E. Vehicle Loop Detection: Each gate system shall have the following loops.

1. Outside obstruction loop

2. Inside obstruction loop

3. Free exit loop

F. The Gate Operator shall be HySecurity gate operator model SlideDriver 40 (222 E ST) with Smart Touch Controller or Equal.

2.08 SURGE/LIGHTNING PROTECTION

A. Power line surge protectors shall be provided to protect equipment from transients on the AC power line. Surge Protectors shall meet the requirements of ANSI/IEEE C62.41. They shall be of the type required to protect equipment installed in an industrial environment.

B. Hardwired Type - Hardwired power line surge protectors shall be wired to the input terminals of the respective panel or equipment. Power line surge protectors shall be by Topaz, Best, Tycor, Control Concepts, or equal.

2.09 POWER SUPPLIES

A. The system furnished under this Contract shall operate on 120VAC, 1 phase power supply.

B. The Security Systems Integrator shall provide transformers, and dc power supplies as required to provide power to each component of the system.

C. Power Supplies and transformers shall be mounted in enclosures suitable for the location the equipment is installed in.

2.10 RACEWAY SYSTEMS

A. Refer to Section 16110.

B. Liquid-tite Flexible Metallic Conduit

1. Conduit shall consist of a galvanized steel case with extruded polyvinyl chloride jacket and accessories. Use for Final connections to equipment.

2. Conduit shall be manufactured by Anaconda or equal. C. Conduit Supports

3. Conduit supports shall be type 316 stainless steel channel with stainless steel fasteners and fittings, clamps, saddles, and accessories.

4. Supports shall be manufactured by Unistrut, Cooper B-Line, or equal.

C. Junction Boxes

1. Junction boxes shall be NEMA 4X stainless steel with hinged cover and screw clamps.

2. Junction boxes shall be manufactured by Hoffman or equal.

2.11 CABLES & CONDUCTORS

A. General

1. Cables and conductors shall be rated for cable tray use where used in cable trays or cable troughs.

2. Cables and conductor shall be plenum rated where used in open plenums.

B. Power Conductors

1. Power conductors shall be stranded copper, single conductor insulated wire rated for 600 Volts. Insulation shall be type THHN/THWN. Power conductors shall be size in accordance with the requirements of the National Electric Code and shall be No. 12AWG minimum.

C. Network Cables

1. Category 5e cable and patch cords shall consist of four (4) unshielded twisted pair of 24 AWG solid bare copper conductors and shall be FEP Teflon insulated. The conductor shall be color coded and the cable plenum jacketed.

2. Cable shall be able to accommodate data transmission speed of up to 100 Mbps fast Ethernet.

3. Cable shall be as manufactured by Belden or equal.

2.12 SPARE PARTS

A. The following spare parts shall be furnished as part of this Contract:

| | Qty. | Description |
|---|---|---|
| 1. | (1) | Intercom |
| 2. | (1) | Gate Controller |

B. Spare parts shall be provided in the equipment's original container, including instruction manuals.

2.13 MISCELLANEOUS

A. Equipment Hangers and Supports

1. All hangers and supports, fasteners, and hardware shall be 316 stainless steel.

B. Nameplates/Equipment Tags

1. Nameplates shall be three layer laminated plastic with ½" high white engraved characters on a black background and punched for mechanical fastening. Fasteners shall be stainless steel.

2. Nameplates shall be provided for all equipment and components to clearly identify the tag/equipment number, name, and description.

C. Grounding

1. Enclosures shall be provided with two grounding lugs located on opposite sides of the enclosure for connection to external grounding system.

2. Provide a ground bus in each cabinet or panel for the shield and signal grounding circuits.

3. Swing-out panels shall be grounded and provided with flexible grounding braids that allow the swing-out panels to be opened.

PART 3: EXECUTION

3.01 COORDINATION MEETINGS

A. The Security Systems Integrator shall be responsible for scheduling and holding an initial coordination meeting with the Contractor, Owner and Engineer to review the scope of the project and project schedule. The meeting shall be attended by the Security Systems Integrator's project manager, sub-contractors and any other parties that are involved with the integration of the SAMS.

B. The Security Systems Integrator shall meet with the Owner's IT group to establish LAN requirements and to coordinate the schedule for connecting to the LAN.

C. The Security Systems Integrator shall meet with the Owner's Security and Safety personnel to establish project specific programming requirements which the Security System Integrator shall program into the SAMS system.

3.02 INSTALLATION

A. The Security Systems Integrator is responsible to provide a complete system for the video and security access system. The riser diagram on the drawings provides general information on the system installation and wiring requirements. The SSI shall incorporate all requirements into the system to allow complete functionality.

B. Equipment shall be installed in accordance with the manufacturer's instructions and as required for operation.

C. Conduit and wiring connections shall be performed in a neat and workman like manner. Power and control cables shall be routed in conduit. Final connections to equipment shall be made with liquid-tight flexible metallic conduit. Power supply connections shall be made to panelboards for 120VAC, 1 phase power. All power supplies or transformers required for the equipment operation shall be provided and installed by the SSI.

D. Panels shall be grounded, and all equipment and circuits included in the panels, as shown, or required to be grounded, shall be connected to the grounding conductors.

E. The final equipment and component locations shall be coordinated by the Security Systems Integrator to avoid interference with standard operation and maintenance practices of adjacent equipment.

F. Wall mounted panels butting to masonry walls shall be provided with closure strips to seal the opening between the panel and the masonry.

G. Devices mounted on or within the enclosures shall be permanently identified. The device and terminal identifications shall agree with those shown on the Contract Drawings.

H. Install power line surge protectors on the incoming power of all equipment susceptible to damage in an industrial or commercial environment due to line surges, lightning, transients, or other line disturbances.

I. All panels containing electronic, microprocessor based, or other line powered equipment susceptible to damage be shall be provided with adequate line surge and transient protection.

J. Pedestal mounted Intercom with Keypad, Intercom with Remote Gate Access Control, Intercoms Vehicle Access Gate Operators shall be installed in the final locations to be coordinated with the Owner.

3.03 MANUFACTURER'S FIELD SERVICES

A. The SSI shall furnish installation technicians to supervise install, adjustment, perform final connections, and system testing.

B. Computer Workstations

1. The Security Systems Integrator shall install all computer hardware components and related cabling. Cabling shall be routed through plastic wire ducts underneath desk- top areas to provide a neat installation. Cables shall be labeled and identified.

C. Network Testing

1. The SSI shall perform network testing of the system communications to determine the quality and integrity of the cabling.

D. Programming and Configuration

1. The Security Systems Integrator shall configure and set up all required administrative and program parameters such that the system is fully operational.

2. The Security Systems Integrator shall configure graphic display screens to be set up groupings and arrangements which meet the Owner's operational preferences.

3.04 FIELD QUALITY CONTROL

A. General

1. The SAMS shall be tested for proper operation and operational sequencing. Proper operation of equipment shall be demonstrated to the Owner/Engineer. Testing and demonstration shall be performed by a qualified service representative of the Security Systems Integrator.

B. Sequencing

1. The Security Systems Integrator shall notify the Owner in writing a minimum of (3) calendar days prior to beginning a particular test.

2. The Security Systems Integrator shall provide all equipment, labor, and materials required to conduct testing.

3.05 OPERATOR TRAINING

A. General

1. The training shall be provided in two 1-day programs. One program shall be at the Operator Level, the other shall be at the Technician Level. Each program shall be provided for a minimum of (5) of the Owner's personnel.

2. Training shall commence on a date agreeable to the Owner, Engineer, and Contractor.

3. Training sessions shall be performed on-site at the Owner's facility. The education and instruction of operating personnel shall be performed be a qualified instructor familiar with the requirements of the control system. A manufacturer's representative or salesperson will not be accepted.

4. Training schedules shall be independent of system testing, startup, and demonstration, unless prior approval is obtained by the Owner.

B. Operator Level Training

1. Training shall be provided for all aspects of the security access system for normal and alarm conditions.

2. Operators shall be informed on all available features, of the graphics interface including walking through actual sequences and control functions. The training program shall be coordinated with the Owner.

C. Technician Level Training

1. Training shall cover the overall system theory, hardware architecture, programming instruction, system generation, system configuration and diagnostics. The programming instruction shall include program development, coding, sample programs, configuration, and debugging at the programming level.

2. Emphasis shall be placed on safety features, maintenance, and features which may require re-adjustment, resetting, or checking and re-calibration.

END OF SECTION

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# SECTION 16792

# VIDEO SURVEILLANCE SYSTEM

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section includes the requirements for the Video Surveillance System.

### 1.02 SECURITY SYSTEMS INTEGRATOR

A. The Video Surveillance System Integrator shall be regularly engaged in the business of security systems. Components shall be provided by companies specializing in manufacturing the Products specified in this Section with minimum of (5) five years documented experience. The Security Systems Integrator shall have maintenance facilities and service personnel within 100 miles of the Project Site.

B. The Video Surveillance System Integrator shall provide all materials, products, services as required to obtain an operable system. The Video Surveillance System Integrator shall have total responsibility for the system performance and conformance to assure proper interfacing and reliable operation of all components of the system. The Video Surveillance System Integrator shall be totally and solely responsible for the quality and proper functioning of all supplied components.

C. The Video Surveillance System Integrator shall be capable of providing on-site maintenance services within 24 hours following a maintenance request, and emergency service within eight hours following an emergency service request. Normal and emergency maintenance service shall be made available 24 hours every day on a call request basis for the one-year warranty period.

D. The Video Surveillance System Integrator shall assume full responsibility for ensuring the proper testing functionality of the system and shall provide all coordination as required to provide a complete functioning system.

E. The Video Surveillance System Integrator shall provide training services as specified herein.

### 1.03 REFERENCES

| | |
|---|---|
| NFPA 70 | National Electrical Code |
| NFPA 72G | Notification Appliances for Protective Signaling Systems |
| NFPA 72H | Guide for Test Procedures for Protective Signaling Systems |
| NFPA 72-1993 | National Fire Alarm Code |

### 1.04 SYSTEM DESCRIPTION

A. The Video Surveillance System Integrator shall provide a complete video surveillance system as summarized in Part 2.

### 1.05 DESIGN REQUIREMENTS

A. Camera locations shall be tailored to maximize the effective viewing area of the video system.

B. The Video Surveillance System Integrator shall conduct a site survey of the proposed facility to locate the proposed equipment locations. The Video Surveillance System Integrator shall include all materials and accessories required to furnish, install, test and startup the systems for the proposed locations. The locations are as shown on the Contract Drawings.

C. The Video Surveillance System Integrator shall develop a project delivery plan which outlines a timeline and task description for how the project will be implemented, including equipment procurement, installation, programming, testing, demonstration, and training components.

D. The Video Surveillance System Integrator shall design and submit all camera mounting systems. Vendor provided standard mounts shall be used wherever practical. Mounts shall be suitable for the desired viewing angle of each installed camera.

1.06 SUBMITTALS

A. Shop Drawings shall include the following information:

1. Shop drawings submittals shall include:

a. Site Coverage Map.

b. Material List.

c. System Block Diagram.

B. System Testing Plan – Submit a testing plan indicating the sequence of the testing and demonstration of the system.

C. Submittal Procedures

1. Submit shop drawings in accordance with Section 01300.

1.07 MAINTENANCE SERVICE

A. Furnish service and maintenance agreement of the complete Video Surveillance System for a period of 18 months following acceptance.

1.08 INSTALLATION CERTIFICATION

A. Upon completion of the Video Surveillance System Integrator installation services, submit certification that the system installed meets the requirements of the manufacturer and conforms to or exceeds specified requirements. Include reports of all tests conducted with certification.

1.09 SCHEDULING

A. The Contractor and Video Surveillance System Integrator shall coordinate work to provide efficient installation and testing of the security system.

1.10 EQUIPMENT WARRANTIES AND SPECIAL GUARANTEES

A. The supplier shall provide the following additional warranties and special guarantees in addition to those specified in Division 1.

1. The equipment manufacturer shall guarantee for a period of three years starting at the time of equipment delivery to the job site or one year starting at the time of Substantial Completion (whichever is shorter), that the equipment supplied is free from defects in materials or workmanship and will meet the specified performance requirements when operated in accordance with the manufacturer's recommendations. The manufacturer shall correct any breach in this warranty at their expense.

## PART 2: PRODUCTS

### 2.01 GENERAL

A. All system components shall be UL listed and labeled.

B. Equipment located outside or in the process areas shall be rated IP67 and UL listed for Wet Locations.

C. Provide all required software licensing and agreements as required to register the software packages in the Owner's name.

### 2.02 VIDEO COMPUTER WORKSTATIONS

A. The following surveillance computer workstations shall be provided for the SAMS network:

1. Administration/Control Building Control Room - Security Workstation provided under the scope of Section 16720, Security Access Management System.

B. Surveillance Server:

1. Provided for collection and retrieval of stored video data.

2. Surveillance Server shall be provided with a UPS power supply.

C. Monitor

| | | |
|---|---|---|
| 1. | General: | LED FHD FreeSync Monitor |
| 2. | Size: | 24" Monitor |
| 3. | Optimal Resolution: | 1920 x 1080 @75Hz. |
| 4. | Viewing Angle: | |
| | Horizontal: | +/- 170 degrees |
| | Vertical: | +/- 160 degrees |
| 5. | Response Time: | 1 ms |
| 6. | Brightness: | 250 candela per square meter |
| 7. | Contrast Ratio: | 100,000,000:1 |
| 8. | Manufacturer: | ASUS or Equal |
| 8. | Model: | VG245H or Equal |

### 2.03 SURVEILLENCE SYSTEM

A. Summary:

1. Cameras as required to cover the areas of the plant site.

2. Cameras shall be high resolution, low light, color cameras for monitoring specific points around the facility. Cameras shall be suitable for installation in Wet and Corrosive Locations.

3. Cameras shall meet the following specifications:

   a. Pan-Tilt-Zoom capabilities as indicated on the Contract Drawings.

   b. Image Sensor: 1/2.8-inch Sony Progressive CMOS.

   c. Total Pixels: 1920 (H) × 1080 (V).

   d. Optical Zoom: 30x.

   e. Focal Length: 4.5–135 mm.

   f. Focus Mode: Auto/PTZ Trigger/Zoom Trigger/Manual.

   g. Exposure Mode: Iris Priority/Shutter Priority/Gain Priority/Manual.

   h. Minimum Illumination:

      1) 0.0187 lux color, 0.012 lux B/W @ F1.6, 30 IRE, shutter speed 1/30.

      2) 0.0574 lux color, 0.0348 lux B/W @ F1.6, 50 IRE, shutter speed 1/30.

      3) 0.005 lux color, 0.0005 lux B/W @ F1.6, long exposure.

   i. Shutter Speed: 1/1–1/30,000 seconds.

   j. Dual Audio Communication: G.711a/G.711Mu/AAC/G.722/G.726/ MPEG2-L2.

   k. Communication: ONVIF Profile S/G support

   l. White Balance: Auto Tracking White Balance (ATW), Auto White Control (Auto), Indoor, Outdoor, Manual.

   m. Signal-to-Noise Ratio: ≥50 dB (AGC off).

   n. Backlight Compensation: BLC/HLC/WDR.

   o. Cameras shall be model HDZ302DE as manufactured by Honeywell or Equal.

4. Power Supplies.

   a. Provide power supplies as required to operate the cameras from a 120 VAC source.

   b. Weather-proof connection.

5. Network Video Recorder/Surveillance Server:

   a. Minimum: 12 TB storage Capacity.

   b. Multi-level user access rights for viewing and managed access to the recorder functions.

   c. Network Video Recorder shall be model MAXPRO NVR XE as manufactured by Honeywell or Equal.

6. Video Network Management Software

   a. Provide all required software for configuring the video system. Functions shall include management of system users and access, and health monitoring of the individual units.

7. All software shall be licensed to the Owner.

B. Closed Circuit Television (CCTV)

1. Refer to the Electrical Site Plan for the proposed camera locations for areas around the facility. The Video Surveillance System Integrator shall adjust the final camera locations to optimize the systems performance. Site investigations shall also include establishing the final camera mounting position and mounting height to provide the most effective viewing angle to provide surveillance of the plant access gate, property area, fence lines, access roads, and process areas.

2. Cameras shall be either hardwired, unless otherwise indicated. The Security System Integrator shall provide the hardwired technology equipment as required to provide a complete and functioning system.

C. Security Camera Locations

1. High Definition PTZ Dome cameras shall be provided at the locations shown on the Contract Drawings.

D. Video Management System

1. The Surveillance Server shall act as a digital recorder and video multiplexer integrated into one video control assembly.

2. The system shall accommodate up to 8 cameras. The unit shall include power supplies, input modules, surge protective devices for a complete system.

3. VMS software shall be provided for each of the SAMS computer workstations specified herein.

4. The system shall allow access to live video as well as recorded video clips.

5. The VMS shall be compatible with the Security Access Management System software package provided for the system.

E. Camera Poles

1. The Contractor shall provide mounting poles if required. Majority of cameras will be installed on light poles as indicated on the Drawings.

2.04 SURGE/LIGHTNING PROTECTION

A. Power line surge protectors shall be provided to protect equipment from transients on the AC power line.

2.05 POWER SUPPLIES

A. Equipment furnished under this Contract shall operate on 120VAC, 1 phase power supplies. The Security Systems Integrator shall provide transformers, and dc power supplies as required to provide power to each component of the system.

B. Power Supplies and transformers shall be mounted in enclosures suitable for the location the equipment is installed in.

2.06 ELECTRICAL WORK

A. The Video Surveillance System Integrator shall mount and install all components of the Video surveillance system.

B. The Video Surveillance System Integrator shall make final connection to the power for all video system devices. Contractor shall provide a lighting/power circuit to within 20 feet of the final camera location.

C. The Video Surveillance System Integrator shall provide network wiring between the Security Control Panels, Gate Control Panel, or the Surveillance Server and the Video System switches and cameras.

D. The main fiber ring interconnecting the plant structures shall be provided by the Contractor as shown on the riser diagram on the drawings. Fiber optic cable shall be provided under this section for the video and security access system.

E. All cabling needed to install the Surveillance Server, monitor, network devices and other host system devices shall be provided by the Video Surveillance System Integrator.

2.07 SPARE PARTS

A. Video Surveillance System Integrator shall provide support for the Video Surveillance System as described in Paragraph 1.09 Maintenance Service. Maintenance Service shall include the replacement parts as required.

B. Provide 1 each type of camera, 2 each power type of power supply, and 2 each type of surge protection, as additional spare parts.

2.08 MISCELLANEOUS

A. Equipment Hangers and Supports

1. All hangers and supports, fasteners, and hardware shall be 316 stainless steel.

B. Nameplates/Equipment Tags

1. Nameplates shall be three layer laminated plastic with ½" high white engraved characters on a black background and punched for mechanical fastening. Fasteners shall be stainless steel.

2. Nameplates shall be provided for all equipment and components to clearly identify the tag/equipment number, name, and description.

C. Grounding

1. Enclosures shall be provided with two grounding lugs located on opposite sides of the enclosure for connection to external grounding system.

2. Provide a ground bus in each cabinet or panel for the shield and signal grounding circuits.

3. Swing-out panels shall be grounded and provided with flexible grounding braids that allow the swing-out panels to be opened.

PART 3: EXECUTION

3.01 INSTALLATION

A. Equipment shall be installed in accordance with the manufacturer's instructions.

B. Conduit and wiring connections shall be performed in a neat and workman like manner. Power and control cables shall be routed in conduit. Final connections to equipment shall be made with liquid-tight flexible metallic conduit. Power supply connections shall be made to lighting and/or instrumentation panelboards (120VAC, 1 phase).

C. Panels shall be grounded, and all equipment and circuits included in the panels, as shown, or required to be grounded, shall be connected to the grounding conductors.

D. Devices mounted on or within the enclosures shall be permanently identified. The device and terminal identifications shall agree with those shown on the Contract Drawings.

E. Install power line surge protectors on the incoming power of all equipment susceptible to damage in an industrial or commercial environment due to line surges, lightning, transients, or other line disturbances.

F. All panels containing electronic, microprocessor based, or other line powered equipment susceptible to damage be shall be provided with adequate line surge and transient protection.

3.02 MANUFACTURER'S FIELD SERVICES

A. The Video Surveillance System Integrator shall furnish installation technicians to supervise install, adjustment, perform final connections, and system testing.

B. Programming and Configuration

1. The Video Surveillance System Integrator shall configure and set up all required administrative and program parameters such that the system is fully operational. This shall include security access databases and reporting, CCTV matrix switchers, PTZ camera features.

2. The Video Surveillance System Integrator shall configure graphic display screens to be set up groupings and arrangements which meet the Owner's operational preferences.

3. The Video Surveillance System Integrator shall assist the Owner's IT group with performing configuration of the system to work on the Owners LAN in order to accommodate the new network addresses and traffic flow.

3.03 FIELD QUALITY CONTROL

A. General

1. The Video Surveillance System shall be tested for proper operation and operational sequencing. Proper operation of equipment shall be demonstrated to the Owner/Engineer. Testing and demonstration shall be performed by a qualified service representative of the Video Surveillance System Integrator.

B. Sequencing

1. The Security Systems Integrator shall notify the Owner in writing a minimum of (3) calendar days prior to beginning a particular test.

2. The Security Systems Integrator shall provide all equipment, labor, and materials required to conduct testing.

3.04 OPERATOR TRAINING

A. General

1. Provide Operator training, as required, to demonstrate the normal functions of the Video Systems.

2. Vendor recommended training time is 4 hours.

END OF SECTION

# SECTION 16855

# HEAT TRACING OF PROCESS PIPING

## PART 1: GENERAL

### 1.01 DESCRIPTION

A. This section includes requirements for materials and installation of thermostat controlled heat tracing for freeze protection of insulated process piping.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical Requirements: 16010

B. Piping Insulation: 15250

### 1.03 SUBMITTALS

A. Submit manufacturer's catalog data, descriptive literature, and installation instructions for heat tracers, heat tracer power connections, splicing and tee kits, thermostat controls, and signal lights to be installed on PVC, CPVC, steel, and ductile-iron pipe, fittings, and valves.

B. Submit specific heat loss calculations for each insulated pipe. Calculations will include pipe sizes, materials, and valve types to document the thermal rating (in watts/lineal foot of pipe) required to maintain the pipe temperature as specified.

C. Submit installation test report.

## PART 2: PRODUCTS

### 2.01 GENERAL

A. The heat tracers, power connections, thermostat controls, splicing kits, tee kits, and signal lights shall be supplied by a single manufacturer.

### 2.02 HEAT TRACER

A. The heat tracer shall be Chemelex Auto Trace, Dekoron 2500 series, or equal.

B. Each heat tracer shall be capable of maintaining the temperature of the insulated pipe, pipefitting, or valve upon which it has been mounted at or above 50°F with an ambient temperature of 0°F.

C. The heat tracers shall utilize a service voltage of 120 volt a-c and a circuit breaker size of 20 amperes. Utilize multiple circuits if the length of heat trace exceeds the manufacturer's recommended maximum loading for a 20 ampere circuit breaker.

D. Each heat tracer shall consist of parallel copper conductors embedded in a semiconductive heating element. The heating element shall be a continuous strip extending between the copper conductors to provide a heating circuit along the entire length of the heat tracer. The heating element shall be covered by an inner insulating jacket. A tinned copper shield shall surround the inner coating and shall in turn be covered by an outer, corrosion resistant fluoro-polymer coating.

E. The heating element in each heat tracer shall automatically decrease its power output as its temperature increases and thereby prevent tracer burnout. Do not use constant wattage heat tracers. The heating element's self-contained temperature regulating capability shall occur independently at each point along the heating circuit.

F. The heat tracer shall be capable of being field cut to any length without impacting its heat output per lineal foot.

G. The heat tracer shall not attain a temperature sufficient to damage the pipe, pipefitting, or valve material upon which it is mounted.

2.03 ALUMINUM TAPE

A. Aluminum tape overheat tracers installed on plastic pipe shall be Chemelex AT-180, Dekoron 1528-0A018, or equal.

2.04 POWER CONNECTION

A. The power connection for each heat tracer shall be Chemelex Series PMK-JLP, Dekoron 1548-40000, or equal.

2.05 SPLICES

A. Use Chemelex Series PMK-LS splice connection kit, Dekoron 1548-40000, or equal.

2.06 TEES

A. Use Chemelex Series PMK-LT tee connection kit, Dekoron 1548-40000, or equal.

2.07 THERMOSTAT CONTROLS

A. Heating circuits shall be operated by thermostat controls.

B. Ambient temperature sensing thermostats shall be Chemelex Model AMC-1A, Dekoron 1660-15909, or equal.

C. Provide a 40 ampere contactor in a NEMA 4X enclosure for multiple 20 ampere circuits, Chemelex E304, or equal.

D. Line sensing thermostats with the temperature sensing bulb mounted on the pipe surface shall be Chemelex Model AMC-1B, Dekoron 1660-13809, or equal.

2.08 SIGNAL LIGHT

A. Connect a signal light to the end of each heating circuit to indicate whether the heat tracer is on or off.

B. The signal light shall be Chemelex Model PMK-SL with PMK-LP connection kit, Dekoron 1556-41003, or equal.

2.09 WARNING SIGNS

A. Locate "Electric Traced" signs on the outer surface of the piping insulation at 10 foot intervals (each side of pipe) to indicate the presence of electric tracing.

2.10 HAZARDOUS AREAS

A. Heat trace equipment installed in hazardous and classified areas shall be suitable and rated for installation in such areas.

PART 3: EXCUTION

3.01 INSTALLATION

A. Install heat tracing free of nicks and cuts to its outer jacket.

B. Mount heat tracing parallel to pipe flow. Do not spiral heat tracing strips around the pipe.

C. Secure heat tracers to pipe at 1 foot intervals with a glass cloth tape with silicon pressure sensitive adhesive. Secure heat tracers to plastic pipe with aluminum tape.

D. Provide and install heat tracing for all piping identified on drawings and as indicated in Section 15250 insulation.

E. General facility information is provided on the electrical drawings. Refer to mechanical drawings and specifications for locations, lengths of pipes, size of pipe, and requirements.

F. Install heat tracing below grade approximately 24 inches for piping going underground.

3.02 TESTING

A. Prior to insulation, operate heat tracing and verify operation by temperature measurement at 5 foot intervals along the length of the pipe being heat traced. Replace all faulty heat trace, repair is not acceptable.

B. After installation of insulation, retest heat trace as indicated above.

END OF SECTION

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# SECTION 16890

# ELECTRICAL FIELD ACCEPTANCE TESTS

## PART 1: GENERAL

### 1.01 DESCRIPTION

A. Acceptance tests shall be performed for all electrical equipment furnished under this contract. The test requirements for equipment shall be as required by applicable standards and manufacturer's recommendations, and in accordance with this specification. In no case will the absence of test requirements herein be construed as alleviation of acceptance testing.

B. The purpose of electrical field acceptance tests is to assure that all electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with the Contract Documents and approved Shop and Working Drawings.

C. Tests are in addition to factory tests at the Manufacturer's facility and may not substitute for same.

D. Tests are in addition to all other tests specified under other Specification Sections and shall be coordinated by the Contractor.

E. Tests in general shall be conducted after the equipment installation is complete.

F. Tests are also intended to provide, ensure, or determine the following:

1. Provide initial acceptance tests and recorded data that can be used as a benchmark for future routine maintenance and troubleshooting by plant personnel.

2. Ensure a successful start-up with a minimum of last minute interruptions and problems.

3. Determine the suitability of the equipment and systems for energization and placing into operation

4. Provide assurance that each system component is not only installed satisfactorily but performs, and will continue to perform, its function in the system with reasonable reliability throughout the life of the equipment.

### 1.02 RELATED SECTIONS

A. Division 1: General

B. Division 16: Electrical.

### 1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and City of Canton laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. All inspections and tests shall be in accordance with the latest edition of the following codes, standards, and specifications except as provided otherwise herein.
    a. American National Standards Institute - ANSI
    b. American Society for Testing and Materials - ASTM
    c. Association of Edison Illuminating Companies - AEIC
    d. Canadian Standards Association - CSA
    e. Institute of Electrical and Electronic Engineers - IEEE
    f. Insulated Cable Engineers Association - ICEA
    g. International Electrical Testing Association - NETA
    h. National Electrical Manufacturer's Association - NEMA
    i. National Fire Protection Association - NFPA
    j. Occupational Safety and Health Administration - OSHA
    k. State and local codes and ordinances
    l. Underwriters Laboratory
    m. All General and Supplementary Conditions of this Contract.
2. All inspections and tests shall utilize the following references:
    a. Contract Documents.
    b. Short Circuit and Coordination Study.
    c. Service Manuals applicable to each particular apparatus.

1.04 SUBMITTALS

A. General: Submittals shall be accordance with Section 01300 – Submittals, and Section 16010 – Electrical-General. Submit all testing procedures for approval prior to any testing.

B. Shop Drawings: Submit in accordance with Section 01300 – Submittals, and Section 16010 – Electrical-General.

C. Test Reports:

1. Contractor shall submit detailed test procedure including test equipment for all field acceptance testing.
2. Contractor shall submit all interim test reports and a copy of field test sheets. Once all discrepancies have been resolved, contractor shall submit a single final test report.
3. Each test report shall include as a minimum the following:
    a. Listing of equipment tested including the list of test equipment used.
    b. Test method and standards governing the test.
    c. Test results.
    d. Recommendations.

4. Test results shall incorporate inspection reports, instrument calibration curves, plotted test results, and all measurements and data.

5. All inspections, tests, and calibrations to be reported in writing for approval by the Engineer. The recorded data form shall have the signatures of the persons conducting the tests and authorized witnesses. The forms shall be designed to serve as the test and inspection checklist for inspection requirements. The test and checkout data shall also include any data taken prior to the adjustments, repairs, drying out, or similar work prior to final testing and acceptance. "As-found" and "as-left" test data shall be recorded and reported in writing.

6. Copies of Test Reports shall be incorporated in each of the related Service Manuals. The Test Reports shall include those items of equipment contained in the O&M manual. Reports shall be separated by a divider labeled "Electrical Field Acceptance Tests". Reports shall contain data for all power conductors and controls including instrumentation conductors and devices for static and dynamic equipment in the Service Manual. In addition, Operating Tests of the equipment shall be included in this section of the Service Manual.

1.05 QUALIFICATIONS

A. All acceptance testing activities described herein must be performed by a testing company that is a fully accredited NETA member. The testing company shall submit qualifications and certification of NETA membership for approval.

PART 2: PRODUCTS

2.01 EQUIPMENT

A. Provide all necessary test equipment and tools as specified herein and as recommended by the tested equipment manufacturer.

B. All test equipment shall be in good mechanical and electrical conditions and shall be calibrated per NETA ATS schedule requirements. Records, which show date and results of instrument calibration or testing, must be kept up-to-date and provided with the test report upon request.

C. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

D. Calibrating standard shall be of higher accuracy than that of the instrument tested.

E. Test equipment shall include but not limited to and shall have operating accuracy equal to, or better than listed below:

1. Portable multimeters shall be true RMS measuring.

2. Multimeters shall have the following accuracy limits, or better (for 60 Hz where applicable):

a. AC voltage ranges: 0.75%±3 last single digits

b. AC current ranges: 0.90%±3 last single digits, including adapters, transducers

c. DC voltage ranges: 0.25%±1 last single digit

d. Resistance ranges: 0.50%±1 last single digit

e. Frequency range: 0.10%±1 last single digit.

f. Clamp-on ammeters: AC current ±3% of range ±1 last single digit.

g. Dissipation/power factor field equipment:

h. ±0.1% power factor values up to 2.0%

i. 5% of the reading for power factor values above 2.

3. Low-range DC resistance equipment: 1.0% of reading, ±2 last single digits.

4. Transformers turns-ratio test equipment: 0.5% or better.

5. Ground electrode test equipment: ±2.0% of range.

6. Insulation (Megger) test sets: 0 - 1000 V DC ±20% of reading at mid-scale for equipment 600 volts and less and 0 - 2500 volts DC ±20% of reading at mid-scale for equipment over 600 volt.

7. Electrical load survey equipment:

   a. ±5% total error, including sensors

   b. 1% resolution

   c. Current transformers ±2% of range

   d. Voltage transformers ±0.5% of range.

8. Liquid dielectric strength test equipment: ±2% of scale.

9. Infrared scanning equipment: sensitivity of 2 C.

10. Phase shifting equipment: ±1.0 over entire range.

11. High-current test equipment: ±2% of range.

12. DC high potential test equipment: ±2% of scale.

13. AC high potential test equipment: ±2% of scale.

14. Multi-amp SR-90, or equal, relay test set.

## PART 3: EXECUTION

### 3.01 TEST COORDINATION AND RESPONSIBILITIES

A. The Contractor shall engage the services of the independent testing firm. The testing firm shall be full NETA member, and proof of the qualifications for the lead, on-site technical person when requested.

B. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

C. All cost associated with the testing shall be the responsibility of the Contractor, including the expenses of retest because of defects and/or failure of equipment to

meet Specifications. Wiring and equipment which is defective, or which fails to meet Specifications, shall be replaced by the Contractor, unless specific approval for repair is given by the Engineer prior to repair. The Contractor shall bear the costs for either action.

D. Contractor shall open circuits, place, and connect all instruments and equipment needed for the tests, remove same and restore circuits when tests are complete.

E. Coordinate activities, and cooperate with others on project, to ensure that systems are energized when required, loads applied, and requirements of other Specification Sections are carried out on timely, coordinated basis.

F. Other Specification Sections may require services of one or more manufacturer's representatives, to ensure that equipment supplied has been installed properly and adjusted to proper working order. Advise representative of all applicable tests in this Section, so that work will be coordinated, and tests combined where feasible.

G. Contractor shall notify the Engineer, in writing, at least seven calendar days before the tests are to take place. The tests shall be conducted in the presence of the Engineer and shall not be started without prior approval.

H. All tests shall be performed as closely as possible to conditions of actual use.

I. All testing and checkout work shall be performed with fully qualified personnel skilled in the particular tests being conducted. This is essential for obtaining and properly evaluating data while the tests are in progress and for ensuring that important facts and questionable data are reported.

J. It is important that equipment warranties or guarantees not be voided by the Contractor's testing and checkout work. The tests will normally be supplemental to and compatible with the manufacturer's installation instructions and recommendations. Where deviations are apparent, the manufacturer's review and approval shall be obtained prior to testing. Reasonable cooperation is to be extended to permit witnessing by the manufacturer's representative if so requested. Where any questionable repairs, modifications, significant adjustments, tests, or checks are to be made, the Contractor shall contact the Engineer to determine if the work should be performed by or with the manufacturer's representative.

K. The Contractor shall ensure that all testing and checkout work is conducted in a safe manner. Special safety pre-cautions such as the following are to be utilized where appropriate:

1. Occupational Safety and Health Act (OSHA).
2. Accident Prevention Manual for Industrial Operations, National Safety Council.
3. Applicable state and local safety operating procedures.
4. City safety procedures.
5. National Fire Protection Association (NFPA 70E).
6. American National Standards for Personnel Protection.
7. Locking procedures.

8. Barricades.

9. Maintenance of voice communications.

10. Erection of warning signs.

11. Stationing of guards and watchmen.

12. De-energization and/or isolation of equipment prior to testing. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.

L. The sequence of all tests and checks shall be such that the equipment can be energized immediately after the completion of the applicable tests.

3.02 PREPARATION

A. All tests shall be performed with regard to protecting solid state devices and electronic components from potential damage. Where applicable, disconnect solid state devices and electronic components prior to applying testing voltage.

B. Make up no connections at service entrance, transformers, substations, motors, motor control centers, and switchgear permanently until correct phase rotation of all equipment is determined and electrical tests have been completed. Install and insulate these connections temporarily, if necessary. Make permanent connections after proper rotation has been established and subsequent to completion of insulation resistance and dielectric tests.

3.03 APPLICATION

A. Wire and Cable Insulation Resistance Tests:

1. Low voltage, 600 V maximum:

a. Inspect wire and cables for physical damage and proper connection in accordance with approved Shop and Working Drawings.

b. Check color-coding with Specifications and NEC standards.

c. Perform continuity test to insure proper connection.

d. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts DC for one minute.

e. Evaluate test results by comparison with wires and cables of the same length and type. Investigate any values less than 50 megohms.

f. Complete Exhibit “A,” attached, for each conductor system, except not required for receptacle or internal lighting circuits.

B. Grounding Systems:

1. Verify that grounding system is in accordance with Contract Documents and applicable codes.

2. The grounding system shall be tested for continuity of connection and for resistance to flow of current through ground connections:

a. The resistance between the main grounding electrode and ground shall be no greater than five ohms for 600 V systems. For electrical substation grounds, the ground resistance shall be no greater than one ohm. All ground tests to be performed a minimum of 10 days after installation.

b. The ground resistance of conduits, equipment cases, and supporting frames shall be only fractionally higher than system ground.

c. Method of measurement of ground resistance shall be as specified by NETA- ATS and be approved by City before the start of tests.

d. Submit a record/report to the Engineer. Include the following:

3. Time, date, temperature, frost information depth (if applicable), and weather conditions.

4. Location of ground grid under test.

5. Date of ground grid installation.

6. Driven depth of electrodes.

7. Moisture content of earth at time of measurement (wet, dry, etc.).

8. Ground test equipment, model numbers, and last date of calibration.

9. Detailed description of method used.

10. Plot of "distance from ground grid versus resistance." Distance of farthest probe is 100 feet, with the movable probe recording at 10-foot increments moving from farthest probe back to ground rod under test. Test each outside ground rod. Resistances shall range from 0 to 50 ohms with enough points to produce a smooth curve.

11. Maintenance information and recommendations (if applicable).

12. Switchgear Assemblies:

a. Inspect for physical, electrical, and mechanical condition.

b. Compare equipment nameplate information with latest one-line diagram.

c. Check for proper anchorage, required area clearances, physical damage, and proper alignment.

d. Inspect all bus connections for high resistance as recommended in NETA-ATS standard. Compare bus connection resistance to value of similar connections.

e. Verify torque and provide written certification on all bolts for bus bar connections:

1) Bus bar and terminal connections shall be inspected to ensure that all joints have proper torque tightness.

2) Torque values for all types of joints involved shall be in accordance with manufacturer's recommendations.

f. Check support and bracing:

1) Bus bar support insulators and barriers shall be inspected to ensure that they are free from contamination.

2) Insulators shall be checked for cracks and signs of arc tracking.

3) Mounting hardware shall be inspected and all joints checked for proper torque value.

g. Test all electrical and mechanical interlock systems for proper operation and sequencing:

1) Closure attempt shall be made on locked-open devices. Opening attempt shall be made on locked-closed devices.

2) Key exchange shall be made with devices operated in off-normal positions.

h. Clean switchgear.

i. Inspect accessible insulators for evidence of physical damage or contaminated surfaces.

j. Verify proper barrier and shutter installation and operation.

k. Verify appropriate contact lubricant on moving current carrying parts and surfaces. Verify appropriate lubrication on moving and sliding surfaces.

l. Exercise all active components.

m. Inspect all mechanical indicating devices for proper operation.

n. Verify proper operation of switchgear heaters. Ensure filters and/or vents are clear.

o. Electrical Tests:

1) Solid state devices and electronic components shall be disconnected prior to applying 500 volts or higher to the circuit.

2) Perform tests on all instrument transformers in accordance with this Section.

3) Perform ground-resistance tests in accordance with this Section.

4) Perform insulation-resistance tests on each bus section, phase-to-phase, and phase-to-ground for one minute.

5) Overpotential test voltages shall be applied in accordance with manufacturer's recommendations or NETA-ATS. Test results are evaluated on a go/no-go basis by slowly raising the test voltage to the required value. The final test voltage shall be applied for one minute.

6) Perform resistance measurements on all bus joints with a low-resistance ohmmeter.

7) Perform insulation-resistance tests at 1,000 volts DC on all control wiring. Do not perform the test on wiring connected to solid state components.

8) Perform control wiring performance test. Use the elementary diagrams of the switchgear to identify each remote control and

protective device. Conduct tests to verify satisfactory performance of each control feature.

9) Perform the following tests on dry-type control power transformers:

a) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

b) Verify that primary and secondary fuse ratings or circuit breakers match drawings.

c) Perform insulation-resistance test. Measurements shall be made from winding-to-winding and windings-to-ground. Test voltages and minimum resistance shall be in accordance with Switchgear Insulation-Resistance Test Voltage table above.

10) Perform current injection test on the entire current circuit in each section of switchgear.

C. Air Switches - Low Voltage Metal-Enclosed Switches:

1. Provide visual and mechanical inspection to ensure proper connections and installation of cables, fuse holders, barriers.

2. Check blade alignments. Perform mechanical operation tests. Verify that fuse sizes and types are in accordance with approved coordination study.

3. Test all electrical and mechanical interlock systems for proper operation.

4. Perform electrical tests, including insulation-resistance tests on each pole, phase-to- phase and phase-to-ground for one minute and contact-resistance test across each switch blade and fuse holder. Test values shall be in accordance with NETA-ATS requirements unless otherwise specified by manufacturer.

D. Circuit Breakers - Low Voltage:

1. Circuit breakers are to be checked for possible damage during shipment or storage.

2. Inspect the breaker visually for physical damage.

3. Perform several mechanical ON-OFF operations.

4. Conduct circuit continuity check on each pole with the circuit breaker in the closed position.

5. Determine short-time pickup and delay, long-time pickup, and delay by primary current injection.

6. Tests solid state trip devices at multiple setting range of pickup and time delays.

7. Apply 300 percent of breaker rated continuous current to each pole to determine that the circuit breaker will trip on an overload.

E. AC Motors - Induction Motors:

1. Inspect for physical damage and compare nameplate information with Drawings and Specifications.

2. Inspect for proper installation, grounding, connection, and lubrication. Motor alignment, wiring capacity, speed and operation shall be checked to verify compliance with Specifications.

3. Check for unusual mechanical or electrical noise or signs of overheating during initial test run.

4. Perform insulation-resistance tests in accordance with ANSI/IEEE standard 43. Test duration as recommended by NETA-ATS.

5. Perform insulation-resistance test on pedestal per manufacturer's instructions.

6. Perform insulation-resistance test on surge protection device in accordance with NETA- ATS specifications.

7. Check resistance temperature detector (RTD) circuits for conformance with drawings. Check that metering or relaying devices using the RTDs are of the proper rating.

8. Check that the motor space heater is operating.

9. Perform a rotation test to ensure proper shaft direction if the motor has been electrically disconnected.

10. Measure running current and evaluate relative to load conditions and nameplate full-load amperes.

11. The motor shall be run for at least four hours as close to full load as possible.

12. See also Section 15170 for additional motor test information.

F. Motor Control:

1. Low and medium voltage motor controls shall be tested in accordance with NETA ATS requirements and manufacturer recommendations.

2. Variable frequency drives (VFD) shall be tested as required in VFD specification section and in accordance with manufacturer recommendations.

3. Verify and provide written certification that all factory terminations have been checked for proper storage.

G. Instrument Transformers:

1. Inspect transformers for physical damage and nameplate information for compliance with Drawings and Specifications.

2. Verify proper connection of transformers with system requirements.

3. Verify tightness of all bolted connections and assure that adequate clearances exist between primary circuits and secondary circuit wiring.

4. Verify that all required grounding and shorting connections provide good contact.

5. Verify proper operation of transformer withdrawal mechanism (tip out) and grounding operation when applicable.

6. Electrical Tests - Current transformers:

    a. Perform insulation-resistance tests on current transformer secondary and wiring- to-ground winding at 1000 volts dc for one minute. Value of test voltage on secondary wiring shall be 1000 volts dc for one minute. Do not perform this test with solid-state devices connected.

    b. Perform a polarity test on each transformer winding and verify manufacturer's polarity markings.

    c. Perform a turns-ratio verification test of each current transformer.

    d. The test data shall include the following:

        1) Manufacturer's stated ratio for each tap position.

        2) Test turns ratio results.

        3) Percent error per tap position.

        4) Manufacturer's indicated polarity.

        5) Test result polarity.

    e. On each set of transformer windings, the turns ratio shall be determined for all no-loads taps, using the two voltmeter method for control transformers and the two ammeter method for current transformers.

    f. Confirm test switch wiring and operation:

        1) A functional test shall be performed on the test switch of the current transformer to ensure that the secondary leads are shorted and that no open circuit conditions exist. A functional test shall also be performed on the control transformers to ensure that no short circuit exists across the secondary leads.

        2) All control wiring shall be checked to ensure proper operation of the device being powered.

    g. Perform other tests specified by the NETA-ATS as required by application.

7. Electrical Tests - Voltage Transformers

    a. Perform insulation-resistance tests on voltage transformers, winding-to-winding, and windings-to-ground. Value of test voltage on secondary wiring shall be 500 volts dc for one minute. Do not perform this test with solid-state devices connected.

    b. Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable.

    c. Perform ratio test as specified in NETA-ATS.

    d. Perform a dielectric withstand test on the primary windings with the secondary windings connected to ground. The dc dielectric voltage shall

be in accordance with “Switchgear Insulation-Resistance Test Voltage” table herein.

H. Metering and Instrumentation:

1. Inspect all devices for physical damage and tightness of electrical connections.

2. Check calibration and accuracy of meters at 25/50/75/100% of full scale.

3. Verify all instrument multipliers.

I. Protective Relays:

1. Inspect relays for physical damage and compliance with Drawings and Specifications.

2. Standard testing and calibration Specifications:

a. To demonstrate that the relay will function as designed throughout the entire range of its operations, acceptance tests shall be performed in accordance with NETA-ATS Protective Relay Testing Specifications.

b. Calibrate and set relays in accordance with approved coordination study.

c. Use approved relay test set.

3. Perform insulation-resistance test on each circuit-to-frame.

4. Test all relays in place to demonstrate that the relaying system will function as specified. Acceptance tests shall be performed as specified and in accordance with NETA-ATS.

5. Test lockout relays and associated test switch trip links and closing circuit contacts. The lockout relays shall be functionally tested to ensure proper system operation. Associated equipment shall be checked for proper alignment and contact closure.

6. All relays shall be checked and calibrated under service conditions against portable standards devices connected in series with the relay-undergoing test. For some in- service testing, the test plugs shall be used to connect devices which shall measure the currents and voltage being applied to the relays.

7. Test all electrical interlocks:

a. Check all electrical interlocks for loose wiring, proper mechanical alignment, and operation. Also inspect all contact surfaces to ensure they are clean and not pitted.

b. All relays shall be checked and calibrated using the built-in test switch and test plug.

8. Test for correct settings and operation of all relay trips and operation indicating flags and seal in contacts.

J. Operating Tests - Mechanical and Electrical Interlocks:

1. Mechanical interlocks shall be examined to ensure the interlock is free to operate and that bearing surfaces are free to perform their intended function.

2. Check for correct adjustment of primary disconnect mechanisms in plug-in units. Plug-in units shall be mechanically interlocked with the door to ensure that the door is held closed with primary disconnect in the ON position.

3. Check for provisions for padlock mechanisms on disconnect operating mechanisms.

4. Check motor starters equipped with a defeater mechanism to ensure that they can be operated to release the door interlock with the disconnect device in the ON position.

K. Operating Tests - Circuit Breaker Operation:

1. Test trip all medium voltage circuit breakers from all devices in the trip circuit and verify operation of all interlocks.

2. Installation and inspection of 480 V power circuit breakers shall be in accordance with NEMA Pub. No. SG-3. Perform tests in accordance with NETA-ATS Specification Paragraph 3.3.05.

3. Test all remote control stations for operation:

a. A functional test shall be performed for all remote pushbutton stations and manual motor starters to ensure their proper operation.

b. Control stations tested under actual operating conditions shall perform their intended function.

3.04 SYSTEM CHECKS

A. Preliminary

1. Connect all motors to protective devices and controls to give proper motor acceleration and correct motor rotation. Interconnect the control wiring to all the control devices associated with a machine, a group of machines, or other device to produce the correct operation, timing, and/or sequencing of the equipment. Devices with trip settings left at the maximum allowable setting will not be accepted. All settings shall be made for the protection of the connected equipment.

2. Adjust overload elements in motor starters and check for coordination with the actual installed motor characteristics. Replace any overload element that is inadequate.

3. Check all motor nameplates for verification of proper voltage, horsepower, speed, phase, and power factor.

B. Operational

1. Give equipment an operational test to determine that all components including motors, controls, protective and switching devices, and auxiliary associated equipment are in operable condition and can function as described and shown on relevant specifications, operating instructions, and drawings.

2. Take motor current reading at full load or as close to full load as the driven machine will develop. If the ammeter reading is over the rated full load current or the proper current for the load at which the machine was operated,

determine the reason for the discrepancy and take the necessary corrective action.

3. Remove the cause of any motor operating above full load rating instead of increasing the overload relay trip rating.

C. Tests shall be as defined in the appropriate standards.

3.05 CLOSEOUT PROCEDURES

A. General - For each project phase, sequence closeout procedures so that work will not be endangered or damaged, and so that every required performance will be fully tested and demonstrated. Closeout shall be in accordance with Section 01700, Record Documents, and as required herein for each partial Certificate of Substantial Completion.

B. Final Operational Check - Make a check of each item in each system to determine that it is set for proper operation. With the Engineer present, operate each system in a test run of appropriate duration to demonstrate compliance with performance requirements. During the following test runs, make final corrections or adjustments of systems to refine and improve performances where possible, including noise and vibration reductions, elimination of hazards, better response of controls, signals and alarms, and similar system performance improvements. Provide testing or inspection devices to permit observation of actual system performances and shall demonstrate that controls and items requiring service or maintenance are accessible.

C. Cleaning and Lubrication - After final performance test run of each electrical system, clean system both externally and internally, comply with manufacturer's instructions for lubrication of both power and hand operated equipment, and remove excess lubrication, touch up minor damage to factory painted finishes and other painting specified as electrical work, and refinish work where damage is extensive.

D. Operating Instructions - General operating instructions are required. In addition to specific training of the Owner's operating personnel specified in the individual sections, and in addition to preparation of written operating instructions and compiled maintenance manuals specified elsewhere in these specifications, provide general operating instructions for each operational system and equipment item of electrical work, and coordinate instructions with instructions for mechanical work, and other equipment where associated with electrical systems or equipment.

E. System Description and Operation

1. Perform in the presence of the Owner, the Owner's operating personnel and the Engineer.

2. Describe each basic electrical system and explain identification system, displayed diagrams, signals, alarms and audio visual provisions.

3. Describe interfaces with mechanical equipment, including interlocks, sequencing, startup, shutdown, emergency, safety, system failure, security, and similar provisions.

4. In the presence of the Owner's personnel, display and conduct a "thumb through" explanation of maintenance manuals, record drawings, spare parts inventory, storage and extra materials, meter readings, and similar service items.

3.06 CONTINUED SYSTEM OPERATIONS SUPPORT

A. Coordinate the Owner's takeover of electrical systems with takeover of each system, including the provision of skilled electrical operating and maintenance personnel until the time the Owner's personnel take over operation of entire system(s) and electrical plant. Respond promptly with continued consultation and services (beyond takeover date) on electrical systems, matching required continued services on associated mechanical systems and equipment until the end of the warranty period.

3.07 DOCUMENTATION PROCEDURE

A. Signed commitments are required. The transfer of electrical systems to the Owner for operation will not proceed until guarantees, warranties, performance certifications, maintenance agreements and similar commitments to be signed by Contractor and other entities have been executed and transmitted to and accepted by the Engineer for placement in the Owner's records.

3.08 THERMOGRAPH INSPECTIONS

A. Perform thermograph inspections on all feeder terminations, subfeed terminations, major power splices, transformer terminations, MCC terminations, motor terminations for motors 5 HP or larger, and major power distribution breakers, switches, and contactors. Testing on major power distribution equipment will be performed with the plant running at a minimum of 70 percent capacity or the highest load that can be operated. Testing on individual pieces of equipment will be performed while the unit is operational at rated load and has operated for at least 30 minutes for continuously operated equipment or near the end of a cycle for equipment that operates on/off. Loads shall be minimum of 40 percent of full load. Readings at overcurrent devices and starters will be for line and load; motors will be connections in motor terminal boxes; and for transformers, primary and secondary terminations. Provide a report of test results to the Owner, including indication of any actions taken to resolve abnormal readings. All thermographic tests shall be reported on this form.

END OF SECTION

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# SECTION 16900

# GENERAL CONTROL SYSTEM REQUIREMENTS

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation necessary to perform the related work specified herein to furnish, install, and test the control system. The control system shall include all instrumentation, local control panels, local control stations, process control system equipment, and network equipment. The responsibility to provide the requirements of this specification section will be performed by a qualified System Integrator (SI) dedicated to the instrumentation and control installation for this project.

B. The SI will provide, install, configure, program, and test all instrumentation, control panels, programmable logic controllers, human machine interface equipment, and other instrumentation and control equipment as defined herein and as described in the following specifications:

Section 16920 - instrumentation

Section 16942 – Control System Equipment

Section 16946 – Cabinets, Panels, Consoles, and Devices

Section 16960 – HMI system

Section 16965 – Control Descriptions

C. Application logic programming of the new Programmable Logic Controllers, modifications of the existing Programmable Logic Controllers (LCP-H), configuration the Operator Interface Terminals (OITs), and the Human Machine Interface (HMI) system, as well as develop of graphics, reports and configuration of network configuration will be performed by the SI for the project.

D. The System Integrator (SI) will provide PLC & OIT coordination for all vendor and manufacturer provided equipment. These PLCs and OITs Control panels will be provided, programmed, and configured by the Manufacturer's and Vendors of these components, and installed by the Contractor; refer to the associated system specification for more details.

1. Grit Removal System – PLC-GR & OIT-GR
2. Fine Screening System – PLC-FS & OIT-FS
3. Membrane Filtration System – PLC-MBR, RIO-MBR (typ. 4) & OIT-MBR
4. Compressor Mixing Air – PLC-CA & OIT-CA
5. Belt Filter Press – PLC-BFP1, PLC-BFP2 and OIT-BFP1, OIT0BFP2
6. Rotary Drum Thickener – PLC-RDT1, PLC-RDT2 & OIT-RDT1, OIT-RDT2
7. Dryer system – PLC-DS & OIT-DS

8. Odor Control System: PLC-OC & OIT-OC
9. Main Switchgear – PLC-SG & OIT-SG
10. Odor Control Switchboard – PLC-SB

E. The manufacturer of the above equipment will provide all hardware, software, system configuration, and all required equipment and material for a complete Control System. The SI will coordinate with the manufacturer for all work related with the integration, communications, between the manufacturer's PLC/OIT and the Plant Control System (PCS). All the preliminary test programs and configuration files of the manufacturer's PLCs and OITs will be developed by them and provided to the SI prior to testing of the system. Final test programs and configuration files will be provided to the SI upon completion of the factory testing. The SI is responsible to review all submittals with equipment interfacing to the plant control system and verify correct operation prior to testing. Manufacturer's submittals will not be approved without written verification that their control system is compatible with the plant control system by the SI.

F. The SI will provide all hardware, software, system configuration, and all required equipment and material for a complete PCS with the exception of the equipment to be provided by manufacturer's as describe above. SI will coordinate with this equipment and provide a complete control system document including IO Lists, Data Transfer files, OIT Graphics and IP addresses, Network switches configuration for integration and communication between manufacturer's equipment and the PCS.

G. The SI is responsible for all specification references herein and other specifications which apply to the overall PCS but may not be specifically referenced. All control equipment coordination, supervision, and work is the responsibility of the SI.

H. The SI is responsible for providing the networking, communications and hardware and software integration of all systems interfaced to the control network. This includes, but is not limited to, the following components:

1. New Programmable Logic Controllers, PLCs:
    a. Existing Administration Building: PLC-A (Replaces existing LCP-Main)
    b. UVPA- Structure: PLC-UVPA
    c. Headworks: PLC-IH
    d. Fine Screen: PLC-BNR2
    e. Dewatering Building: PLC-DW
    f. MCC-H area: PLC-H, RIO-H1 (modified existing LCP-H)
    g. WAS Holding Tank Facility: RIO-BNR1
    h. BNR/MBR MCC Room: PLC-BNR
    i. Main Switchgear: PLC-MSG
2. New Operator Interface Terminals, OITs:
    a. Dewatering Building OIT: OIT-DW
    b. BNR/MBR Electrical Building: OIT-BNR

c. UV Control Room: OIT-UVPA

d. Ex. Admin Building OIT: OIT-A

3. New Power Monitor Devices, PMs

a. Main Switchgear: PM-MSG (2)

b. Odor Control Switchgear: PM-OCSG

c. Motor Control Centers: PM-MCCA, PM-MCCH, PM-MCCDW, PM-MCCBNR

I. The existing PLC control system at City of Canton WWTP shall be replaced with a new Plant Control System (PCS). The new PCS is indicated on the drawings and the Control System Diagram. The existing control system enclosures and RIO cabinets are shown on the electrical drawings and identified in the control panel list in Section 16946. The existing control panels containing Allen Bradley PLC and Flexlogix components shall be modified to be a Terminal Junction box and RIO-BNR2, as indicated above, and will interface the existing equipment with the new PLS PLC enclosures. The System Integrator shall perform field investigation of the existing Flexlogix as the existing Flexlogix PLC control system to verify the accuracy of the existing Flexlogix Panel wiring diagram and IO list. The SI shall perform all field investigation of the existing system prior to any submittals or shop drawings of the new equipment. Each of the existing PLC and RIO cabinets that shall be reviewed, investigated, and tested by qualified field technicians to determine existing wiring and existing field equipment. The SI shall install new wire labels on the existing wiring and develop loop and interconnect drawings of the existing wiring from the field device to the existing PLC/RIO enclosures and to the new PLC control panels. All field verification, location of wiring and conduit, location of equipment, and terminations is the responsibility of the system integrator and contractor. The SI shall perform all field verification and develop loop and interconnect drawings for submittal and approval. The SI shall be responsible for the field investigation of all existing PLC cabinets, existing remote IO cabinets, existing networking, existing field terminations and wiring, existing panel terminations and wiring, existing 120 volt power circuits, and all other work required to document verify/update the existing control system documentation This includes the development of detailed drawings identifying all existing inputs and outputs, existing control wiring, and identification of all types and voltages of existing signals. The existing PLC system will be replaced by the SI for this contract as indicated herein. Field investigation time and work, design and drafting time and work, equipment costs, and other requirements necessary for a complete and thorough investigation of the existing system and implementation of all existing IO into the new control system is the responsibility of the SI. All field work shall include a minimum of two field technicians for each site visit. A minimum of 160 man hours performed by qualified technicians shall be included for the field investigation of the system. This is not inclusive of travel, design, drafting, time not performed in the field investigating, and other requirements necessary to develop accurate field documentation and drawings. After approval of the loop and interconnect drawings, the SI shall develop new panel drawings for the existing Flexlogix control panels to be modified. Panels shall include new back panels if required, with new terminal blocks, din rail, mounting hardware, lighting, circuit breakers, and other required components for a complete retrofit of all existing panels. Existing enclosure for LCP-H to remain. Any exterior openings in the enclosure that are not used for the new control system shall be plugged with appropriate

closures. Existing wiring shall be connected to the new terminal blocks, new wire labeling shall be installed on all existing wiring to coordinate with the loop and interconnect drawings. New wiring, with identification, and conduit shall be installed between the new terminal box and new PLC-A control panel for interfacing the existing equipment to the new PLC system. The existing system shall be modified in a method as to limit the downtime of the existing system to a maximum of 8 hours for each 24 hour period. This may require temporary wiring and interfacing by the contractor and system integrator to allow the plant to maintain operation during the switchover of components.

J. The SI shall include an additional 120 hours of field investigation that is not including in any other work specified, or in the field investigation time noted above. This additional time will be used as requested by the engineer and the Owner for investigation of existing equipment.

1.02 QUALITY ASSURANCE

A. Equipment, materials, and workmanship shall comply with the latest revisions of the following codes and standards, in addition to all local codes and standards.

1. Instrumentation: Instrument Society of America (ISA).

2. Wiring: National Electrical Code (NEC), ISA S5.3 and S5.4.

3. Control Panels and Equipment: NEMA, UL, and ANSI.

4. Institute of Electrical and Electronics Engineers (IEEE).

5. Electronic Industries Association (EIA).

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Prior to submitting any control system hardware or control panels the SI shall submit detailed drawings of field investigation of the existing control system and panels. The City has some drawings for the existing equipment, but it should be assumed that no accurate drawings are available. This existing system submittal shall include the following as a minimum:

- Complete drawing of each existing PLC panel including all terminations, wiring, PLC components
- Input and Output List of all digital and analog IO including voltages and types
- Analog loop drawings with wire identification
- Digital Interconnect drawings with wire identification
- Power drawings and requirements for each panel
- Network wiring and connections between panels
- Dimensional, layout, and schematic drawings for new RIO-BNR2 panel

C. The submittals shall be prepared and organized by the approved SI. Submit drawings and data as a complete package at one time after submission and approval of the SI qualifications as noted below.

1. Submittals shall be in three-ring hardcover binders and arranged for convenient use including tab sheets, all indexed, and cross-referenced.

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

    a. Component name.

    b. Manufacturer's model number.

    c. Project location.

    d. Input and output characteristics.

    e. Requirements for electric supply.

3. Submit certified dimensional drawings and catalog cuts for each size and type of component specified herein. Catalog cuts are to be highlighted to define specific materials of construction and features specified herein.

4. Submit power consumption (120 VAC and 24VDC) calculation for power supplies and UPS sizing.

5. Submit heat load calculations for all panels including interior and exterior panels. Exterior PLC and RIO panels shall include air conditioning.

6. Submit control panel and programmable logic controller power and control schematics including connection drawings. Drawings shall show locations and wiring for all terminal blocks, power supplies, over-current protection, and equipment. All equipment shall have nameplates, and all wiring shall have wire numbers associated with terminal connections. Submit a tag list for all wiring and terminations of the control panels for approval. Wire identification shall correspond IO requirements if applicable, and terminal block points for wires not associated with IO.

7. Submit complete Input and Output (IO) List on Excel spreadsheet which indicates tag-name, description of tag, IO terminal block points, wire identification, I/O point in PLC, energized state, and un-energized state, range, new or existing point. SI shall update the list based on field verification prior to each test including the factory test, preliminary test, and final test. IO list shall be submitted and approved prior to PLC panel drawing submittals.

8. Submit instruction bulletins for each type of component specified herein. The instruction bulletin shall include installation instructions, wiring diagrams, power requirements, maintenance instructions, and any other details of a specialized nature to the instruments furnished.

9. Group the data sheets together in the submittal by systems, as a separate group for each system. If within a single system, a single component is employed more than once, one data sheet with one brochure or bulletin may cover all identical uses of that component in that system.

10. Submit component interconnect and loop drawings showing the interconnecting wiring between all new components, connections of new equipment to existing equipment, and control equipment provided for the project. Drawings shall accurately depict all wiring and terminal connections including routing of wire, wire numbers, and panel and instrumentation and

equipment terminal connections. An interconnect and loop drawing shall show the connection from the field device through junction boxes, terminal blocks, and other equipment up to the new PLC IO module. Identification of field terminal blocks on panel IO drawings are not acceptable as interconnect and loop drawings. The SI is responsible for identification of all new and existing terminal connections, junction boxes, RIO terminations, and coordination with the equipment vendors to incorporate the required information on the loop and interconnect drawings.

11. Submit arrangement and construction drawings for consoles, control panels, and for other enclosed assemblies for field installation. These drawings shall include dimensions, identification of all components, terminal block and device layout, preparation and finish data, and nameplates. These drawings also shall include enough other details to define the style and overall appearance of the assembly; include a finish treatment sample.

12. Submit wiring diagrams, schematics, interconnect, and loop drawings for each panel and enclosure provided. Drawings shall include terminal block and wire identification for panel and field connections, including physical layouts in the panel.

13. Submit installation, mounting and anchoring details for all new and relocated components or entry details.

14. Submit complete and detailed bills of material including manufacturer and model number of all equipment.

15. Submit preliminary electronic configuration files for all PLC, OIT, Power Monitor, and HMI configuration to the Owner /Engineer a minimum of 60 days prior to the Factory Acceptance Test. Submit final electronic configuration finals upon completion of the Factory Acceptance Test for applicable equipment and completion of the Witnessed Preliminary Test for applicable equipment.

16. Submit via workshops with the engineer all PLC and HMI programming, development, and database in accordance with the control strategies and the specifications. The SI shall include a minimum of four (4) – 4 hour workshops at the City of Canton for development and presentation of the HMI and PLC system graphics, control strategies, and operation to the City and Engineer.

17. Submit sample calibration reports with shop drawings and final calibration reports for each instrument at the completion of the preliminary testing. All final calibration reports shall include NIST calibration date of test equipment used for calibration. Tag-names, instrument ranges, serial numbers, test equipment used, and other applicable information shall be included in the calibration reports.

18. Submit complete test procedures for each phase of testing including factory tests, preliminary tests, and final tests. Upon completion of each testing phase and prior to the acceptance of any test or equipment, the completed test procedure shall be submitted.

19. Submit pre-submittal conference agenda and documentation.

20. Submit System Integrator Qualifications.

21. Submit proof of all software licenses demonstrating that the licenses are held by Owner for all licensed software.

D. Operations and Maintenance Manuals

1. Submit Operation and Maintenance Manuals in accordance with Division 1 Specifications. In addition to requirements in those sections and as specified herein, include the following additional information:

a. HMI and OIT programming and configuration files in paper and electronic files.

b. PLC programming and configuration displays in paper and electronic file.

c. The organization of the initial submittal shall be compatible to eventual inclusion one volume of the operation, maintenance, and repair manuals.

d. In addition to the other specifications and requirements, the complete operation and maintenance manual shall contain all the information included in the submittal drawings and data, and the additional information required herein, all bound in hard cover binders and arranged for convenient use including tab sheets, all indexed and cross referenced, and all final as-built drawings.

e. The operation manual shall contain:

1) Operating instructions written for the benefit of plant operating personnel for normal operational conditions. Including details of the operation of each local control panel, instrumentation, and applicable equipment.

2) Calibration and maintenance instructions, including final calibration reports for all instruments which indicate the range, test results, serial number, model number and manufacturer of equipment.

3) Trouble-shooting instructions.

4) Supplier list and instructions for ordering replacement parts, including name, address, and phone number of local supplier, plus manufacturer name and model number of equipment.

E. Submit Manufacturer's Certificates for complete plant control system in accordance with Division 1 Specifications.

1.04 SPECIAL TOOLS AND SPARE PARTS

A. All Spare parts recommended by the equipment manufacturer shall be provided.

B. Provide tool kits and test equipment, as recommended by the manufacturer, necessary for assembling, calibrating, and maintaining equipment.

C. Refer to applicable specification sections for spare part requirements.

D. Provide a Hart communicator with power supply and case. Communicator shall be latest model available.

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Delivery, handle and store the equipment in accordance with Division 1 specifications and the manufacturer's instructions.

B. Proper and suitable tools, equipment and appliances for safe and convenient handling and placing of materials and equipment shall be used. During loading, unloading, and placing, care shall be taken in handling equipment and materials so that no equipment and materials, including Owner furnished and existing, are damaged.

C. Materials and equipment, which are damaged or affected as a result of improper handling or storage, shall be subject to removal at direction of Engineer and replaced with new materials, at no cost to the Owner.

D. Store and safeguard equipment. Instruments shall not be stored outdoors. Provide dry, secure storage facilities.

1.06 RELATED PRODUCTS

A. Provide the equipment, material, work, testing, calibration, and all other requirements as specified in the following sections and as shown on the drawings:

1. Instrumentation – Section 16920.
2. Control System Equipment – Section 16942
3. Cabinets, Panels, Consoles and Devices – Section 16946
4. HMI Hardware and Software – Section 16960
5. Control Descriptions – Section 16965
6. All Applicable Electrician and Mechanical Sections.

B. The SI is responsible to provide configuration and coordination of the power monitors provided in Section 16155. The SI shall coordinate with the manufacturer and vendor of this equipment and provide complete configuration information in their submittals.

C. Other specification sections required for interfacing of the PCS with vendor provided equipment shall be the responsibility of the SI. This includes but is not limited to the MBR, Belt Filter Press, Rotary Drum Thickened, Dryer, UV systems, etc.

1.07 QUALIFICATIONS AND RESPONSIBILITY OF SYSTEM INTEGRATOR

A. The Contractor's subcontractor, herein referred to as the System Integrator (SI) shall furnish and install all proposed hardware and software as specified herein, supply and install all internal and external wiring within the system, perform and supply all engineering, drafting and configuration to deliver a complete and operable system as specified. All systems shall be the unit responsibility of the SI.

B. The SI shall be responsible for coordinating and interfacing with existing and new equipment specified under the contract documents which are an integral part of the system. The SI shall incorporate interfacing in the detailed systems drawings and data sections.

C. SI will provide the PLC control strategy logic, OIT software development, and HMI software development for the system. The SI shall be responsible for all testing, PLC and OIT configuration, HMI network configuration and communications and complete system verification of all system hardware, communications, and operation.

D. The SI shall meet all required qualifications as indicated in Item E below and be regularly engaged in control system integration work in the water and wastewater industry. Failure to provide and obtain approval of the required information will deem the SI submitted as unqualified. It shall be the Contractor's complete responsibility to provide the required documentation for a qualified SI. Only qualified SI's will be acceptable for the project.

E. Qualification submittal: The Contractor shall submit for approval within 15 (fifteen) calendar days after Contract Award, detailed information of the SI qualifications. The qualification submittal shall be submitted and approved before any further submittals will be accepted. Failure to submit and obtain approval of the minimum requirements shall be grounds for rejection of the SI as an acceptable SI. The qualification submittals shall contain, as a minimum, the following information:

1. SI shall submit five (5) references for wastewater projects successfully completed, on time without outstanding claims or litigation, within the last 5 (five) years. References shall include name, address, phone number and email of Owner and Engineer on the project. References shall include a detailed description of all work accomplished on the project for PLC fabrication and integration, Ethernet networking, instrumentation calibration, development of loop and interconnect drawings, and similar work as required for this project. References that do not meet the criteria above or if references provide an unfavorable response are grounds for rejection.

2. The name, resume, and qualification of supervisory personnel, to be solely responsible for the installation, showing at least 5 water/wastewater control system projects of similar scope and complexity completed successfully. Minimum of project manager assigned to the project, field supervisor assigned to the project, and control system technicians assigned to the project are required.

3. Submit organization chart of all key personnel on project, including field technicians to perform field investigation. All field investigation shall be performed by approved technicians.

4. The contractor's local place of business shall be located within a 100 miles radius of the City of Canton Wastewater Treatment Plant, Georgia.

5. The SI shall provide proof of a current UL 508A certification of their industrial control panel shop for the assembly of all control panels.

F. The system installation and wiring connections to peripheral equipment and instruments shall be the responsibility of the SI using qualified personnel possessing the necessary equipment and having experience in making similar installations.

G. The SI shall provide all programming required for system configuration; communications to the I/O, communications to the OITs, Power Monitors, and

existing HMI system; and communications between PLCs; and general system operation. Additionally, the SI shall provide all coordination with the System Suppliers, as example: GR, UV, MBR, BFP, RDT. Dryer, AC, etc.; the VFD supplier, and the Blower Manufacturer for communications and configuration of the equipment connected and networked to the control system. The SI shall have complete responsibility for coordination of all subcontractors of equipment to provide a complete and operational PCS.

H. The SI shall be responsible for providing all software, hardware, and equipment necessary for configuration, programming, and testing of the specified control system equipment and instrumentation.

I. The proposed field instruments shall be new. Manufacturers and model or type numbers are provided as part of the instrument narrative descriptions. The proposed manufacturers are those on which the instrument design has been based.

J. The SI shall attend scheduling meetings with the Owner and Contractor to develop a startup schedule for the PCS. A minimum of ten (10) four-hour meetings shall be required for the project, four of which will be dedicated to HMI and PLC control strategy and graphics development. Other meetings as required for coordination shall be performed by the SI and associated parties. The SI shall submit monthly reports to the Contractor/Owner/Engineer stating the requirements of the schedule as it relates to the engineer, in reference to the system design, installation, system testing, configuration, and startup. The schedule shall be provided each month by the SI and include all dates for the required work. The schedule will be used by the Engineer and Owner for testing and startup purposes of the control system. An initial pre-submittal conference shall be performed by the SI after approval of qualifications, and within 60 days of approval. The pre-submittal shall include:

1. Provide materials 10-days prior to the conference:
    a. Instrument Index that lists the devices and instruments specified in Division 16 identify each by tag number, description, function, manufacturer, and model number
    b. Product descriptive literature with a statement that the item is as specified.
    c. Proposed equal products with comparative listing of the published specifications for the specified item and the proposed item.
    d. Project Control System Block Diagram.
    e. Detailed plan and sequence of work for replacing the existing PLC system. Plan shall include field investigations, drawing development, field modifications, temporary connections, and testing.
    f. Sample control panel schematic diagram proposed for this project. Sample can be a copy from a previous project provided that it represents the format being proposed for
    g. Sample analog and discrete loop and interconnect diagrams proposed for this project. Sample can be a copy from a previous project provided that it represents the format being proposed for.

2. The pre-submittal conference will not replace the Product and Shop Drawing Submittal review process.

K. The SI shall be responsible for coordinating and interfacing with equipment supplied under these contract documents which are integral parts of the system. The Contractor shall provide all interfacing, devices, fitting, connections required for the entire system operation. The SI shall demonstrate operation of all software and hardware, including verification and testing of I/O and communication. Incorporate interfacing in the detailed systems drawings and data section of the contract documents.

L. The SI shall develop a master plan including a schedule for accomplishing all tasks. The SI shall coordinate with the Contractor, major process and electrical equipment manufacturers, other subcontractors, the Owner, and the Engineer when developing the plan. The plan shall include all tests dates for Factory and Field Testing of control system and other devices connected to the system. The existing control system shall remain in operation during construction until the new control system has been implemented. The contractor and SI shall provide all work, including temporary connectors and cables to maintain system operation.

1.08 INPUT/OUTPUT (LIST I/O)

A. The I/O list and the drawings shall be used as a basis for fabrication of the control system. The list shown is a minimum quantity of points. The SI shall develop and provide an IO list in MS Excel for all points specified on the project. The IO list shall be submitted with all applicable information and be used throughout the project for the SI, Owner and Engineer, to verify the program and testing of the project.

B. Table 16900-T1 “Input/Output List” is included at the end of this section. The SI is responsible to provide a minimum of 20% spare points at each PLC panel. The Input/Output List at the end of the section provides a minimum quantity of points for the existing PLC system. Based on the contractor’s findings during the field investigation, a final IO list will be developed which includes an accurate count and description of all points.

1.09 P&IDS

A. The Process and Instrumentation Diagrams (P&IDs) represent the basic process of the instrumentation and control system. The P&IDs are provided as a supplement to the specifications, I/O list, and drawings, and shall be used only if information is not shown or specified elsewhere.

1.10 DESIGN

A. The SI shall utilize the I/O list, drawings, and schematics, P&IDs, manufacturer’s shop drawings, submittal information, field investigation, development of drawings and IO, and all available material as the basic criteria for the design of the control system. The SI design shall include all instrumentation provided for the project; all control panels, schematics, and manufacturer’s data including data sheets, wiring diagrams, piping layouts, assembly drawings, and other requirements set forth in these specifications.

B. Control system Design Documents shall be provided by the SI in a complete submittal package, interim or partial submittal packages shall not be acceptable.

Installation and testing of the control system and instrumentation will not be accepted until a complete design package has been submitted and approved.

1.11 TESTING AND FINAL CHECKOUT

A. The Owner/Engineer shall witness testing, start-up, and final checkout of the system to determine if the system complies with the contract documents.

B. Provide minimum 4 hours of instruction for each type of instrument.

1.12 GUARANTEE

A. See: One-year guarantee, General Provisions.

B. Repair or replace defective components, rectify malfunctions, correct system problems, and correct faulty workmanship, at no additional cost to the Owner during the guarantee period.

C. SI shall provide new components for the replacement of defective components; the use of the Owner's spare parts is prohibited.

1.13 SYSTEM PROGRAMMING AND CONFIGURATION

A. The SI shall provide all programming required for system configuration; communications to the I/O, communications to the HMI and OITs, communications between PLCs; and system operation.

B. The SI will provide the final system programming of the control strategy logic after successful configuration of the system is implemented, tested, and demonstrated by the SI to the Owner and the engineer. The control system, wiring, network cables, and associated equipment shall remain connected to the equipment after the factory acceptance test for the SI to debug their program. The system nor the components used during the factory test shall not be shipped from the facility, prior to completion of this 10 day period.

C. The SI shall be responsible for providing all software, hardware, and equipment necessary for configuration, programming, and testing of the specified control system equipment and instrumentation.

1.14 INSTRUMENT TAGGING

A. Attach a stainless steel tag with stainless steel wire to each instrument and mechanical device, such as transmitters, valves, etc. Permanently emboss or engrave the stainless steel tag with the instrument tag number. Tag numbers will be those identified on the Contract Documents and as defined for the instrumentation.

1.15 MATCHING STYLE, APPEARANCE, AND TYPE

A. All display instruments of each type shall represent the same outward appearance, having the same physical size and shape and the same size and style of numbers and pointers.

PART 2: PRODUCTS

2.01 GENERAL

A. Electrical components shall operate on 115 volts ac, 60 hertz unless otherwise specified.

B. Provide two-and four-wire transmitter power supplies in local panels as required. Provide surge terminal blocks for connections of all 120Vac power and analog signals which are wired using conduit and raceways which are either underground or exposed on exterior of structures. Refer to Specification 16920 for Instrumentation surge suppressor specifications.

C. Provide fuses or overcurrent protection for all instrumentation, IO modules, PLCs, OITs, and associated control equipment, as recommended by the instrument manufacturer.

D. The SI is responsible to meet all requirements of the contract documents and review comments as they apply to the contract. Variations will not be implemented due to the SI's lack of certification of certain UL components or fabrication practices. It shall be the SI's complete responsibility to obtain all UL requirements for the control system and applicable devices.

E. All digital inputs to the PLC system shall be obtained from relays or devices with dry contacts rated at a minimum 10 amp at 120 volts. Other contacts required in the system shall have this minimum requirement and be of ample capacity for the system connected.

F. Process transmitters shall generate 4-20 mA DC analog output signals.

G. The PLC shall generate 4-20 mA DC analog output signals.

H. Interposing relays shall be implemented on all digital outputs for the PLC system. Contacts on relays shall be 10 amps at 120 volt, minimum.

2.02 MANUFACTURERS

A. Refer to specific section for manufacturer.

2.03 DESIGN CONDITIONS

A. All control equipment and instrumentation shall meet or exceed the following environmental conditions.

1. Temperature: Minimum 10 to 40 degrees C.

2. Relative Humidity: Maximum wet bulb 28 degrees C.

3. Refer to other Sections for additional requirements.

PART 3: PART 3 - EXECUTION

3.01 INSTALLATION

A. Uniformity of Components

1. Components which perform the same or similar functions shall, to the greatest degree possible, be of the same or similar type, the same manufacture, the same grade of construction, the same size, and have the same appearance.

B. Installation of Equipment and Accessories

1. Install new equipment in accordance with the installation detail drawings as prepared and submitted by the SI and reviewed by the Owner. Mount equipment so that it is rigidly supported, level and plumb, and in such a manner as to provide accessibility; protect it from damage; isolate it from heat, shock, and vibration; and be free from interference with other equipment, piping, and electrical work. Do not install consoles, cabinets, and panels until construction work adjacent to their location has been completed to the extent that there shall be no damage to the equipment.

2. Locate devices, including accessories, where they shall be accessible.

3. Mount equipment in cabinets or existing panels as specified. Mount associated terminals on a common panel or rack; mounting panels and racks shall have a baked enamel coating.

4. Coordinate the installation of the electrical service to the specified components related to the system to assure a compatible and functionally correct system. All accessories shall be coordinated, and a compatible installation shall be the responsibility of the Contractor.

5. Provide and install sun shields/rain hoods for all instrumentation transmitters and control panels mounted outside and exterior from buildings. This includes instrumentation and control panels provided by manufacturers and other vendors specified throughout the contract documents.

C. Calibration

1. Calibrate and configure the programmable control and instrumentation system after installation in conformance with the component manufacturer's instructions. This shall provide that those components having adjustable features are set carefully for the specific conditions and applications of this installation and that the components and/or systems are within the specified limits of accuracy. Defective elements which cannot achieve proper calibration or accuracy, either individually or within a system shall be replaced. This calibration work shall be accomplished by a technical field representative of the equipment supplier. Certify in writing to the Engineer that all calibrations have been made and that all systems are ready to operate.

2. Provide 5 point field verification for each instrument. If 5 point verification cannot be performed, such as for flow instruments, provide witnessed field configuration. Submit field calibration report for each instrument on the project, provided by the SI or other vendors, including the tag number, serial number, date of calibration/verification, range, calibration results for each point, and name of qualified technician performing calibration. The SI shall submit sample calibration reports prior to field calibration of instrumentation.

3. All instrumentation calibrations shall be recorded and documented on calibration reports provided to the engineer in a submittal. Final approved reports shall be included in the O&M manual.

4. All test equipment used for field calibration shall have a current, less than 12 months, certification that the equipment has been NIST calibrated. Any field instrumentation which is calibrated using test equipment not NIST calibrated shall not be accepted.

5. After approval of the field calibration reports, the SI shall provide and install a final calibration label on each instrument which includes the tag number, date of calibration/verification, range, and initials of person performing calibration/ verification.

3.02 MANUFACTURER'S SERVICES

A. The Contractor shall refer to the Division 1 for the requirements of the manufacturer services for all equipment provided in Section 16900 and related sections of the Contract Documents. The services indicated in the Division 1 shall be in addition to those indicated in the specification sections.

B. Provide the services of the manufacturer's representative for not less than ten 8-hour days on-site for installation inspection, start-up, and testing of each instrument and component.

C. Provide the services of the SI for not less than ten 8-hour days onsite for verification that the complete control system is installed as required for the project. This verification will include all control panels, control wiring, networking, panel installation and operation, and overall system implementation.

D. The SI shall provide an addition 200 hours of onsite support for HMI and PLC programming modifications as required by the engineer and city. These hours are in addition to all other time specified herein.

3.03 FIELD TESTING

A. General

1. Tests will require scheduling among all parties involved so that the tests may proceed without delays or disruptions by uncompleted work. Coordinate operational tests dependent upon completion and sequencing of work specified elsewhere. The Owner shall approve all test dates.

2. For each test, the SI shall submit for approval a test procedure a minimum of 30 days prior to the test. The procedure shall include a list of each I/O point, instrument, device, and control panel in a tabular format. The procedure shall include time and date for testing of each point and each control device. The time and date will be initialed by the SI and the Engineer witnessing the test. Contract drawings and shop drawings are not acceptable. Upon successful completion of each test, the completed and signed procedure shall be submitted.

3. It shall be understood by the SI and Contractor that the project may be brought online through a phased approach, which will require Subsystem testing for each of the test phases. The SI shall develop independent test procedures for each phase implemented.

4. The Owner or Owner's representative will witness all testing. The SI shall be responsible for all performance testing, including any required hardware,

software, cabling, test equipment, and other devices. Should the SI not be prepared for the test date scheduled the test will be canceled and rescheduled at a date approved by the Owner.

5. The SI shall provide and configure all software for all systems and equipment which are delivered and installed to the project. Software required for demonstration, testing, and operation of the proposed equipment and systems shall be developed and provided by the SI. The software provided and developed by the SI shall be capable of achieving the desired plant operational and communications requirements as defined in the Contract Documents. The SI shall install and develop all software required to demonstrate the required operation and communications of the system. The SI shall provide and configure all the test software required to demonstrate the system operation for the new and existing equipment required by the Contract Documents. All software provided by the SI shall be coordinated with the Engineer and obtain approval prior to installation.

B. Factory Acceptance Test

1. Prior to the SI shipping the equipment to site, the SI shall perform a factory acceptance test (FAT) of the system with a simulated network. Each PLC cabinet will be fully configured by the SI and simulated for operation on the network in the FAT.

2. The FAT performed by the SI will include the following as a minimum

   a. Inventory of all System Components

   b. Wiring Diagrams of I/O to relays and terminals from each control panel and each I/O point

   c. Wiring diagrams of the network used in the FAT from PLC to PLC, PLC to the OIT, PLC to Power Monitors, PLC to programming workstation, HMI System (including servers, graphics, reports, historic data), and all other equipment in the network.

   d. Testing procedure to verify the command and status signals to and from each I/O point from the cabinet to the programming terminal

3. Operational tests shall be performed prior to shipping the control system to the jobsite to demonstrate that the hardware, I/O points, and system configuration, network and other components will perform each operation required for all specified conditions and in accordance with Contract Documents. The Engineer and a representative for the Owner shall witness the tests. After the testing is completed, provide a certification and log of all tests to the Owner for review and comment. The panel wiring, layout, configuration, model numbers and equipment shall be checked against the submittal drawings.

4. The factory witness test shall take as long as necessary to demonstrate to the Owner and the Engineer that the hardware and software performs each operation as required per the specifications.

5. The SI shall demonstrate all HMI and OIT graphics, database, and operation during the factory test. The SI shall install and load all PLC programs for this testing.

6. Prior to factory system testing, submit a written detailed test procedure for review by the Owner, including a layout of the proposed test network and any test equipment provided. Notify the Owner in writing four weeks in advance of the scheduled testing.

7. The factory test will include the new PLCs, OITs, RIOs, HMI, Ethernet Switches, and new Fiber Optic Patch Cables, Category 5e/6 Network Cables, and associated Equipment for a complete Test.

8. The SI is responsible to configuration of a network demonstrating data transfer between PLCs, to the OIT, from a power monitor, HMI servers, HMI stations, and to a PC using an applicable software driver for communications.

9. Upon successful completions of the FAT by the SI, the SI shall install and test the PLC, HMI and OIT programming.

C. Preliminary Test – Unwitnessed

1. After installation of the complete specified system, the Contractor shall perform an unwitnessed preliminary test. All equipment shall be operable and interfaced to the control system. The unwitnessed test shall demonstrate that the system is completely wired and operation prior to scheduling the witnessed test with the Engineer.

2. For the completion of the unwitnessed preliminary test, the SI shall perform a complete I/O point test to demonstrate the specified data is transmitted from the field device to the PLC I/O registers and from the PLC I/O registers to the field devices. A certified test identifying all I/O points individually tested shall be provided by the SI, for approval by the Owner. The SI shall load and utilize their own PLC programming software to perform the testing.

3. The unwitnessed preliminary test will be separated into dependent tests each time a system is put into operation. The SI shall verify all control system operations required for each device prior to establishing system operation.

4. The SI shall demonstrate communications and data transfer between the PLCs, PCs, power monitors, and OITs, servers. Data shall be show in the software at each OIT from the respective PLC, and at the PC from all PLCs, HMI system from all PLCs.

5. The unwitnessed preliminary test shall demonstrate actual operation of equipment and is not to function as a wiring check test. All equipment shall be operational and completely wired. The test will demonstrate operation of the equipment. Equipment not operational shall be noted in the test procedure and documented. The Owner shall have sole discretion on which points will be acceptable to simulate due to process restrictions.

6. Prior to beginning the witnessed preliminary test, the SI shall submit the approved and completed test results for the unwitnessed preliminary test. Only the test results submitted and approved will be included in the witnessed testing.

7. The unwitnessed preliminary test witnessed preliminary test, final test, and reliability test shall be performed by process Subsystems in lieu of a complete facility test if required by the Contractor’s construction schedule for

implementation of the project. The SI is responsible for all coordination of the Subsystem tests and associated components as required by the Contractor's schedule to bring on each process.

D. Preliminary Test – Witnessed

1. All systems shall be retested as specified in the witnessed preliminary test in the presence of the Engineer and the Owner

2. Prior to the Witnessed test all other test results and configurations must be submitted and approved including fiber optic test results, VFD and MCC test and configuration, and network configuration.

3. The SI shall perform the witnessed preliminary test in order to demonstrate achievement of the specified performance. The witnessed preliminary test will correct operation of all PLC IO, local control panel operation, instrumentation calibration, and will demonstrate communications to all equipment on the network.

4. The SI shall have all wiring and network connections to the new and existing equipment complete and operational for this testing.

5. The SI shall demonstrate all HMI graphics, database structure, PLC programming and configuration during the witnessed preliminary test.

6. When systems are assessed to have been successfully carried through the witnessed preliminary test and the Owner concurs in this assessment, a date for final testing involving the Owner operations personnel will be agreed upon.

E. Final Test

1. All systems shall be completely tested and operation prior to scheduling the final test for the control systems.

2. The SI shall perform a Final test of the system demonstrating that all equipment and IO are fully operational. The Final test shall occur in a consecutive uninterrupted time frame, as this should be a re-check of the Witnessed Preliminary Test. Should failures occur during the Final Test, the test may be cancelled at the discretion of the Owner and rescheduled upon correction of the failures.

3. All deficiencies noted in the preliminary testing shall be corrected and demonstrated during the final test period.

4. Transmission of data between PLCs, OITs, and other equipment shall be demonstrated using real time data from instruments and equipment.

F. Reliability Testing

1. The SI shall recheck the system at this time to verify proper operation, calibration and final adjustments shall be made.

2. Upon 100% successful completion of the Preliminary and Final testing, and approval of the test results by the Owner, the SI will load the control logic software in the PLCs, the OIT configuration software, and the HMI software on the PC.

3. The SI will debug his software for a total time of 14 working days (for each request of Final Test by the Contractor), and verifying the hardware, prior to the start of the reliability test.

G. Acceptance Testing

1. After the programming software is debugged by the SI, the Acceptance testing period for the applicable subsystem shall be scheduled. The Acceptance test for each subsystem shall consist of fourteen consecutive days of continuous testing. The SI shall be on call 24 hours a day ready to respond and repair the system within two (2) hours during this time. The system shall be 100% operational for the Acceptance test period. If the system fails to be 100% operational, the SI shall remedy the problem immediately. The Acceptance test will then restart and consist of fourteen consecutive days of continuous testing from the time of failure. The Acceptance test period will occur for each Subsystem brought into operation.

H. Final Acceptance Testing

1. After all Subsystems are completely online and operational, the Final Acceptance Test shall be performed to demonstrate operation of the complete system with all equipment and processes operational. The Final Acceptance testing period for the complete control system, processes, and connected equipment shall consist of fourteen consecutive days of continuous testing. The SI shall be on call 24 hours a day ready to respond and repair the system within two (2) hours during this time. The system shall be 100% operational for the Final Acceptance test period. If the system fails to be 100% operational, the SI shall remedy the problem immediately. The Final Acceptance test will then restart and consist of fourteen consecutive days of continuous testing from the time of failure.

3.04 TRAINING

A. General

1. SI shall provide the Owner operating and maintenance personnel and/or the Owner Representative with a minimum of ten (10) 8 hour days of formal instruction in the functions and operations of the communications, PLC systems, OITs, PCs, HMI system instrumentation, and other control related equipment, provided under this contract. The training shall cover overall system theory, hardware architecture, bus communications, maintenance, and diagnostics. The education and instruction of operating personnel shall be by a qualified instructor familiar with the requirements for this project. Each daily training session shall be for eight hours of formal instruction. Session dates and locations shall be directed by the Owner

B. Manuals

1. The SI shall provide six copies of training manuals for each course.

2. The training manuals shall include, but not be limited to:

a. Description of operation of each hardware component of the system.

b. Normal operational procedures.

c. Abnormal (emergency) operational procedures.

d. Communications and configuration techniques.

e. System maintenance.

f. Calibration – including a demonstration for each instrument, device, and component.

3. Operations and maintenance manuals may be used to supplement training manuals.

C. Training Syllabus

1. A training syllabus shall be submitted by the Contractor a minimum of four (4) weeks prior to training for approval by the Owner. The syllabus shall outline all training criteria and include the instructor's name and qualifications.

END OF SECTION

# SECTION 16900

## Instrumentation and Control Attachments

The following attachments are included as part of specification section 16900:

Table 16900 - T1 Input/Output List

Table 16920 – T1 Instrumentation List

Table 16946 – T1 Control Panel List

Suez – MBR – Documentation

Veolia – Dryer - Documentation

| Enclosure Location | Area / PLC | Equipment/Process | New Signals 8 AI | 16 DI | 8 AO | 16 DO | Network Comm to System MCPs |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Ex Admin Bldg | PLC-A | Ex Influent & Headworks IO to Remains (Estimated) | 8 | 32 | 8 | 8 | |
| | | Ex 750 KW GEN (estimated) | 0 | 5 | 0 | 0 | |
| | | Plant Drain PS1 | 4 | 15 | 2 | 2 | |
| | | Internal Panel Signals | 0 | 4 | 0 | 0 | |
| | | **Total Signals /Type** | **12** | **56** | **10** | **10** | |
| | | Total Signals+20% /Type | 15 | 68 | 12 | 12 | |
| | | Total IO Modules /Type | 2 | 5 | 2 | 1 | |
| | | #slots/ #Racks | 10 | (1) Rack 13 Slots - 3 spare slots | | | |
| | | Ethernet Switch Ports | (1) PLC, (1) OIT, (1) Radio, (1) Existing Modicon PLC in Switchboard, (4) - Spare | | | | |
| | | | | | | | |
| Headwoks Area | PLC-IH | Headworks | 6 | 14 | 1 | 0 | Bar Screen, Grit & Conveyor |
| | | SG-OC Switchgear | 0 | 4 | 0 | 1 | Power Monitor |
| | | Odor Control | 0 | 0 | 0 | 0 | Odor Control System |
| | | Internal Panel Signals | 0 | 4 | 0 | 0 | |
| | | **Total Signals /Type** | **6** | **22** | **1** | **1** | |
| | | Total Signals+20% /Type | 8 | 27 | 2 | 2 | |
| | | Total IO Modules /Type | 1 | 2 | 1 | 1 | |
| | | #slots/ #Racks | 5 | (1) Rack 7 Slots - 2 spare slots | | | |
| | | Ethernet Switch Ports Min | (1) PLC, (2) Bar Screens, (1) Grit & Conv, (1) OC Syst, (1) OC-SWGR, (1) Radio, (5) Spare | | | | |
| | | | | | | | |
| Solids Handling Building | PLC-DW | RDTs | 2 | 0 | 0 | 0 | RDT 1 & 2 |
| | | RDT Polymer System | 4 | 15 | 3 | 4 | |
| | | BFP Feed Pumps | 8 | 18 | 3 | 3 | |
| | | BFPs | 6 | 31 | 2 | 15 | BFP 1 & 2 |
| | | Dryer System | 0 | 0 | 0 | 0 | Dryer System |
| | | BFP Polymer System | 4 | 15 | 3 | 4 | |
| | | BFP Conveyors | 0 | 24 | 0 | 8 | |
| | | DW Drain PS | 4 | 15 | 2 | 2 | |
| | | Misc DW Bldg | 0 | 32 | 0 | 3 | |
| | | Internal Panel Signals | 0 | 4 | 0 | 0 | |
| | | **Total Signals /Type** | **28** | **154** | **13** | **39** | |
| | | Total Signals+20% /Type | 34 | 185 | 16 | 47 | |
| | | Total IO Modules /Type | 5 | 12 | 2 | 3 | |
| | | #slots/ #Racks | 22 | Racks: (3) 10 Slots - 8 spare slots | | | |
| | | Ethernet Switch Ports Min | (2) RDT, (2) BFP, (1) Dryer, (1) PLC, (2) RIOs, (1) OIT, (1) Radio, (1) Odor Control, (1) Hopper, (4) Spare | | | | |
| | | | | | | | |
| BNR/MBR Elec Bldg | PLC-BNR | BNR AT1 | 15 | 30 | 8 | 4 | |
| | | BNR AT2 | 15 | 24 | 8 | 2 | |
| | | BNR AT3 | 15 | 24 | 8 | 2 | |
| | | BNR Blowers | 4 | 10 | 0 | 0 | (4) BNR Blowers |
| | | MBR System | 0 | 0 | 0 | 0 | MBR System |
| | | Scum System | 1 | 10 | 0 | 3 | |
| | | RAS Splitter Box | 1 | 1 | 0 | 0 | |
| | | WAS Pumps | 3 | 15 | 3 | 3 | |
| | | BNR Misc | 0 | 4 | 0 | 0 | |
| | | Internal Panel Signals | 0 | 4 | 0 | 0 | |
| | | **Total Signals /Type** | **54** | **122** | **27** | **14** | |
| | | Total Signals+20% /Type | 65 | 147 | 33 | 17 | |
| | | Total IO Modules /Type | 9 | 10 | 5 | 2 | |
| | | #slots/ #Racks | 26 | (3) Racks 10 Slots - 4 spare slots | | | |

| Enclosure Location | Area / PLC | Equipment/Process | New Signals 8 AI | 16 DI | 8 AO | 16 DO | Network Comm to System MCPs |
|---|---|---|---|---|---|---|---|
| | | Ethernet Switch Ports Min | (1) PLC, (2) RIOs, (4) BNR Blw, (2) PLC-FSs, (1) PLC-MBR, (1) OIT, (1) Radio, (4) Spare | | | | |
| | | | | | | | |
| | RIO-BNR1 | WAS Holding TK & Reuse PS | 2 | 8 | 0 | 0 | |
| | | Compressed Air Mixing | 0 | 0 | 0 | 0 | Compressed Air Mixing System |
| | | Internal Panel Signals | 0 | 4 | 0 | 0 | |
| | | **Total Signals /Type** | **2** | **12** | **0** | **0** | |
| | | Total Signals+20% /Type | 3 | 15 | 0 | 0 | |
| | | Total IO Modules /Type | 1 | 1 | 0 | 0 | |
| | | #slots/ #Racks | 2 | (1) Rack 7 Slots - 5 spare slots | | | |
| | | Ethernet Switch Ports Min | (1) RIOs, (1) Comprssed Air, (1) Radio, (5) Spare | | | | |
| | | | | | | | |
| | RIO-BNR2 | Fine Screenings | 0 | 21 | 0 | 9 | (2) Fine Screening Systems |
| | | Alum System | 8 | 22 | 6 | 7 | |
| | | Internal Panel Signals | 0 | 4 | 0 | 0 | |
| | | **Total Signals /Type** | **8** | **47** | **6** | **16** | |
| | | Total Signals+20% /Type | 10 | 57 | 8 | 20 | |
| | | Total IO Modules /Type | 2 | 4 | 1 | 2 | |
| | | #slots/ #Racks | 9 | (1) Racks 13 Slots - 4 spare slots | | | |
| | | Ethernet Switch Ports Min | (1) RIOs, (2) Fine Screening Systems, (1) Radio, (4) Spare | | | | |
| | | | | | | | |
| MCC-H Bldg | PLC-H | BNR AT4 | 15 | 22 | 8 | 2 | |
| | | Digest Tank & Blowers | 12 | 12 | 4 | 0 | (3) Digest Blowers |
| | | Internal Panel Signals | 0 | 4 | 0 | 0 | |
| | | **Total Signals /Type** | **27** | **38** | **12** | **2** | |
| | | Total Signals+20% /Type | 33 | 46 | 15 | 3 | |
| | | Total IO Modules /Type | 5 | 3 | 2 | 1 | |
| | | #slots/ #Racks | 11 | (2) Racks 7 Slots - 3 spare slots | | | |
| | | Ethernet Switch Ports Min | (1) PLC-H, (3) Digester Blws, (1) Radio, (1) - RIO, (4) Spare | | | | |
| | | | | | | | |
| WAS Holding Tk | RIO-H1 | WAS Holding Tk Blowers | 0 | 0 | 0 | 0 | (3) WAS Blowers (Ex) |
| | | Ex IO in LCP-H to Remain (Estimated) | 8 | 32 | 8 | 8 | |
| | | Internal Panel Signals | 0 | 4 | 0 | 0 | |
| | | **Total Signals /Type** | **8** | **36** | **8** | **8** | |
| | | Total Signals+20% /Type | 10 | 44 | 10 | 10 | |
| | | Total IO Modules /Type | Existing Enclosure | | | | |
| | | #Slots/ #Racks | Existing Enclosure | | | | |
| | | Ethernet Switch Ports Min | (1) RIO, (3) WAS Blws, (1) - PLC - H | | | | |
| | | | | | | | |
| UV/Post Aeration Area | PLC-UVPA | UV & Post Aeration | 4 | 8 | 1 | 4 | UV System |
| | | Post Aeration Tanks & Blower | 3 | 16 | 0 | 4 | (3) PA Blower |
| | | Internal Panel Signals | 0 | 4 | 0 | 0 | |
| | | **Total Signals /Type** | **7** | **28** | **1** | **8** | |
| | | Total Signals+20% /Type | 9 | 34 | 2 | 10 | |
| | | Total IO Modules /Type | 2 | 3 | 1 | 1 | |
| | | #Slots/ #Racks | 7 | (1) Rack 10 Slots -3 spare slots | | | |
| | | Ethernet Switch Ports Min | (3) PA Blw, (1) UV Syst, (1) PLC, (1) Radio, (2) spare | | | | |
| | | | | | | | |
| Main Switchgear | PLC-MSG | SG-Main | 0 | 14 | 0 | 3 | Main & Gen Power Monitors |
| | | Internal Panel Signals | 0 | 4 | 0 | 0 | |
| | | **Total Signals /Type** | **0** | **18** | **0** | **3** | |
| | | Total Signals+20% /Type | 0 | 22 | 0 | 4 | |

Summary

| Enclosure Location | Area / PLC | Equipment/Process | New Signals | | | | Network Comm to System MCPs |
|---|---|---|---|---|---|---|---|
| | | | 8 AI | 16 DI | 8 AO | 16 DO | |
| | | Total IO Modules /Type | 0 | 2 | 0 | 1 | |
| | | #Slots/ #Racks | 3 | (1) Rack 7 Slots -4 spare slots | | | |
| | | Ethernet Switch Ports Min | (2) Power Monitors, (2) PLC, (4) spare | | | | |
| | | | | | | | |
| | | | | | | | |
| **Total Hardwired IO signals** | | | **152** | **533** | **78** | **101** | |
| **Total Hardwired IO signals + 20%** | | | **187** | **645** | **98** | **125** | |

NOTES:
1. FV - For existing Equipment, System integrator shall field verify all ranges of operation for interfacing to new plant control system.
2. Not all IO shown refer to P&IDs, Contract Drawings, and Specifications for additional points.
3. Internal Panel IO not included in IO tables, shown as line in summary

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **SG-Main Main Breaker** | | | | | | | | | | | | |
| XH | 2500 | XH-2500 | Main Breaker Open | DI | PLC-MSG | Off | Open | | | 1 | | |
| XL | 2500 | XL-2500 | Main Breaker Close | DI | PLC-MSG | Off | Close | | | 1 | | |
| XF | 2500 | XF-2500 | Main Breaker Trip | DI | PLC-MSG | Off | Trip | | | 1 | | |
| XC | 2500 | XC-2500 | Main Breaker Open/Closed | DO | PLC-MSG | Close | Open | | | 1 | | 1 |
| **SG-Main Main Breaker 1** | | | | | | | | | | | | |
| XH | 2500 | XH-2500 | Main Breaker Open | DI | PLC-MSG | Off | Open | | | 1 | | |
| XL | 2500 | XL-2500 | Main Breaker Close | DI | PLC-MSG | Off | Close | | | 1 | | |
| XF | 2500 | XF-2500 | Main Breaker Trip | DI | PLC-MSG | Off | Trip | | | 1 | | |
| XC | 2500 | XC-2500 | Main Breaker Open/Closed | DO | PLC-MSG | Close | Open | | | 1 | | 1 |
| **SG-Main Main Breaker 1 Power Monitor** | | | | | | | | | | | | |
| IT | 2500 | II-2500 | Main Breaker Current | AI | PLC-MSG | 0 | 5,000 | A | Network | | | |
| VT | 2500 | VI-2500 | Main Breaker Voltage | AI | PLC-MSG | 0 | 600 | V | Network | | | |
| JT | 2500 | JI-2500 | Main Breaker Power | AI | PLC-MSG | 0 | 4,500 | KVA | Network | | | |
| VL | 2500 | VL-2500 | Main Breaker Undervoltage | DI | PLC-MSG | Off | UnderVolt | | Network | | | |
| VH | 2500 | VH-2500 | Main Breaker Overvoltage | DI | PLC-MSG | Off | OverVolt | | Network | | | |
| **SG-Main TIE Breaker** | | | | | | | | | | | | |
| XH | 2501 | XH-2501 | Tie Breaker Open | DI | PLC-MSG | Off | Open | | | 1 | | |
| XL | 2501 | XL-2501 | Tie Breaker Close | DI | PLC-MSG | Off | Close | | | 1 | | |
| XF | 2501 | XF-2501 | Tie Breaker Trip | DI | PLC-MSG | Off | Trip | | | 1 | | |
| XC | 2501 | XC-2501 | Tie Breaker Open/Closed | DO | PLC-MSG | Close | Open | | | 1 | | 1 |
| **SG-Main Main Breaker 2** | | | | | | | | | | | | |
| XH | 2502 | XH-2502 | Tie Breaker Open | DI | PLC-MSG | Off | Open | | | 1 | | |
| XL | 2502 | XL-2502 | Tie Breaker Close | DI | PLC-MSG | Off | Close | | | 1 | | |
| XF | 2502 | XF-2502 | Tie Breaker Trip | DI | PLC-MSG | Off | Trip | | | 1 | | |
| XC | 2502 | XC-2502 | Tie Breaker Open/Closed | DO | PLC-MSG | Close | Open | | | 1 | | 1 |
| **SG-Main Main Breaker 2 Power Monitor** | | | | | | | | | | | | |
| IT | 2502 | II-2502 | Main Breaker Current | AI | PLC-MSG | 0 | 5,000 | A | Network | | | |
| VT | 2502 | VI-2502 | Main Breaker Voltage | AI | PLC-MSG | 0 | 600 | V | Network | | | |
| JT | 2502 | JI-2502 | Main Breaker Power | AI | PLC-MSG | 0 | 4,500 | KVA | Network | | | |
| VL | 2502 | VL-2502 | Main Breaker Undervoltage | DI | PLC-MSG | Off | UnderVolt | | | 1 | | |
| VH | 2502 | VH-2502 | Main Breaker Overvoltage | DI | PLC-MSG | Off | OverVolt | | | 1 | | |
| | | | | | PLC-MSG IO Signals | | | | 0 | 14 | 0 | 3 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **SG-OC Main Breaker** | | | | | | | | | | | | |
| XH | 2550 | XH-2550 | Main Breaker Open | DI | PLC-IH | Off | Open | | | 1 | | |
| XL | 2550 | XL-2550 | Main Breaker Close | DI | PLC-IH | Off | Close | | | 1 | | |
| XF | 2550 | XF-2550 | Main Breaker Trip | DI | PLC-IH | Off | Trip | | | 1 | | |
| XC | 2550 | XC-2550 | Main Breaker Open/Closed | DO | PLC-IH | Close | Open | | | 1 | | 1 |
| **SG-OC Main Breaker Power Monitor** | | | | | | | | | | | | |
| IT | 2550 | II-2550 | Main Breaker Current | AI | PLC-IH | 0 | 3200 | A | Network | | | |
| VT | 2550 | VI-2550 | Main Breaker Voltage | AI | PLC-IH | 0 | 600 | V | Network | | | |
| JT | 2550 | JI-2550 | Main Breaker Power | AI | PLC-IH | 0 | 3000 | KVA | Network | | | |
| VL | 2550 | VL-2550 | Main Breaker Undervoltage | DI | PLC-IH | Off | UnderVolt | | Network | | | |
| VH | 2550 | VH-2550 | Main Breaker Overvoltage | DI | PLC-IH | Off | OverVolt | | Network | | | |
| | | | | | PLC-IH IO Signals | | | | 0 | 4 | 0 | 1 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **750KW Generator** | | | | | | | | | | | | |
| XN | 2560 | XN-2560 | Generator Run | DI | PLC-A | Off | Run | | | 1 | | |
| XF | 2560 | XF-2560 | Generator Fail | DI | PLC-A | Off | Fail | | | 1 | | |
| XF | 2560 | XF-2560 | Generator Low Fuel | DI | PLC-A | Off | Low Fuel | | | 1 | | |
| XF | 2560 | XF-2560 | Generator Fuel Tank Leak | DI | PLC-A | Off | Tk Leak | | | 1 | | |
| XF | 2560 | XF-2560 | Generator Low Battery | DI | PLC-A | Off | Low Batt | | | 1 | | |
| | | | | | PLC-A IO Signals | | | | 0 | 5 | 0 | 0 |

System Integrator shall field verify all existing IO for Interfacing into new PLC.

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **Influent Sampler Flow Meter #1 - 1-ISP-F-1** | | | | | | | | | | | | |
| FC | 100 | FC-100 | Influent Sampler Flow Meter #1. Flow | AO | PLC-IH | 0 | FV | GPM | | | 1 | |
| **Drain PS 1 Flow Meter #1 - 17-PD1-F-1** | | | | | | | | | | | | |
| FE/FIT | 200 | FI-200 | Drain PS 1. Flow | AI | PLC-IH | 0 | FV | GPM | 1 | | | |
| **Influent Flow Meter #1 - 1-I-F-1** | | | | | | | | | | | | |
| FE/FIT | 210 | FI-201 | Influent Flow | AI | PLC-IH | 0 | FV | GPM | 1 | | | |
| **Influent Bar Screen #1** | | | | | | | | | | | | |
| LE/LIT | 303 | LI-303 | Screen #1 Upstream Level | AI | PLC-IH | 0 | FV | FT | 1 | | | |
| LSH | 303 | LH-303 | Screen #1 Upstream Hi Level | DI | PLC-IH | Off | Hi Level | | | 1 | | |
| LE/LIT | 304 | FI-304 | Screen #1 Downstrem Level | AI | PLC-IH | 0 | FV | FT | 1 | | | |
| MN | 300 | MN-300 | Screen #1 Run | DI | PLC-IH | Off | Run | | | 1 | | |
| MF | 300 | MF-300 | Screen #1 Fail | DI | PLC-IH | Off | Fail | | | 1 | | |
| MN | 302 | MN-300 | Screen #1 Conveyor Run | DI | PLC-IH | Off | Run | | | 1 | | |
| MF | 302 | MF-300 | Screen #1 Conveyor Fail | DI | PLC-IH | Off | Fail | | | 1 | | |
| MC | 300 | MC-300 | Screen #1 Start/Stop | DO | PLC-IH | Stop | Start | | | 1 | | |
| **Influent Bar Screen #2** | | | | | | | | | | | | |
| LE/LIT | 313 | LI-313 | Screen #2 Upstrem Level | AI | PLC-IH | 0 | FV | FT | 1 | | | |
| LSH | 313 | LH-313 | Screen #2 Upstrem Hi Level | DI | PLC-IH | Off | Hi Level | | | 1 | | |
| LE/LIT | 314 | FI-314 | Screen #2 Downstrem Level | AI | PLC-IH | 0 | FV | FT | 1 | | | |
| MN | 310 | MN-310 | Screen #2 Run | DI | PLC-IH | Off | Run | | | 1 | | |
| MF | 310 | MF-310 | Screen #2 Fail | DI | PLC-IH | Off | Fail | | | 1 | | |
| MN | 312 | MN-310 | Screen #2 Conveyor Run | DI | PLC-IH | Off | Run | | | 1 | | |
| MF | 312 | MF-310 | Screen #2 Conveyor Fail | DI | PLC-IH | Off | Fail | | | 1 | | |
| MC | 310 | MC-310 | Screen #2 Start/Stop | DO | PLC-IH | Stop | Start | | | 1 | | |
| **Grit Removal #1 &2** | | | | | | | | | | | | |
| MN | 320 | LH-320 | Grit Removal #1 Run | DI | PLC-IH | Off | Run | | Network | | | |
| MF | 320 | MF-320 | Grit Removal #1 Fail | DI | PLC-IH | Off | Fail | | Network | | | |
| MC | 320 | MC-320 | Grit Removal #1 Start/Stop | DO | PLC-IH | Stop | Start | | Network | | | |
| MN | 330 | LH-320 | Grit Removal #1 Run | DI | PLC-IH | Off | Run | | Network | | | |
| MF | 330 | MF-320 | Grit Removal #1 Fail | DI | PLC-IH | Off | Fail | | Network | | | |
| MC | 330 | MC-320 | Grit Removal #1 Start/Stop | DO | PLC-IH | Stop | Start | | Network | | | |
| **Grit Conveyor 1-GC-M-1** | | | | | | | | | | | | |
| MN | 340 | MN-340 | Grit Conveyor Run | DI | PLC-IH | Off | Run | | | 1 | | |
| MF | 340 | MF-340 | Grit Conveyor Fail | DI | PLC-IH | Off | Fail | | | 1 | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| | | | PLC-IH IO Signals | | | | | | 6 | 14 | 1 | 0 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **Fine Screenings Influent Channel Sluice Gate #1 4-IFS-SG-1** | | | | | | | | | | | | |
| MA | 401 | MA-401 | FS1 Influent Sluice Gate 1. Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| ZH | 401 | ZH-401 | FS1 Influent Sluice Gate 1. Open | DI | RIO-BNR2 | Off | Open | | | 1 | | |
| ZL | 401 | ZL-401 | FS1 Influent Sluice Gate 1. Close | DI | RIO-BNR2 | Off | Close | | | 1 | | |
| ZF | 401 | ZF-401 | FS1 Influent Sluice Gate 1. Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| ZO | 401 | MN-401 | FS1 Influent Sluice Gate 1. Open | DO | RIO-BNR2 | Off | Open | | | | | 1 |
| ZC | 401 | MF-401 | FS1 Influent Sluice Gate 1. Close | DO | RIO-BNR2 | Off | Close | | | | | 1 |
| **Fine Screenings System #1 - 4-FS-1** | | | | | | | | | | | | |
| YN | 410 | YN-410 | Fine Screenings #1. Control Power | DI | RIO-BNR2 | Off | On | | Network | | | |
| MA | 410 | MA-410 | Fine Screenings #1. Remote | DI | RIO-BNR2 | Off | Remote | | Network | | | |
| XF | 410 | XF-410 | Fine Screenings #1. Fail | DI | RIO-BNR2 | Off | Fail | | Network | | | |
| LH | 410 | LH-410 | Fine Screenings #1. High Level | DI | RIO-BNR2 | Off | Hi Lvl | | Network | | | |
| LHH | 410 | LHH-410 | Fine Screenings #1. Hi High Level | DI | RIO-BNR2 | Off | Hi Hi Lvl | | Network | | | |
| YN | 410 | YN-410 | Fine Screenings #1. E-Stop | DI | RIO-BNR2 | Off | E-Stop | | Network | | | |
| MN | 410 | MA-410 | Fine Screenings #1. Run | DI | RIO-BNR2 | Off | Run | | Network | | | |
| MN | 410 | MA-410 | Fine Screenings #1. Pump Run | DI | RIO-BNR2 | Off | Run | | Network | | | |
| SI | 410 | SI-410 | Fine Screenings #1. Speed Indication | AI | RIO-BNR2 | 0 | 100 | % | Network | | | |
| MC | 1210 | MC-410 | Fine Screenings #1. Start/Stop | DO | RIO-BNR2 | Stop | Start | | Network | | | |
| SC | 410 | SC-410 | Fine Screenings #1. Speed Control | AO | RIO-BNR2 | 0 | 100 | % | Network | | | |
| **Fine Screen Effluent Channel Sluice Gate #1 4-EFS-SG-1** | | | | | | | | | | | | |
| MA | 430 | MA-430 | FS1 Effluent Sluice Gate 1. Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| ZH | 430 | ZH-430 | FS1 Effluent Sluice Gate 1. Open | DI | RIO-BNR2 | Off | Open | | | 1 | | |
| ZL | 430 | ZL-430 | FS1 Effluent Sluice Gate 1. Close | DI | RIO-BNR2 | Off | Close | | | 1 | | |
| ZF | 430 | ZF-430 | FS1 Effluent Sluice Gate 1. Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| ZO | 430 | MN-430 | FS1 Effluent Sluice Gate 1. Open | DO | RIO-BNR2 | Off | Open | | | | | 1 |
| ZC | 430 | MF-430 | FS1 Effluent Sluice Gate 1. Close | DO | RIO-BNR2 | Off | Close | | | | | 1 |
| **Fine Screen Influent Channel Sluice Gate #2 4-IFS-SG-2** | | | | | | | | | | | | |
| MA | 402 | MA-402 | FS1 Influent Sluice Gate 2. Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| ZH | 402 | ZH-402 | FS1 Influent Sluice Gate 2. Open | DI | RIO-BNR2 | Off | Open | | | 1 | | |
| ZL | 402 | ZL-402 | FS1 Influent Sluice Gate 2. Close | DI | RIO-BNR2 | Off | Close | | | 1 | | |
| ZF | 402 | ZF-402 | FS1 Influent Sluice Gate 2. Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| ZO | 402 | MN-402 | FS1 Influent Sluice Gate 2. Open | DO | RIO-BNR2 | Off | Open | | | | | 1 |
| ZC | 402 | MF-402 | FS1 Influent Sluice Gate 2. Close | DO | RIO-BNR2 | Off | Close | | | | | 1 |
| **Fine Screenings System #2 - 4-FS-2** | | | | | | | | | | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| YN | 420 | YN-420 | Fine Screenings #2. Control Power | DI | RIO-BNR2 | Off | On | | Network | | | |
| MA | 420 | MA-420 | Fine Screenings #2. Remote | DI | RIO-BNR2 | Off | Remote | | Network | | | |
| XF | 420 | XF-420 | Fine Screenings #2. Fail | DI | RIO-BNR2 | Off | Fail | | Network | | | |
| LH | 420 | LH-420 | Fine Screenings #2. High Level | DI | RIO-BNR2 | Off | Hi Lvl | | Network | | | |
| LHH | 420 | LHH-420 | Fine Screenings #2. Hi High Level | DI | RIO-BNR2 | Off | Hi Hi Lvl | | Network | | | |
| YN | 420 | YN-420 | Fine Screenings #2. E-Stop | DI | RIO-BNR2 | Off | E-Stop | | Network | | | |
| MN | 420 | MA-420 | Fine Screenings #2. Run | DI | RIO-BNR2 | Off | Run | | Network | | | |
| MN | 420 | MA-420 | Fine Screenings #2. Pump Run | DI | RIO-BNR2 | Off | Run | | Network | | | |
| SI | 420 | SI-420 | Fine Screenings #2. Speed Indication | AI | RIO-BNR2 | 0 | 100 | % | Network | | | |
| MC | 1210 | MC-1210 | Fine Screenings #2. Start/Stop | DO | RIO-BNR2 | Stop | Start | | Network | | | |
| SC | 420 | SC-420 | Fine Screenings #2. Speed Control | AO | RIO-BNR2 | 0 | 100 | % | Network | | | |
| **Fine Screenings Effluent Channel Sluice Gate #2 4-EFS-SG-2** | | | | | | | | | | | | |
| MA | 440 | MA-440 | FS2 Effluent Sluice Gate 1. Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| ZH | 440 | ZH-440 | FS2 Effluent Sluice Gate 1. Open | DI | RIO-BNR2 | Off | Open | | | 1 | | |
| ZL | 440 | ZL-440 | FS2 Effluent Sluice Gate 1. Close | DI | RIO-BNR2 | Off | Close | | | 1 | | |
| ZF | 440 | ZF-440 | FS2 Effluent Sluice Gate 1. Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| ZO | 440 | MN-440 | FS2 Effluent Sluice Gate 1. Open | DO | RIO-BNR2 | Off | Open | | | | | 1 |
| ZC | 440 | MF-440 | FS2 Effluent Sluice Gate 1. Close | DO | RIO-BNR2 | Off | Close | | | | | 1 |
| **Fine Screenings Conveyor 4-FS-C-1** | | | | | | | | | | | | |
| YN | 450 | YN-450 | FS Conveyor Power Power | DI | RIO-BNR2 | Off | On | | | 1 | | |
| MA | 450 | MA-450 | FS Conveyor Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| MN | 450 | MN-450 | FS Conveyor Run | DI | RIO-BNR2 | Off | Run | | | 1 | | |
| YN | 450 | YN-450 | FS Conveyor E-stop | DI | RIO-BNR2 | Off | E-Stop | | | 1 | | |
| MF | 450 | MF-450 | FS Conveyor Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| MC | 450 | MC-450 | FS Conveyor Start/Sto | DO | RIO-BNR2 | Stop | Start | | | | | 1 |
| | | | | | RIO-BNR2 IO Signals | | | | 0 | 21 | 0 | 9 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **BNR Influent Channel Sluice Gate 1- 5-AT-ISG-1** | | | | | | | | | | | | |
| ZL | 501 | ZL-501 | BNR Influent Channel Sluice Gate # 1. Closed | DI | PLC-BNR | Off | Close | | | 1 | | |
| ZH | 501 | ZH-501 | BNR Influent Channel Sluice Gate # 1. Open | DI | PLC-BNR | Off | Open | | | 1 | | |
| **AT1 OX-1-1 DO #1 - 5-AT1-DO-1** | | | | | | | | | | | | |
| AE/AIT | 502A | AI-502A | AT1 OX-1-1 DO #1 DO | AI | PLC-BNR | 0 | 10 | mg/L | 1 | | | |
| **AT1 OX-1-1 DO #2 - 5-AT1-DO-2** | | | | | | | | | | | | |
| AE/AIT | 502B | AI-502B | AT1 OX-1-1 DO #2 DO | AI | PLC-BNR | 0 | 10 | mg/L | 1 | | | |
| **AT1 OX-1-1 Air Control Valve 1 - 5-AT1-V-1** | | | | | | | | | | | | |
| ZI | 503 | SI-503 | AT1 OX-1-1 Air Valve # 1. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 503 | MA-503 | AT1 OX-1-1 Air Valve # 1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 503 | XF-503 | AT1 OX-1-1 Air Valve # 1. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 503 | XC-503 | AT1 OX-1-1 Air Valve # 1. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT1 OX-1-1 Air Control Valve 2 - 5-AT1-V-2** | | | | | | | | | | | | |
| ZI | 504 | SI-504 | AT1 OX-1-1 Air Valve # 2. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 504 | MA-504 | AT1 OX-1-1 Air Valve # 2. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 504 | XF-504 | AT1 OX-1-1 Air Valve # 2. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 504 | XC-504 | AT1 OX-1-1 Air Valve # 2. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT1 AX-1-1 ORP #1 - 5-AT1-ORP-1** | | | | | | | | | | | | |
| AE/AIT | 505 | AI-505 | AT1 AX-1-1 ORP #1 ORP | AI | PLC-BNR | 0 | TBD | mg/L | 1 | | | |
| **AT1 OX-1-2 DO #3 - 5-AT1-DO-3** | | | | | | | | | | | | |
| AE/AIT | 508A | AI-508A | AT1 OX-1-2 DO #3 DO | AI | PLC-BNR | 0 | 10 | mg/L | 1 | | | |
| **AT1 OX-1-2 DO #4 - 5-AT1-DO-4** | | | | | | | | | | | | |
| AE/AIT | 508B | AI-508B | AT1 OX-1-2 DO #4 DO | AI | PLC-BNR | 0 | 10 | mg/L | 1 | | | |
| **AT1 OX-1-2 Air Control Valve 3 - 5-AT1-V-3** | | | | | | | | | | | | |
| ZI | 509 | SI-509 | AT1 OX-1-2 Air Valve # 3. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 509 | MA-509 | AT1 OX-1-2 Air Valve # 3. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 509 | XF-509 | AT1 OX-1-2 Air Valve # 3. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 509 | XC-509 | AT1 OX-1-2 Air Valve # 3. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT1 OX-1-2 Air Control Valve 4 - 5-AT1-V-4** | | | | | | | | | | | | |
| ZI | 510 | SI-510 | AT1 OX-1-2 Air Valve # 4. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 510 | MA-510 | AT1 OX-1-2 Air Valve # 4. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 510 | XF-510 | AT1 OX-1-2 Air Valve # 4. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 510 | XC-510 | AT1 OX-1-2 Air Valve # 4. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **BNR AT1 Sluice Gate #1 - 5-AT1-SG-1** | | | | | | | | | | | | |
| ZL | 511 | ZL-511 | AT1 Sluice Gate # 1. Closed | DI | PLC-BNR | Off | Close | | | 1 | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| ZH | 511 | ZH-511 | AT1 Sluice Gate # 1. Open | DI | PLC-BNR | Off | Open | | | 1 | | |
| **AT1 AX-1-1 Recycle Flow Meter #1 - 5-AT1-F-5** | | | | | | | | | | | | |
| FE/FIT | 516 | FI-516 | AT1 AX--11 Recycle Flow Meter #1. Flow | AI | PLC-BNR | 0 | TBD | GPM | 1 | | | |
| **AT1 AX-1-1 Recycle Valve #1 - 5-AT1-V-5** | | | | | | | | | | | | |
| ZI | 536 | SI-536 | AT1 AX-1-1 Recycle Valve #1. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 536 | MA-536 | AT1 AX-1-1 Recycle Valve #1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 536 | XF-536 | AT1 AX-1-1 Recycle Valve #1. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 536 | XC-536 | AT1 AX-1-1 Recycle Valve #1. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT1 AX-1-1 Recycle Pump #1 - 5-AT1-P-1** | | | | | | | | | | | | |
| SI | 515 | SI-515 | AT1 AX-1-1 IR Pump # 1. Speed Indication | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 515 | MA-515 | AT1 AX-1-1 IR Pump # 1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| MN | 515 | MN-515 | AT1 AX-1-1 IR Pump # 1. Run Status | DI | PLC-BNR | Off | Run | | | 1 | | |
| TSH | 515 | TH-515 | AT1 AX-1-1 IR Pump # 1. Hi Temperaure | DI | PLC-BNR | Off | Hi Temp | | | 1 | | |
| YF | 515 | YF-515 | AT1 AX-1-1 IR Pump # 1. Seal Leak | DI | PLC-BNR | Off | Seal Fail | | | 1 | | |
| MF | 515 | MF-515 | AT1 AX-1-1 IR Pump # 1. VFD Fail | DI | PLC-BNR | Off | Fail | | | 1 | | |
| MC | 515 | MC-515 | AT1 AX-1-1 IR Pump # 1. Motor Control | DO | PLC-BNR | Stop | Start | | | | | 1 |
| SC | 515 | SC-515 | AT1 AX-1-1 IR Pump # 1. Speed Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT1 OX-1-2 Recycle Flow Meter #2 - 5-AT1-F-6** | | | | | | | | | | | | |
| FE/FIT | 556 | FI-556 | AT1 OX-1-2 Recycle Flow Meter #2. Flow | AI | PLC-BNR | 0 | TBD | GPM | 1 | | | |
| **AT1 OX-1-2 Recycle Valve #2 - 5-AT1-V-6** | | | | | | | | | | | | |
| ZI | 576 | SI-576 | AT1 OX-1-2 Recycle Valve #2. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 576 | MA-576 | AT1 OX-1-2 Recycle Valve #2. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 576 | XF-576 | AT1 OX-1-2 Recycle Valve #2. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 576 | XC-576 | AT1 OX-1-2 Recycle Valve #2. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT1 OX-1-2 Recycle Pump #2 - 5-AT1-P-2** | | | | | | | | | | | | |
| SI | 517 | SI-517 | AT1 OX-1-2 IR Pump # 1. Speed Indication | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 517 | MA-517 | AT1 AX-1-2 IR Pump # 1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| MN | 517 | MN-517 | AT1 OX-1-2 IR Pump # 1. Run Status | DI | PLC-BNR | Off | Run | | | 1 | | |
| TSH | 517 | TH-517 | AT1 OX-1-2 IR Pump # 1. Hi Temperaure | DI | PLC-BNR | Off | Hi Temp | | | 1 | | |
| YF | 517 | YF-517 | AT1 OX-1-2 IR Pump # 1. Seal Leak | DI | PLC-BNR | Off | Seal Fail | | | 1 | | |
| MF | 517 | MF-517 | AT1 OX-1-2 IR Pump # 1. VFD Fail | DI | PLC-BNR | Off | Fail | | | 1 | | |
| MC | 517 | MC-517 | AT1 OX-1-2 IR Pump # 1. Motor Control | DO | PLC-BNR | Stop | Start | | | | | 1 |
| SC | 517 | SC-517 | AT1 OX-1-2 IR Pump # 1. Speed Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **BNR Effluent Channel Sluice Gate #1 4-EAT-SG-1** | | | | | | | | | | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| MA | 518 | MA-518 | BNR Effluent Sluice Gate 1. Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| ZH | 518 | ZH-518 | BNR Effluent Sluice Gate 1. Open | DI | RIO-BNR2 | Off | Open | | | 1 | | |
| ZL | 518 | ZL-518 | BNR Effluent Sluice Gate 1. Close | DI | RIO-BNR2 | Off | Close | | | 1 | | |
| ZF | 518 | ZF-518 | BNR Effluent Sluice Gate 1. Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| ZO | 518 | MN-518 | BNR Effluent Sluice Gate 1. Open | DO | RIO-BNR2 | Off | Open | | | | | 1 |
| ZC | 518 | MF-518 | BNR Effluent Sluice Gate 1. Close | DO | RIO-BNR2 | Off | Close | | | | | 1 |
| | | | PLC-BNR IO Signals | | | | | | 15 | 30 | 8 | 4 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **AT2 OX-2-1 DO #1 - 5-AT2-DO-1** | | | | | | | | | | | | |
| AE/AIT | 522A | AI-522A | AT2 OX-2-1 DO #1 DO | AI | PLC-BNR | 0 | 10 | mg/L | 1 | | | |
| **AT2 OX-2-1 DO #2 - 5-AT2-DO-2** | | | | | | | | | | | | |
| AE/AIT | 522B | AI-522B | AT2 OX-2-1 DO #2 DO | AI | PLC-BNR | 0 | 10 | mg/L | 1 | | | |
| **AT2 OX-2-1 Air Control Valve 1 - 5-AT2-V-1** | | | | | | | | | | | | |
| ZI | 523 | SI-523 | AT2 OX-2-1 Air Valve # 1. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 523 | MA-523 | AT2 OX-2-1 Air Valve # 1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 523 | XF-523 | AT2 OX-2-1 Air Valve # 1. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 523 | XC-523 | AT2 OX-2-1 Air Valve # 1. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT2 OX-2-1 Control Valve 2 - 5-AT2-V-2** | | | | | | | | | | | | |
| ZI | 524 | SI-524 | AT2 OX-2-1 Air Valve # 2. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 524 | MA-524 | AT2 OX-2-1 Air Valve # 2. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 524 | XF-524 | AT2 OX-2-1 Air Valve # 2. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 524 | XC-524 | AT2 OX-2-1 Air Valve # 2. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT2 AX-2-1 ORP #1 - 5-AT2-ORP-1** | | | | | | | | | | | | |
| AE/AIT | 525 | AI-525 | AT2 AX-2-1 ORP #1 ORP | AI | PLC-BNR | 0 | TBD | mg/L | 1 | | | |
| **AT2 OX-2-2 DO #3 - 5-AT2-DO-3** | | | | | | | | | | | | |
| AE/AIT | 528A | AI-528A | AT2 OX-2-2 DO #3 DO | AI | PLC-BNR | 0 | 10 | mg/L | 1 | | | |
| **AT2 OX-2-2 DO #4 - 5-AT2-DO-4** | | | | | | | | | | | | |
| AE/AIT | 528B | AI-528B | AT2 OX-2-2 DO #4 DO | AI | PLC-BNR | 0 | 10 | mg/L | 1 | | | |
| **AT2 OX-2-2 Air Control Valve 3 - 5-AT2-V-3** | | | | | | | | | | | | |
| ZI | 529 | SI-529 | AT2 OX-2-2 Air Valve # 3. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 529 | MA-529 | AT2 OX-2-2 Air Valve # 3. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 529 | XF-529 | AT2 OX-2-2 Air Valve # 3. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 529 | XC-529 | AT2 OX-2-2 Air Valve # 3. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT2 OX-2-2 Air Control Valve 4 - 5-AT2-V-4** | | | | | | | | | | | | |
| ZI | 530 | SI-530 | AT2 OX-2-2 Air Valve # 4. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 530 | MA-530 | AT2 OX-2-2 Air Valve # 4. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 530 | XF-530 | AT2 OX-2-2 Air Valve # 4. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 530 | XC-530 | AT2 OX-2-2 Air Valve # 4. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **BNR AT2 Sluice Gate #1 - 5-AT2-SG-1** | | | | | | | | | | | | |
| ZL | 531 | ZL-531 | AT2 Sluice Gate # 1. Closed | DI | PLC-BNR | Off | Close | | | 1 | | |
| ZH | 531 | ZH-531 | AT2 Sluice Gate # 1. Open | DI | PLC-BNR | Off | Open | | | 1 | | |
| **AT2 AX-2-1 Recycle Flow Meter #1 - 5-AT2-F-5** | | | | | | | | | | | | |
| FE/FIT | 582 | FI-582 | AT2 AX-2-1 Recycle Flow Meter #1. Flow | AI | PLC-BNR | 0 | TBD | GPM | 1 | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **AT2 AX-2-1 Recycle Valve #1 - 5-AT2-V-5** | | | | | | | | | | | | |
| ZI | 583 | SI-583 | AT2 AX-2-1 Recycle Valve #1. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 583 | MA-583 | AT2 AX-2-1 Recycle Valve #1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 583 | XF-583 | AT2 AX-2-1 Recycle Valve #1. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 583 | XC-583 | AT2 AX-2-1 Recycle Valve #1. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT2 AX-2-1 Recycle Pump #1 - 5-AT2-P-1** | | | | | | | | | | | | |
| SI | 535 | SI-535 | AT2 AX-2-1 IR Pump # 1. Speed Indication | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 535 | MA-535 | AT2 AX-2-1 IR Pump # 1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| MN | 535 | MN-535 | AT2 AX-2-1 IR Pump # 1. Run Status | DI | PLC-BNR | Off | Run | | | 1 | | |
| TSH | 535 | TH-535 | AT2 AX-2-1 IR Pump # 1. Hi Temperaure | DI | PLC-BNR | Off | Hi Temp | | | 1 | | |
| YF | 535 | YF-535 | AT2 AX-2-1 Pump # 1. Seal Leak | DI | PLC-BNR | Off | Seal Fail | | | 1 | | |
| MF | 535 | MF-535 | AT2 AX-2-1 IR Pump # 1. VFD Fail | DI | PLC-BNR | Off | Fail | | | 1 | | |
| MC | 535 | MC-535 | AT2 AX-2-1 IR Pump # 1. Motor Control | DO | PLC-BNR | Stop | Start | | | | | 1 |
| SC | 535 | SC-535 | AT2 AX-2-1 IR Pump # 1. Speed Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT2 OX-2-2 Recycle Flow Meter #2 - 5-AT2-F-6** | | | | | | | | | | | | |
| FE/FIT | 584 | FI-584 | AT2 OX-2-2 Recycle Flow Meter #2. Flow | AI | PLC-BNR | 0 | TBD | GPM | 1 | | | |
| **AT2 OX-2-2 Recycle Valve #2 - 5-AT2-V-6** | | | | | | | | | | | | |
| ZI | 585 | SI-585 | AT2 OX-2-2 Recycle Valve #2. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 585 | MA-585 | AT2 OX-2-2 Recycle Valve #2. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 585 | XF-585 | AT2 OX-2-2 Recycle Valve #2. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 585 | XC-585 | AT2 OX-2-2 Recycle Valve #2. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT2 OX-2-2 Recycle Pump #2 - 5-AT2-P-2** | | | | | | | | | | | | |
| SI | 537 | SI-537 | AT2 OX-2-2 IR Pump # 2. Speed Indication | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 537 | MA-537 | AT2 AX-2-2 IR Pump # 2. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| MN | 537 | MN-537 | AT2 OX-2-2 IR Pump # 2. Run Status | DI | PLC-BNR | Off | Run | | | 1 | | |
| TSH | 537 | TH-537 | AT2 OX-2-2 IR Pump # 2. Hi Temperaure | DI | PLC-BNR | Off | Hi Temp | | | 1 | | |
| YF | 537 | YF-537 | AT2 OX-2-2 IR Pump # 2. Seal Leak | DI | PLC-BNR | Off | Seal Fail | | | 1 | | |
| MF | 537 | MF-537 | AT2 OX-2-2 IR Pump # 2. VFD Fail | DI | PLC-BNR | Off | Fail | | | 1 | | |
| MC | 537 | MC-537 | AT2 OX-2-2 IR Pump # 2. Motor Control | DO | PLC-BNR | Stop | Start | | | | | 1 |
| SC | 537 | SC-537 | AT2 OX-2-2 IR Pump # 2. Speed Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| | | | | | PLC-MB IO Signals | | | | 15 | 24 | 8 | 2 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **AT3 OX-3-1 DO #1 - 5-AT3-DO-1** | | | | | | | | | | | | |
| AE/AIT | 542A | AI-542A | AT3 OX-3-1 DO #1 DO | AI | PLC-BNR | 0 | 10 | mg/L | 1 | | | |
| **AT3 OX-3-1 DO #2 - 5-AT3-DO-2** | | | | | | | | | | | | |
| AE/AIT | 542B | AI-542B | AT3 OX-3-1 DO #2 DO | AI | PLC-BNR | 0 | 10 | mg/L | 1 | | | |
| **AT3 OX-3-1 Air Control Valve 1 - 5-AT3-V-1** | | | | | | | | | | | | |
| ZI | 543 | SI-543 | AT3 OX-3-1 Air Valve # 1. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 543 | MA-543 | AT3 OX-3-1 Air Valve # 1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 543 | XF-543 | AT3 OX-3-1 Air Valve # 1. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 543 | XC-543 | AT3 OX-3-1 Air Valve # 1. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT3 OX-3-1 Air Control Valve 2 - 5-AT3-V-2** | | | | | | | | | | | | |
| ZI | 544 | SI-544 | AT3 OX-3-1 Air Valve # 2. Position Indication | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 544 | MA-544 | AT3 OX-3-1 Air Valve # 2. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 544 | XF-544 | AT3 OX-3-1 Air Valve # 2. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 544 | XC-544 | AT3 OX-3-1 Air Valve # 2. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT3 AX-3-A ORP #1 - 5-AT3-ORP-1** | | | | | | | | | | | | |
| AE/AIT | 545 | AI-545 | AT3 AX-3-1 ORP #1 ORP | AI | PLC-BNR | 0 | TBD | mg/L | 1 | | | |
| **AT3 OX-3-2 DO #3 - 5-AT3-DO-3** | | | | | | | | | | | | |
| AE/AIT | 548A | AI-548A | AT3 OX-3-2 DO #3 DO | AI | PLC-BNR | 0 | 10 | mg/L | 1 | | | |
| **AT3 OX-3-2 DO #4 - 5-AT3-DO-4** | | | | | | | | | | | | |
| AE/AIT | 548B | AI-548B | AT3 OX-3-2 DO #4 DO | AI | PLC-BNR | 0 | 10 | mg/L | 1 | | | |
| **AT3 OX-3-2 Air Control Valve 3 - 5-AT3-V-3** | | | | | | | | | | | | |
| ZI | 549 | SI-549 | AT3 OX-3-2 Air Valve # 3. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 549 | MA-549 | AT3 OX-3-2 Air Valve # 3. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 549 | XF-549 | AT3 OX-3-2 Air Valve # 3. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 549 | XC-549 | AT3 OX-3-2 Air Valve # 3. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT3 OX-3-2 Air Control Valve 4 - 5-AT3-V-4** | | | | | | | | | | | | |
| ZI | 550 | SI-550 | AT3 OX-3-2 Air Valve # 4. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 550 | MA-550 | AT3 OX-3-2 Air Valve # 4. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 550 | XF-550 | AT3 OX-3-2 Air Valve # 4. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 550 | XC-550 | AT3 OX-3-2 Air Valve # 4. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **BNR AT3 Sluice Gate #1 - 5-AT3-SG-1** | | | | | | | | | | | | |
| ZL | 551 | ZL-551 | AT3 Sluice Gate # 1. Closed | DI | PLC-BNR | Off | Close | | | 1 | | |
| ZH | 551 | ZH-551 | AT3 Sluice Gate # 1. Open | DI | PLC-BNR | Off | Open | | | 1 | | |
| **AT3 AX-3-1 Recycle Flow Meter #1 - 5-AT3-F-5** | | | | | | | | | | | | |
| FE/FIT | 588 | FI-588 | AT3 AX-3-1 Recycle Flow Meter #1. Flow | AI | PLC-BNR | 0 | TBD | GPM | 1 | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **AT3 AX-3-1 Recycle Valve #1 - 5-AT3-V-5** | | | | | | | | | | | | |
| ZI | 589 | SI-589 | AT3 AX-3-1 Recycle Valve #1. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 589 | MA-589 | AT3 AX-3-1 Recycle Valve #1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 589 | XF-589 | AT3 AX-3-1 Recycle Valve #1. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 589 | XC-589 | AT3 AX-3-1 Recycle Valve #1. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT3 AX-3-1 Recycle Pump #1 - 5-AT3-P-1** | | | | | | | | | | | | |
| SI | 555 | SI-555 | AT3 AX-3-1 IR Pump # 1. Speed Indication | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 555 | MA-555 | AT3 AX-3-1 IR Pump # 1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| MN | 555 | MN-555 | AT3 AX-3-1 IR Pump # 1. Run Status | DI | PLC-BNR | Off | Run | | | 1 | | |
| TSH | 555 | TH-555 | AT3 AX-3-1 IR Pump # 1. Hi Temperaure | DI | PLC-BNR | Off | Hi Temp | | | 1 | | |
| YF | 555 | YF-555 | AT3 AX-3-1 IR Pump # 1. Seal Leak | DI | PLC-BNR | Off | Seal Fail | | | 1 | | |
| MF | 555 | MF-555 | AT3 AX-3-1 IR Pump # 1. VFD Fail | DI | PLC-BNR | Off | Fail | | | 1 | | |
| MC | 555 | MC-555 | AT3 AX-3-1 IR Pump # 1. Motor Control | DO | PLC-BNR | Stop | Start | | | | | 1 |
| SC | 555 | SC-555 | AT3 AX-3-1 IR Pump # 1. Speed Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT3 OX-3-2 Recycle Flow Meter #2 - 5-AT3-F-6** | | | | | | | | | | | | |
| FE/FIT | 590 | FI-586 | AT3 OX-3-2 Recycle Flow Meter #2. Flow | AI | PLC-BNR | 0 | TBD | GPM | 1 | | | |
| **AT3 OX-3-2 Recycle Valve #2 - 5-AT3-V-6** | | | | | | | | | | | | |
| ZI | 591 | SI-591 | AT3 OX-3-2 Recycle Valve #2. Position Ind | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 591 | MA-591 | AT3 OX-3-2 Recycle Valve #2. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| XF | 591 | XF-591 | AT3 OX-3-2 Recycle Valve #2. Valve Failure | DI | PLC-BNR | Off | Fail | | | 1 | | |
| XC | 591 | XC-591 | AT3 OX-3-2 Recycle Valve #2. Position Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **AT3 OX-3-2 Recycle Pump #2 - 5-AT3-P-2** | | | | | | | | | | | | |
| SI | 557 | SI-557 | AT3 OX-3-2 IR Pump # 1. Speed Indication | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 557 | MA-557 | AT3 AX-3-1 IR Pump # 1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| MN | 557 | MN-557 | AT3 OX-3-2 IR Pump # 1. Run Status | DI | PLC-BNR | Off | Run | | | 1 | | |
| TSH | 557 | TH-557 | AT3 OX-3-2 IR Pump # 1. Hi Temperaure | DI | PLC-BNR | Off | Hi Temp | | | 1 | | |
| YF | 557 | YF-557 | AT3 OX-3-2 IR Pump # 1. Seal Leak | DI | PLC-BNR | Off | Seal Fail | | | 1 | | |
| MF | 557 | MF-557 | AT3 OX-3-2 IR Pump # 1. VFD Fail | DI | PLC-BNR | Off | Fail | | | 1 | | |
| MC | 557 | MC-557 | AT3 OX-3-2 IR Pump # 1. Motor Control | DO | PLC-BNR | Stop | Start | | | | | 1 |
| SC | 557 | SC-557 | AT3 OX-3-2 IR Pump # 1. Speed Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| | | | | | PLC-BNR IO Signals | | | | 15 | 24 | 8 | 2 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **AT4 OX-4-1 DO #1 - 6-AT4-DO-1** | | | | | | | | | | | | |
| AE/AIT | 562A | AI-562A | AT4 OX-4-1 DO #1 DO | AI | PLC-H | 0 | 10 | mg/L | 1 | | | |
| **AT4 OX-4-1 DO #2 - 6-AT4-DO-2** | | | | | | | | | | | | |
| AE/AIT | 562B | AI-562B | AT4 OX-4-1 DO #2 DO | AI | PLC-H | 0 | 10 | mg/L | 1 | | | |
| **AT4 OX-4-1 Air Control Valve 1 - 6-AT4-V-1** | | | | | | | | | | | | |
| ZI | 563 | SI-563 | AT4 OX-4-1 Air Valve # 1. Position Ind | AI | PLC-H | 0 | 100 | % | 1 | | | |
| HMS | 563 | MA-563 | AT4 OX-4-1 Air Valve # 1. Remote | DI | PLC-H | Off | Remote | | | 1 | | |
| XF | 563 | XF-563 | AT4 OX-4-1 Air Valve # 1. Valve Failure | DI | PLC-H | Off | Fail | | | 1 | | |
| XC | 563 | XC-563 | AT4 OX-4-1 Air Valve # 1. Position Control | AO | PLC-H | 0 | 100 | % | | | 1 | |
| **AT4 OX-4-1 Air Control Valve 2 - 6-AT4-V-2** | | | | | | | | | | | | |
| ZI | 564 | SI-564 | AT4 OX-4-1 Air Valve # 2. Position Ind | AI | PLC-H | 0 | 100 | % | 1 | | | |
| HMS | 564 | MA-564 | AT4 OX-4-1 Air Valve # 2. Remote | DI | PLC-H | Off | Remote | | | 1 | | |
| XF | 564 | XF-564 | AT4 OX-4-1 Air Valve # 2. Valve Failure | DI | PLC-H | Off | Fail | | | 1 | | |
| XC | 564 | XC-564 | AT4 OX-4-1 Air Valve # 2. Position Control | AO | PLC-H | 0 | 100 | % | | | 1 | |
| **AT4 AX-4-1 ORP #1 - 6-AT4-ORP-1** | | | | | | | | | | | | |
| AE/AIT | 565 | AI-565 | AT4 AX-4-1 ORP #1 ORP | AI | PLC-H | 0 | TBD | mg/L | 1 | | | |
| **AT4 OX-4-2 DO #3 - 6-AT4-DO-3** | | | | | | | | | | | | |
| AE/AIT | 568A | AI-568A | AT4 OX-4-2 DO #3 DO | AI | PLC-H | 0 | 10 | mg/L | 1 | | | |
| **AT4 OX-4-2 DO #4 - 6-AT4-DO-4** | | | | | | | | | | | | |
| AE/AIT | 568B | AI-568B | AT4 OX-4-2 DO #4 DO | AI | PLC-H | 0 | 10 | mg/L | 1 | | | |
| **AT4 OX-4-2 Air Control Valve 3 - 6-AT4-V-3** | | | | | | | | | | | | |
| ZI | 569 | SI-569 | AT4 OX-4-2 Air Valve # 3. Position Ind | AI | PLC-H | 0 | 100 | % | 1 | | | |
| HMS | 569 | MA-569 | AT4 OX-4-2 Air Valve # 3. Remote | DI | PLC-H | Off | Remote | | | 1 | | |
| XF | 569 | XF-569 | AT4 OX-4-2 Air Valve # 3. Valve Failure | DI | PLC-H | Off | Fail | | | 1 | | |
| XC | 569 | XC-569 | AT4 OX-4-2 Air Valve # 3. Position Control | AO | PLC-H | 0 | 100 | % | | | 1 | |
| **AT4 OX-4-2 Air Control Valve 4 - 6-AT4-V-4** | | | | | | | | | | | | |
| ZI | 570 | SI-570 | AT4 OX-4-2 Air Valve # 4. Position Ind | AI | PLC-H | 0 | 100 | % | 1 | | | |
| HMS | 570 | MA-570 | AT4 OX-4-2 Air Valve # 4. Remote | DI | PLC-H | Off | Remote | | | 1 | | |
| XF | 570 | XF-570 | AT4 OX-4-2 Air Valve # 4. Valve Failure | DI | PLC-H | Off | Fail | | | 1 | | |
| XC | 570 | XC-570 | AT4 OX-4-2 Air Valve # 4. Position Control | AO | PLC-H | 0 | 100 | % | | | 1 | |
| **AT4 AX-4-1 Recycle Flow Meter #1 - 6-AT4-F-5** | | | | | | | | | | | | |
| FE/FIT | 594 | FI-594 | AT4 AX-4-1 Recycle Flow Meter #1. Flow | AI | PLC-H | 0 | TBD | GPM | 1 | | | |
| **AT4 AX-4-1 Recycle Valve #1 - 6-AT4-V-5** | | | | | | | | | | | | |
| ZI | 595 | SI-595 | AT4 AX-4-1 Recycle Valve #1. Position Ind | AI | PLC-H | 0 | 100 | % | 1 | | | |
| HMS | 595 | MA-595 | AT4 AX-4-1 Recycle Valve #1. Remote | DI | PLC-H | Off | Remote | | | 1 | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| XF | 595 | XF-595 | AT4 AX-4-1 Recycle Valve #1. Valve Failure | DI | PLC-H | Off | Fail | | | 1 | | |
| XC | 595 | XC-595 | AT4 AX-4-1 Recycle Valve #1. Position Control | AO | PLC-H | 0 | 100 | % | | | 1 | |
| **AT4 AX-4-1 Recycle Pump #1 - 6-AT4-P-1** | | | | | | | | | | | | |
| SI | 575 | SI-575 | AT4 AX-4-1 IR Pump # 1. Speed Indication | AI | PLC-H | 0 | 100 | % | 1 | | | |
| HMS | 575 | MA-575 | AT4 AX-4-1 IR Pump # 1. Remote | DI | PLC-H | Off | Remote | | | 1 | | |
| MN | 575 | MN-575 | AT4 AX-4-1 IR Pump # 1. Run Status | DI | PLC-H | Off | Run | | | 1 | | |
| TSH | 575 | TH-575 | AT4 AX-4-1 IR Pump # 1. Hi Temperaure | DI | PLC-H | Off | Hi Temp | | | 1 | | |
| YF | 575 | YF-575 | AT4 AX-4-1 IR Pump # 1. Seal Leak | DI | PLC-H | Off | Seal Fail | | | 1 | | |
| MF | 575 | MF-575 | AT4 AX-4-1 IR Pump # 1. VFD Fail | DI | PLC-H | Off | Fail | | | 1 | | |
| MC | 575 | MC-575 | AT4 AX-4-1 IR Pump # 1. Motor Control | DO | PLC-H | Stop | Start | | | | | 1 |
| SC | 575 | SC-575 | AT4 AX-4-1 IR Pump # 1. Speed Control | AO | PLC-H | 0 | 100 | % | | | 1 | |
| **AT4 OX-4-2 Recycle Flow Meter #2 - 6-AT4-F-6** | | | | | | | | | | | | |
| FE/FIT | 596 | FI-596 | AT4 OX-4-2 Recycle Flow Meter #2. Flow | AI | PLC-H | 0 | TBD | GPM | 1 | | | |
| **AT4 OX-4-2 Recycle Valve #2 - 6-AT4-V-6** | | | | | | | | | | | | |
| ZI | 597 | SI-597 | AT4 OX-4-2 Recycle Valve #2. Position Ind | AI | PLC-H | 0 | 100 | % | 1 | | | |
| HMS | 597 | MA-597 | AT4 OX-4-2 Recycle Valve #2. Remote | DI | PLC-H | Off | Remote | | | 1 | | |
| XF | 597 | XF-597 | AT4 OX-4-2 Recycle Valve #2. Valve Failure | DI | PLC-H | Off | Fail | | | 1 | | |
| XC | 597 | XC-597 | AT4 OX-4-2 Recycle Valve #2. Position Control | AO | PLC-H | 0 | 100 | % | | | 1 | |
| **AT4 OX-4-2 Recycle Pump #2 - 6-AT4-P-2** | | | | | | | | | | | | |
| SI | 577 | SI-577 | AT4 OX-4-2 IR Pump # 1. Speed Indication | AI | PLC-H | 0 | 100 | % | 1 | | | |
| HMS | 577 | MA-577 | AT4 AX-4-1 IR Pump # 1. Remote | DI | PLC-H | Off | Remote | | | 1 | | |
| MN | 577 | MN-577 | AT4 OX-4-2 IR Pump # 1. Run Status | DI | PLC-H | Off | Run | | | 1 | | |
| TSH | 577 | TH-577 | AT4 OX-4-2 IR Pump # 1. Hi Temperaure | DI | PLC-H | Off | Hi Temp | | | 1 | | |
| YF | 577 | YF-577 | AT4 OX-4-2 IR Pump # 1. Seal Leak | DI | PLC-H | Off | Seal Fail | | | 1 | | |
| MF | 577 | MF-577 | AT4 OX-4-2 IR Pump # 1. VFD Fail | DI | PLC-H | Off | Fail | | | 1 | | |
| MC | 577 | MC-577 | AT4 OX-4-2 IR Pump # 1. Motor Control | DO | PLC-H | Stop | Start | | | | | 1 |
| SC | 577 | SC-577 | AT4 OX-4-2 IR Pump # 1. Speed Control | AO | PLC-H | 0 | 100 | % | | | 1 | |
| | | | | | PLC-H IO Signals | | | | 15 | 22 | 8 | 2 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **Alum Tank #1 Level - 17-TK1-L-1** | | | | | | | | | | | | |
| LE/LIT | 700 | LI-700 | Alum Day Tank #1. Level | AI | RIO-BNR2 | 0 | TBD | FT | 1 | | | |
| **Ex Alum Tank #2 Level - 17-TK2-L-1** | | | | | | | | | | | | |
| LE/LIT | 701 | LI-701 | Alum Storage Tank #2. Level | AI | RIO-BNR2 | 0 | TBD | FT | 1 | | | |
| **Emergency Eyewash Safety Shower 1** | | | | | | | | | | | | |
| FSH | 702 | FH-702 | Emergency Eyewash 1. Hi Flow | DI | RIO-BNR2 | Off | Hi Flow | | | 1 | | |
| **Alum Tanks Transfer Pump - 17-TK-P-1** | | | | | | | | | | | | |
| HMS | 705 | MA-705 | Alum Tks Transfer Pump #1. Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| MN | 705 | MN-705 | Alum Tks Transfer Pump #1. Run Status | DI | RIO-BNR2 | Off | Run | | | 1 | | |
| MF | 705 | MF-705 | Alum Tks Transfer Pump #1. Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| MC | 705 | MC-705 | Alum Tks Transfer Pump #1. Control Motor | DO | RIO-BNR2 | Stop | Start | | | | | 1 |
| **Alum Skid 1 Pump #1 - 17-AL-P-1** | | | | | | | | | | | | |
| HMS | 710 | MA-710 | Skid Alum Pump #1. Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| MN | 710 | MN-710 | Skid Alum Pump #1. Run Status | DI | RIO-BNR2 | Off | Run | | | 1 | | |
| MF | 710 | MF-710 | Skid Alum Pump #1. Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| SI | 710 | SI-710 | Skid Alum Pump #1. Speed Indication | AI | RIO-BNR2 | 0 | 100 | % | 1 | | | |
| SC | 710 | SC-710 | Skid Alum Pump #1. Speed Control | AO | RIO-BNR2 | 0 | 100 | % | | | 1 | |
| MC | 710 | MC-710 | Skid Alum Pump #1. Control Motor | DO | RIO-BNR2 | Stop | Start | | | | | 1 |
| **Alum Skid 1 Pump #2 - 17-AL-P-2** | | | | | | | | | | | | |
| HMS | 720 | MA-720 | Skid Alum Pump #2. Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| MN | 720 | MN-720 | Skid Alum Pump #2. Run Status | DI | RIO-BNR2 | Off | Run | | | 1 | | |
| MF | 720 | MF-720 | Skid Alum Pump #2. Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| SI | 720 | SI-720 | Skid Alum Pump #2. Speed Indication | AI | RIO-BNR2 | 0 | 100 | % | 1 | | | |
| SC | 720 | SC-720 | Skid Alum Pump #2. Speed Control | AO | RIO-BNR2 | 0 | 100 | % | | | 1 | |
| MC | 720 | MC-720 | Skid Alum Pump #2. Control Motor | DO | RIO-BNR2 | Stop | Start | | | | | 1 |
| **Alum Skid 1 Pump #3 - 17-AL-P-3** | | | | | | | | | | | | |
| HMS | 730 | MA-730 | Skid Alum Pump #3. Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| MN | 730 | MN-730 | Skid Alum Pump #3. Run Status | DI | RIO-BNR2 | Off | Run | | | 1 | | |
| MF | 730 | MF-730 | Skid Alum Pump #3. Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| SI | 730 | SI-730 | Skid Alum Pump #3. Speed Indication | AI | RIO-BNR2 | 0 | 100 | % | 1 | | | |
| SC | 730 | SC-730 | Skid Alum Pump #3. Speed Control | AO | RIO-BNR2 | 0 | 100 | % | | | 1 | |
| MC | 730 | MC-730 | Skid Alum Pump #3. Control Motor | DO | RIO-BNR2 | Stop | Start | | | | | 1 |
| **Alum Skid 2 Pump #1 - 17-AL-P-4** | | | | | | | | | | | | |
| HMS | 740 | MA-740 | Skid Alum Pump #4. Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| MN | 740 | MN-740 | Skid Alum Pump #4. Run Status | DI | RIO-BNR2 | Off | Run | | | 1 | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| MF | 740 | MF-740 | Skid Alum Pump #4. Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| SI | 740 | SI-740 | Skid Alum Pump #4. Speed Indication | AI | RIO-BNR2 | 0 | 100 | % | 1 | | | |
| SC | 740 | SC-740 | Skid Alum Pump #4. Speed Control | AO | RIO-BNR2 | 0 | 100 | % | | | 1 | |
| MC | 740 | MC-740 | Skid Alum Pump #4. Control Motor | DO | RIO-BNR2 | Stop | Start | | | | | 1 |
| **Alum Skid 2 Pump #2 - 17-AL-P-5** | | | | | | | | | | | | |
| HMS | 750 | MA-750 | Skid Alum Pump #5. Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| MN | 750 | MN-750 | Skid Alum Pump #5. Run Status | DI | RIO-BNR2 | Off | Run | | | 1 | | |
| MF | 750 | MF-750 | Skid Alum Pump #5. Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| SI | 750 | SI-750 | Skid Alum Pump #5. Speed Indication | AI | RIO-BNR2 | 0 | 100 | % | 1 | | | |
| SC | 750 | SC-750 | Skid Alum Pump #5. Speed Control | AO | RIO-BNR2 | 0 | 100 | % | | | 1 | |
| MC | 750 | MC-750 | Skid Alum Pump #5. Control Motor | DO | RIO-BNR2 | Stop | Start | | | | | 1 |
| **Alum Skid 2 Pump #3 - 17-AL-P-6** | | | | | | | | | | | | |
| HMS | 760 | MA-760 | Skid Alum Pump #6. Remote | DI | RIO-BNR2 | Off | Remote | | | 1 | | |
| MN | 760 | MN-760 | Skid Alum Pump #6. Run Status | DI | RIO-BNR2 | Off | Run | | | 1 | | |
| MF | 760 | MF-760 | Skid Alum Pump #6. Fail | DI | RIO-BNR2 | Off | Fail | | | 1 | | |
| SI | 760 | SI-760 | Skid Alum Pump #6. Speed Indication | AI | RIO-BNR2 | 0 | 100 | % | 1 | | | |
| SC | 760 | SC-760 | Skid Alum Pump #6. Speed Control | AO | RIO-BNR2 | 0 | 100 | % | | | 1 | |
| MC | 760 | MC-760 | Skid Alum Pump #6. Control Motor | DO | RIO-BNR2 | Stop | Start | | | | | 1 |
| | | | | | RIO-BNR2 IO Signals | | | | 8 | 22 | 6 | 7 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **Membrane Bldg Emergency Eyewash Safety Shower 1** | | | | | | | | | | | | |
| FSH | 2181 | FH-2081 | Emergency Eyewash 1. Hi Flow | DI | PLC-BNR | 0 | Hi Flow | | | 1 | | |
| **Membrane Bldg Emergency Eyewash Safety Shower 2** | | | | | | | | | | | | |
| FSH | 2082 | FH-2082 | Emergency Eyewash 5. Hi Flow | DI | PLC-BNR | 0 | Hi Flow | | | 1 | | |
| **Electrical Room High Temperature Switch 1 (5-BNR-TS-1)** | | | | | | | | | | | | |
| TSH | 2183 | TH-2183 | Electrical Room High Temp | DI | PLC-BNR | 0 | Hi Temp | | | 1 | | |
| **Electrical Room Low Temperature Switch 2 (5-BNR-TS-2)** | | | | | | | | | | | | |
| TSL | 2184 | TL-2184 | Electrical Room Low Temp | DI | PLC-BNR | 0 | Low Temp | | | 1 | | |
| | | | | PLC-BNR IO Signals | | | | | 0 | 4 | 0 | 0 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **BNR Air Supply Pressure #1 - 5-A-PT-1** | | | | | | | | | | | | |
| PIT | 601 | PI-601 | BNR Air Supply Presssure | AI | PLC-BNR | 0 | TBD | PSI | 1 | | | |
| **BNR Air Supply Pressure #2 - 5-A-PT-2** | | | | | | | | | | | | |
| PIT | 602 | PI-602 | BNR Air Supply Presssure | AI | PLC-BNR | 0 | TBD | PSI | 1 | | | |
| **BNR Air Supply Pressure #3 - 5-A-PT-3** | | | | | | | | | | | | |
| PIT | 603 | PI-603 | BNR Air Supply Presssure | AI | PLC-BNR | 0 | TBD | PSI | 1 | | | |
| **BNR Air Supply Pressure #4 - 5-A-PT-4** | | | | | | | | | | | | |
| PIT | 604 | PI-604 | BNR Air Supply Presssure | AI | PLC-BNR | 0 | TBD | PSI | 1 | | | |
| **BNR Blower #1 Valve 5-A-V-1** | | | | | | | | | | | | |
| ZL | 610 | ZL-610 | Blower #1 Air Valve. Closed | DI | PLC-BNR | Off | Open | | | 1 | | |
| ZH | 610 | ZH-610 | Blower #1 Air Valve. Open | DI | PLC-BNR | Off | Close | | | 1 | | |
| **BNR Blower #1 5-A-BL-1** | | | | | | | | | | | | |
| HMS | 610 | MA-610 | Blower #1. Remote | DI | PLC-BNR | Off | Remote | | Network | | | |
| PDT | 611 | PD-611 | Blower #1. Filter Alarm | DI | PLC-BNR | Off | Filter Alm | | Network | | | |
| MN | 610 | MN-610 | Blower #1. Run Status | DI | PLC-BNR | Off | Run | | Network | | | |
| PIT | 612 | PI-612 | Blower #1. Suction Pressure | AI | PLC-BNR | 0 | TBD | PSI | Network | | | |
| TIT | 613 | TI-613 | Blower #1. Oil Temperature | AI | PLC-BNR | 0 | TBD | F | Network | | | |
| PIT | 614 | PI-614 | Blower #1. Discharge Pressure | AI | PLC-BNR | 0 | TBD | PSI | Network | | | |
| TIT | 615 | TI-615 | Blower #1. Discharge Temperature | AI | PLC-BNR | 0 | TBD | F | Network | | | |
| XF | 610 | XF-610 | Blower #1. System Fail | DI | PLC-BNR | Off | Fail | | Network | | | |
| XW | 610 | XW-610 | Blower #1. System Warnig | DI | PLC-BNR | Off | Warning | | Network | | | |
| SI | 610 | SI-610 | Blower #1. Speed Indication | AI | PLC-BNR | 0 | 100 | % | Network | | | |
| MC | 610 | MC-610 | Blower #1. Start/Stop | DO | PLC-BNR | Stop | Start | | Network | | | |
| SC | 610 | SC-610 | Blower #1. Speed Control | AO | PLC-BNR | 0 | 100 | % | Network | | | |
| **BNR Blower #2 Valve 5-A-V-2** | | | | | | | | | | | | |
| ZL | 620 | ZL-620 | Blower #2 Air Valve. Closed | DI | PLC-BNR | Off | Open | | | 1 | | |
| ZH | 620 | ZH-620 | Blower #2 Air Valve. Open | DI | PLC-BNR | Off | Close | | | 1 | | |
| **BNR Blower #2 5-A-BL-2** | | | | | | | | | | | | |
| HMS | 620 | MA-620 | Blower #2. Remote | DI | PLC-BNR | Off | Remote | | Network | | | |
| PDT | 621 | PD-621 | Blower #2. Filter Alarm | DI | PLC-BNR | Off | Filter Alm | | Network | | | |
| MN | 620 | MN-620 | Blower #2. Run Status | DI | PLC-BNR | Off | Run | | Network | | | |
| PIT | 622 | PI-622 | Blower #2. Suction Pressure | AI | PLC-BNR | 0 | TBD | PSI | Network | | | |
| TIT | 623 | TI-623 | Blower #2. Oil Temperature | AI | PLC-BNR | 0 | TBD | F | Network | | | |
| PIT | 624 | PI-624 | Blower #2. Discharge Pressure | AI | PLC-BNR | 0 | TBD | PSI | Network | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| TIT | 625 | TI-625 | Blower #2. Discharge Temperature | AI | PLC-BNR | 0 | TBD | F | Network | | | |
| XF | 620 | XF-620 | Blower #2. System Fail | DI | PLC-BNR | Off | Fail | | Network | | | |
| XW | 620 | XW-620 | Blower #2. System Warnig | DI | PLC-BNR | Off | Warning | | Network | | | |
| SI | 620 | SI-620 | Blower #2. Speed Indication | AI | PLC-BNR | 0 | 100 | % | Network | | | |
| MC | 620 | MC-620 | Blower #2. Start/Stop | DO | PLC-BNR | Stop | Start | | Network | | | |
| SC | 620 | SC-620 | Blower #2. Speed Control | AO | PLC-BNR | 0 | 100 | % | Network | | | |
| **BNR Blower #3 Valve 5-A-V-3** | | | | | | | | | | | | |
| ZL | 630 | ZL-630 | Blower #3 Air Valve. Closed | DI | PLC-BNR | Off | Open | | | 1 | | |
| ZH | 630 | ZH-630 | Blower #3 Air Valve. Open | DI | PLC-BNR | Off | Close | | | 1 | | |
| **BNR Blower #3 5-A-BL-3** | | | | | | | | | | | | |
| HMS | 630 | MA-630 | Blower #3. Remote | DI | PLC-BNR | Off | Remote | | Network | | | |
| PDT | 631 | PD-631 | Blower #3. Filter Alarm | DI | PLC-BNR | Off | Filter Alm | | Network | | | |
| MN | 630 | MN-630 | Blower #3. Run Status | DI | PLC-BNR | Off | Run | | Network | | | |
| PIT | 632 | PI-632 | Blower #3. Suction Pressure | AI | PLC-BNR | 0 | TBD | PSI | Network | | | |
| TIT | 633 | TI-633 | Blower #3. Oil Temperature | AI | PLC-BNR | 0 | TBD | F | Network | | | |
| PIT | 634 | PI-634 | Blower #3. Discharge Pressure | AI | PLC-BNR | 0 | TBD | PSI | Network | | | |
| TIT | 635 | TI-635 | Blower #3. Discharge Temperature | AI | PLC-BNR | 0 | TBD | F | Network | | | |
| XF | 630 | XF-630 | Blower #3. System Fail | DI | PLC-BNR | Off | Fail | | Network | | | |
| XW | 630 | XW-630 | Blower #3. System Warnig | DI | PLC-BNR | Off | Warning | | Network | | | |
| SI | 630 | SI-630 | Blower #3. Speed Indication | AI | PLC-BNR | 0 | 100 | % | Network | | | |
| MC | 630 | MC-630 | Blower #3. Start/Stop | DO | PLC-BNR | Stop | Start | | Network | | | |
| SC | 630 | SC-630 | Blower #3. Speed Control | AO | PLC-BNR | 0 | 100 | % | Network | | | |
| **BNR Blower #4 Valve 5-A-V-4** | | | | | | | | | | | | |
| ZL | 640 | ZL-640 | Blower #4 Air Valve. Closed | DI | PLC-BNR | Off | Open | | | 1 | | |
| ZH | 640 | ZH-640 | Blower #4 Air Valve. Open | DI | PLC-BNR | Off | Close | | | 1 | | |
| **BNR Blower #4 5-A-BL-4** | | | | | | | | | | | | |
| HMS | 640 | MA-640 | Blower #4. Remote | DI | PLC-BNR | Off | Remote | | Network | | | |
| PDT | 641 | PD-641 | Blower #4. Filter Alarm | DI | PLC-BNR | Off | Filter Alm | | Network | | | |
| MN | 640 | MN-640 | Blower #4. Run Status | DI | PLC-BNR | Off | Run | | Network | | | |
| PIT | 642 | PI-642 | Blower #4. Suction Pressure | AI | PLC-BNR | 0 | TBD | PSI | Network | | | |
| TIT | 643 | TI-643 | Blower #4. Oil Temperature | AI | PLC-BNR | 0 | TBD | F | Network | | | |
| PIT | 644 | PI-644 | Blower #4. Discharge Pressure | AI | PLC-BNR | 0 | TBD | PSI | Network | | | |
| TIT | 645 | TI-645 | Blower #4. Discharge Temperature | AI | PLC-BNR | 0 | TBD | F | Network | | | |
| XF | 640 | XF-640 | Blower #4. System Fail | DI | PLC-BNR | Off | Fail | | Network | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| XW | 640 | XW-640 | Blower #4. System Warnig | DI | PLC-BNR | Off | Warning | | Network | | | |
| SI | 640 | SI-640 | Blower #4. Speed Indication | AI | PLC-BNR | 0 | 100 | % | Network | | | |
| MC | 640 | MC-640 | Blower #4. Start/Stop | DO | PLC-BNR | Stop | Start | | Network | | | |
| SC | 640 | SC-640 | Blower #4. Speed Control | AO | PLC-BNR | 0 | 100 | % | Network | | | |
| **BNR Blower #5 Valve 5-A-V-5** | | | | | | | | | | | | |
| ZL | 650 | ZL-650 | Blower #5 Air Valve. Closed | DI | PLC-BNR | Off | Open | | | 1 | | |
| ZH | 650 | ZH-650 | Blower #5 Air Valve. Open | DI | PLC-BNR | Off | Close | | | 1 | | |
| **BNR Blower #5 5-A-BL-5** | | | | | | | | | | | | |
| HMS | 650 | MA-650 | Blower #5. Remote | DI | PLC-BNR | Off | Remote | | Network | | | |
| PDT | 651 | PD-651 | Blower #5. Filter Alarm | DI | PLC-BNR | Off | Filter Alm | | Network | | | |
| MN | 650 | MN-650 | Blower #5. Run Status | DI | PLC-BNR | Off | Run | | Network | | | |
| PIT | 652 | PI-652 | Blower #5. Suction Pressure | AI | PLC-BNR | 0 | TBD | PSI | Network | | | |
| TIT | 653 | TI-653 | Blower #5. Oil Temperature | AI | PLC-BNR | 0 | TBD | F | Network | | | |
| PIT | 654 | PI-654 | Blower #5. Discharge Pressure | AI | PLC-BNR | 0 | TBD | PSI | Network | | | |
| TIT | 655 | TI-655 | Blower #5. Discharge Temperature | AI | PLC-BNR | 0 | TBD | F | Network | | | |
| XF | 650 | XF-650 | Blower #5. System Fail | DI | PLC-BNR | Off | Fail | | Network | | | |
| XW | 650 | XW-650 | Blower #5. System Warnig | DI | PLC-BNR | Off | Warning | | Network | | | |
| SI | 650 | SI-650 | Blower #5. Speed Indication | AI | PLC-BNR | 0 | 100 | % | Network | | | |
| MC | 650 | MC-650 | Blower #5. Start/Stop | DO | PLC-BNR | Stop | Start | | Network | | | |
| SC | 650 | SC-650 | Blower #5. Speed Control | AO | PLC-BNR | 0 | 100 | % | Network | | | |
| | | | | | PLC-BNR IO Signals | | | | 4 | 10 | 0 | 0 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **Scum Collection Box Level - 5-SC-L-1** | | | | | | | | | | | | |
| LE/LIT | 660 | LI-660 | Scum Collection Box. Level | AI | PLC-BNR | 0 | TBD | FT | 1 | | | |
| **Scum Collection Box Hi Level - 5-SC-LS-1** | | | | | | | | | | | | |
| LSH | 661 | LH-661 | Scum Collection Box. Hi Level | DI | RIO-H1 | Off | Hi Level | | | 1 | | |
| **Scum Collection Box PW Solenoid Valve - 5-PW-V-1** | | | | | | | | | | | | |
| ZC | 663 | ZC-663 | Scum Box Potable Water Valve | DO | PLC-BNR | Close | Open | | | | | 1 |
| **Scum Collection Box PW low Flow - 5-PW-FS-1** | | | | | | | | | | | | |
| FSL | 662 | FL-662 | Scum Box Potable Low Flow | DI | PLC-BNR | Off | Low Flow | | | 1 | | |
| **Scum Pump 1 - 5-SC-P-1** | | | | | | | | | | | | |
| HMS | 670 | MA-670 | Scum Pump #1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| MN | 670 | MN-670 | Scum Pump #1. Run Status | DI | PLC-BNR | Off | Run | | | 1 | | |
| MF | 670 | MF-670 | Scum Pump #1. Fail | DI | PLC-BNR | Off | Fail | | | 1 | | |
| MO | 671 | PL-671 | Scum Pump #1. Low Pressure | DI | PLC-BNR | Off | Lo Press | | | 1 | | |
| MC | 670 | MC-670 | Scum Pump #1. Motor Control | DO | PLC-BNR | Stop | Start | | | | | 1 |
| **Scum Pump 2 - 5-SC-P-2** | | | | | | | | | | | | |
| HMS | 680 | MA-680 | Scum Pump #2. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| MN | 680 | MN-680 | Scum Pump #2. Run Status | DI | PLC-BNR | Off | Run | | | 1 | | |
| MF | 680 | MF-680 | Scum Pump #2. Fail | DI | PLC-BNR | Off | Fail | | | 1 | | |
| MO | 681 | PL-681 | Scum Pump #2. Low Pressure | DI | PLC-BNR | Off | Lo Press | | | 1 | | |
| MC | 680 | MC-680 | Scum Pump #2. Motor Control | DO | PLC-BNR | Stop | Start | | | | | 1 |
| | | | | | PLC-BNR IO Signals | | | | 1 | 10 | 0 | 3 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **RAS Splitte Box Level - 5-RAS-L-1** | | | | | | | | | | | | |
| LE/LIT | 660 | LI-660 | RAS Splitter Box. Level | AI | PLC-BNR | 0 | TBD | FT | 1 | | | |
| **RAS Splitter Box  Hi Level - 5-RAS-LS-1** | | | | | | | | | | | | |
| LSH | 661 | LH-661 | RAS Splitter Box. Hi Level | DI | PLC-BNR | Off | Hi Level | | | 1 | | |
| | | | | | PLC-BNR IO Signals | | | | 1 | 1 | 0 | 0 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **UV Influent Flow 10-IUV-F-1** | | | | | | | | | | | | |
| FE/FIT | 1000 | FI-1000 | UV Influent Flow | AI | PLC-UVPA | 0 | TBD | GPM | 1 | | | |
| **UV Disinfection System** | | | | | | | | | | | | |
| LE/LIT | 1001 | LI-1011 | UV System Influent Level | AI | PLC-UVPA | 0 | TBD | FT | Network | | | |
| LE/LIT | 1002 | LI-1012 | UV System Effluent Level | AI | PLC-UVPA | 0 | TBD | FT | Network | | | |
| LSL | 1003 | LL-1013 | UV System Low Level | DI | PLC-UVPA | Off | Low Lvl | | Network | | | |
| AE/AIT | 1010 | AI-1011 | UV System Transmittance | AI | PLC-UVPA | 0 | TBD | % | Network | | | |
| JN | 1010 | JN-1010 | UV System. Control Power | DI | PLC-UVPA | Off | Pwr | | Network | | | |
| XA | 1010 | XA-1010 | UV System. Remote | DI | PLC-UVPA | Off | Rem | | Network | | | |
| YN | 1010 | YN-1010 | UV System. E-Stop | DI | PLC-UVPA | Off | E-Stop | | Network | | | |
| XF | 1010 | XF-1010 | UV System. Fail | DI | PLC-UVPA | Off | Fail | | Network | | | |
| XC | 1010 | XC-1010 | UV System. Start/Stop | DO | PLC-UVPA | Stop | Start | | Network | | | |
| YN | 1010 | YN-1010 | Lamp Status ON | DI | PLC-UVPA | Off | On | | Network | | | |
| YF | 1010 | YF-1010 | Wiper Fault | DI | PLC-UVPA | Off | Fail | | Network | | | |
| YN | 1010 | YA-1010 | Cleaning Auto | DI | PLC-UVPA | Off | Auto | | Network | | | |
| AE/AIT | 1010 | AI-1010 | Lamp UV Intensity | AI | PLC-UVPA | 0 | 100 | % | Network | | | |
| **UV Channel Effluent Sluice Gate #1 10-UV-SG-1** | | | | | | | | | | | | |
| MA | 1014 | MA-1014 | UV Effluent Sluice Gate 1. Remote | DI | PLC-UVPA | Off | Remote | | Network | | | |
| ZH | 1014 | ZH-1014 | UV Effluent Sluice Gate 1. Open | DI | PLC-UVPA | Off | Open | | Network | | | |
| ZL | 1014 | ZL-1014 | UV Effluent Sluice Gate 1. Close | DI | PLC-UVPA | Off | Close | | Network | | | |
| ZF | 1014 | ZF-1014 | UV Effluent Sluice Gate 1. Fail | DI | PLC-UVPA | Off | Fail | | Network | | | |
| ZO | 1014 | MN-1014 | UV Effluent Sluice Gate 1. Open | DO | PLC-UVPA | Off | Open | | Network | | | |
| ZC | 1014 | MF-1014 | UV Effluent Sluice Gate 1. Close | DO | PLC-UVPA | Off | Close | | Network | | | |
| **PA Tank 1 Sluice Gate #1 10-PA-SG-1** | | | | | | | | | | | | |
| MA | 1015 | MA-1015 | PA Tank 1 Sluice Gate 1. Remote | DI | PLC-UVPA | Off | Remote | | | 1 | | |
| ZH | 1015 | ZH-1015 | PA Tank 1 Sluice Gate 1. Open | DI | PLC-UVPA | Off | Open | | | 1 | | |
| ZL | 1015 | ZL-1015 | PA Tank 1 Sluice Gate 1. Close | DI | PLC-UVPA | Off | Close | | | 1 | | |
| ZF | 1015 | ZF-1015 | PA Tank 1 Sluice Gate 1. Fail | DI | PLC-UVPA | Off | Fail | | | 1 | | |
| ZO | 1015 | MN-1015 | PA Tank 1 Sluice Gate 1. Open | DO | PLC-UVPA | Off | Open | | | | | 1 |
| ZC | 1015 | MF-1015 | PA Tank 1 Sluice Gate 1. Close | DO | PLC-UVPA | Off | Close | | | | | 1 |
| **Post Aeration Tank 1 DO #1 - 10-PA-DO-1** | | | | | | | | | | | | |
| AE/AIT | 1020 | AI-1020 | Post Aeration Tk 1 DO Level | AI | PLC-UVPA | 0 | 10 | mg/L | 1 | | | |
| **PA Tank 1 Sluice Gate #1 10-PA-SG-1** | | | | | | | | | | | | |
| MA | 1025 | MA-1025 | PATank 2 Sluice Gate 1. Remote | DI | PLC-UVPA | Off | Remote | | | 1 | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| ZH | 1025 | ZH-1025 | PATank 2 Sluice Gate 1. Open | DI | PLC-UVPA | Off | Open | | | 1 | | |
| ZL | 1025 | ZL-1025 | PATank 2 Sluice Gate 1. Close | DI | PLC-UVPA | Off | Close | | | 1 | | |
| ZF | 1025 | ZF-1025 | PATank 2 Sluice Gate 1. Fail | DI | PLC-UVPA | Off | Fail | | | 1 | | |
| ZO | 1025 | MN-1025 | PATank 2 Sluice Gate 1. Open | DO | PLC-UVPA | Off | Open | | | | | 1 |
| ZC | 1025 | MF-1025 | PATank 2 Sluice Gate 1. Close | DO | PLC-UVPA | Off | Close | | | | | 1 |
| **Post Aeration Tank 2 DO #2 - 10-PA-DO-2** | | | | | | | | | | | | |
| AE/AIT | 1030 | AI-1030 | Post Aeration Tk 2 DO Level | AI | PLC-UVPA | 0 | 10 | mg/L | 1 | | | |
| **Post Aeration Sampler Flow Pace 10-PASP-F-1** | | | | | | | | | | | | |
| FC | 1040 | FC-1040 | Post Aeration Sample Flow | AO | PLC-UVPA | 0 | 100 | % | | | 1 | |
| **Post Aeration Tank Dropbox Turbidity - 10-PA-TURB-1** | | | | | | | | | | | | |
| AE/AIT | 1040 | AI-1040 | Post Aeration Dropbox Turbidity | AI | PLC-UVPA | | | | 1 | | | |
| | | | | | PLC-PA IO Signals | | | | 4 | 8 | 1 | 4 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **UVPA Air Supply Pressure #1 - 10-A-PT-1** | | | | | | | | | | | | |
| PIT | 1047 | PI-1047 | PA Air Supply Presssure 1 | AI | PLC-UVPA | 0 | TBD | PSI | 1 | | | |
| **PA Air Valve 5 10-PA-V-5** | | | | | | | | | | | | |
| MA | 1048 | MA-1048 | PA Air Valve 5. Remote | DI | PLC-UVPA | Off | Remote | | | 1 | | |
| ZH | 1048 | ZH-1048 | PA Air Valve 5. Open | DI | PLC-UVPA | Off | Open | | | 1 | | |
| ZL | 1048 | ZL-1048 | PA Air Valve 5. Close | DI | PLC-UVPA | Off | Close | | | 1 | | |
| ZF | 1048 | ZF-1048 | PA Air Valve 5. Fail | DI | PLC-UVPA | Off | Fail | | | 1 | | |
| ZO | 1048 | MN-1048 | PA Air Valve 5. Open | DO | PLC-UVPA | Off | Open | | | | | 1 |
| ZC | 1048 | MF-1048 | PA Air Valve 5. Close | DO | PLC-UVPA | Off | Close | | | | | 1 |
| **UVPA Aeration Blower #1 Valve 10-A-V-1** | | | | | | | | | | | | |
| ZL | 1040 | ZL-1040 | Blower #1 Air Valve 1. Closed | DI | PLC-PA | Off | Open | | | 1 | | |
| ZH | 1040 | ZH-1040 | Blower #1 Air Valve 1. Open | DI | PLC-PA | Off | Close | | | 1 | | |
| **UVPA Aeration Blower #1 10-A-BL-1** | | | | | | | | | | | | |
| HMS | 1040 | MA-1040 | Blower #1. Remote | DI | PLC-PA | Off | Remote | | Network | | | |
| PDT | 1041 | PD-1041 | Blower #1. Filter Alarm | DI | PLC-PA | Off | Filter Alm | | Network | | | |
| MN | 1040 | MN-1040 | Blower #1. Run Status | DI | PLC-PA | Off | Run | | Network | | | |
| PIT | 1042 | PI-1042 | Blower #1. Suction Pressure | AI | PLC-PA | 0 | TBD | PSI | Network | | | |
| TIT | 1043 | TI-1043 | Blower #1. Oil Temperature | AI | PLC-PA | 0 | TBD | F | Network | | | |
| PIT | 1044 | PI-1044 | Blower #1. Discharge Pressure | AI | PLC-PA | 0 | TBD | PSI | Network | | | |
| TIT | 1045 | TI-1045 | Blower #1. Discharge Temperature | AI | PLC-PA | 0 | TBD | F | Network | | | |
| XF | 1040 | XF-1040 | Blower #1. System Fail | DI | PLC-PA | Off | Fail | | Network | | | |
| XW | 1040 | XW-1040 | Blower #1. System Warnig | DI | PLC-PA | Off | Warning | | Network | | | |
| SI | 1040 | SI-1040 | Blower #1. Speed Indication | AI | PLC-PA | 0 | 100 | % | Network | | | |
| MC | 1040 | MC-1040 | Blower #1. Start/Stop | DO | PLC-PA | Stop | Start | | Network | | | |
| SC | 1040 | SC-1040 | Blower #1. Speed Control | AO | PLC-PA | 0 | 100 | % | Network | | | |
| **UVPA Air Supply Pressure #1 - 10-A-PT-2** | | | | | | | | | | | | |
| PIT | 1057 | PI-1057 | PA Air Supply Presssure 2 | AI | PLC-PA | 0 | TBD | PSI | 1 | | | |
| **UVPA Aeration Blower #2 Valve 10-A-V-2** | | | | | | | | | | | | |
| ZL | 1050 | ZL-1050 | Blower #2 Air Valve 2. Closed | DI | PLC-PA | Off | Open | | | 1 | | |
| ZH | 1050 | ZH-1050 | Blower #2 Air Valve 2. Open | DI | PLC-PA | Off | Close | | | 1 | | |
| **UVPA Aeration Blower #2 10-A-BL-2** | | | | | | | | | | | | |
| HMS | 1050 | MA-1050 | Blower #2. Remote | DI | PLC-PA | Off | Remote | | Network | | | |
| PDT | 1051 | PD-1051 | Blower #2. Filter Alarm | DI | PLC-PA | Off | Filter Alm | | Network | | | |
| MN | 1050 | MN-1050 | Blower #2. Run Status | DI | PLC-PA | Off | Run | | Network | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| PIT | 1052 | PI-1052 | Blower #2. Suction Pressure | AI | PLC-PA | 0 | TBD | PSI | Network | | | |
| TIT | 1053 | TI-1053 | Blower #2. Oil Temperature | AI | PLC-PA | 0 | TBD | F | Network | | | |
| PIT | 1054 | PI-1054 | Blower #2. Discharge Pressure | AI | PLC-PA | 0 | TBD | PSI | Network | | | |
| TIT | 1055 | TI-1055 | Blower #2. Discharge Temperature | AI | PLC-PA | 0 | TBD | F | Network | | | |
| XF | 1050 | XF-1050 | Blower #2. System Fail | DI | PLC-PA | Off | Fail | | Network | | | |
| XW | 1050 | XW-1050 | Blower #2. System Warnig | DI | PLC-PA | Off | Warning | | Network | | | |
| SI | 1050 | SI-1050 | Blower #2. Speed Indication | AI | PLC-PA | 0 | 100 | % | Network | | | |
| MC | 1050 | MC-1050 | Blower #2. Start/Stop | DO | PLC-PA | Stop | Start | | Network | | | |
| SC | 1050 | SC-1050 | Blower #2. Speed Control | AO | PLC-PA | 0 | 100 | % | Network | | | |
| **UVPA Aeration Blower #3 Valve 10-A-V-3** | | | | | | | | | | | | |
| ZL | 1060 | ZL-1060 | Blower #3 Air Valve 3. Closed | DI | PLC-PA | Off | Open | | | 1 | | |
| ZH | 1060 | ZH-1060 | Blower #3 Air Valve 3. Open | DI | PLC-PA | Off | Close | | | 1 | | |
| **UVPA Aeration Blower #3 Valve 10-A-V-4** | | | | | | | | | | | | |
| ZL | 1069 | ZL-1069 | Blower #3 Air Valve 4. Closed | DI | PLC-PA | Off | Open | | | 1 | | |
| ZH | 1069 | ZH-1069 | Blower #3 Air Valve 4. Open | DI | PLC-PA | Off | Close | | | 1 | | |
| **UVPA Aeration Blower #3 10-A-BL-3** | | | | | | | | | | | | |
| HMS | 1060 | MA-1060 | Blower #3. Remote | DI | PLC-PA | Off | Remote | | Network | | | |
| PDT | 1061 | PD-1061 | Blower #3. Filter Alarm | DI | PLC-PA | Off | Filter Alm | | Network | | | |
| MN | 1060 | MN-1060 | Blower #3. Run Status | DI | PLC-PA | Off | Run | | Network | | | |
| PIT | 1062 | PI-1062 | Blower #3. Suction Pressure | AI | PLC-PA | 0 | TBD | PSI | Network | | | |
| TIT | 1063 | TI-1063 | Blower #3. Oil Temperature | AI | PLC-PA | 0 | TBD | F | Network | | | |
| PIT | 1064 | PI-1064 | Blower #3. Discharge Pressure | AI | PLC-PA | 0 | TBD | PSI | Network | | | |
| TIT | 1065 | TI-1065 | Blower #3. Discharge Temperature | AI | PLC-PA | 0 | TBD | F | Network | | | |
| XF | 1060 | XF-1060 | Blower #3. System Fail | DI | PLC-PA | Off | Fail | | Network | | | |
| XW | 1060 | XW-1060 | Blower #3. System Warnig | DI | PLC-PA | Off | Warning | | Network | | | |
| SI | 1060 | SI-1060 | Blower #3. Speed Indication | AI | PLC-PA | 0 | 100 | % | Network | | | |
| MC | 1060 | MC-1060 | Blower #3. Start/Stop | DO | PLC-PA | Stop | Start | | Network | | | |
| SC | 1060 | SC-1060 | Blower #3. Speed Control | AO | PLC-PA | 0 | 100 | % | Network | | | |
| **PA Air Valve 6 10-PA-V-6** | | | | | | | | | | | | |
| MA | 1058 | MA-1058 | PA Air Valve 6. Remote | DI | PLC-UVPA | Off | Remote | | | 1 | | |
| ZH | 1058 | ZH-1058 | PA Air Valve 6. Open | DI | PLC-UVPA | Off | Open | | | 1 | | |
| ZL | 1058 | ZL-1058 | PA Air Valve 6. Close | DI | PLC-UVPA | Off | Close | | | 1 | | |
| ZF | 1058 | ZF-1058 | PA Air Valve 6. Fail | DI | PLC-UVPA | Off | Fail | | | 1 | | |
| ZO | 1058 | MN-1058 | PA Air Valve 6. Open | DO | PLC-UVPA | Off | Open | | | | | 1 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| ZC | 1058 | MF-1058 | PA Air Valve 6. Close | DO | PLC-UVPA | Off | Close | | | | | 1 |
| **Post Aeration Tank Dropbox Turbidity - 10-PA-TURB-1** | | | | | | | | | | | | |
| AE/AIT | 1040 | AI-1040 | Post Aeration Dropbox Turbidity | AI | PLC-UVPA | 0 | TBD | NTU | 1 | | | |
| | | | | | PLC-UVPA IO Signals | | | | 3 | 16 | 0 | 4 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **WAS Storage Tank Level - 11-WT-L-1** | | | | | | | | | | | | |
| LE/LIT | 1100 | LI-1100 | WAS Storage Tank. Level | AI | RIO-BNR1 | 0 | TBD | FT | 1 | | | |
| **WAS Storage Tank Hi Level - 11-WT-LS-1** | | | | | | | | | | | | |
| LSH | 1101 | LH-1101 | WAS Storage Tank. Hi Level | DI | RIO-BNR1 | Off | Hi Level | | | 1 | | |
| **WAS Bypass Flow Meter #1 - 11-WB-F-1** | | | | | | | | | | | | |
| FE/FIT | 1160 | FI-1155 | WAS Bypass Flow. Flow | AI | RIO-BNR1 | 0 | TBD | GPM | 1 | | | |
| **Reuse Pumps #1 & 2 - 11-RP-P-1&2** | | | | | | | | | | | | |
| PSH | 1140 | MA-1140 | Reuse Pump Station Disch Hi Press | DI | RIO-BNR1 | Off | Hi Press | | | 1 | | |
| PSL | 1140 | MA-1140 | Reuse Pump Station Disch Lo Press | DI | RIO-BNR1 | Off | Lo Press | | | 1 | | |
| LSL | 1140 | MA-1140 | Reuse Pump Station Low Level | DI | RIO-BNR1 | Off | Lo Level | | | 1 | | |
| MN | 1140 | MN-1140 | Reuse Pump Station Pump #1. Run Status | DI | RIO-BNR1 | Off | Run | | | 1 | | |
| MF | 1140 | MF-1140 | Reuse Pump Station Pump #1. Fail | DI | RIO-BNR1 | Off | Fail | | | 1 | | |
| MN | 1150 | MN-1150 | Reuse Pump Station Pump #2. Run Status | DI | RIO-BNR1 | Off | Run | | | 1 | | |
| MF | 1150 | MF-1150 | Reuse Pump Station Pump #2. Fail | DI | RIO-BNR1 | Off | Fail | | | 1 | | |
| | | | | RIO-BNR IO Signals | | | | | 2 | 8 | 0 | 0 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **Sludge Feed Pump #1 - 11-SF-P-1** | | | | | | | | | | | | |
| SI | 1110 | SI-1110 | Sludge Feed Pump #1. Speed Indication | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 1110 | MA-1110 | Sludge Feed Pump #1. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| MN | 1110 | MN-1110 | Sludge Feed Pump #1. Run Status | DI | PLC-BNR | Off | Run | | | 1 | | |
| TSH | 1110 | TH-1110 | Sludge Feed Pump #1. Hi Temperaure | DI | PLC-BNR | Off | Hi Temp | | | 1 | | |
| YF | 1110 | YF-1110 | Sludge Feed Pump #1. Seal Leak | DI | PLC-BNR | Off | Seal Fail | | | 1 | | |
| MF | 1110 | MF-1110 | Sludge Feed Pump #1. VFD Fail | DI | PLC-BNR | Off | Fail | | | 1 | | |
| MC | 1110 | MC-1110 | Sludge Feed Pump #1. Motor Control | DO | PLC-BNR | Stop | Start | | | | | 1 |
| SC | 1110 | SC-1110 | Sludge Feed Pump #1. Speed Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **Sludge Feed Pump #2 - 11-SF-P-2** | | | | | | | | | | | | |
| SI | 1120 | SI-1120 | Sludge Feed Pump #2. Speed Indication | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 1120 | MA-1120 | Sludge Feed Pump #2. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| MN | 1120 | MN-1120 | Sludge Feed Pump #2. Run Status | DI | PLC-BNR | Off | Run | | | 1 | | |
| TSH | 1120 | TH-1120 | Sludge Feed Pump #2. Hi Temperaure | DI | PLC-BNR | Off | Hi Temp | | | 1 | | |
| YF | 1120 | YF-1120 | Sludge Feed Pump #2. Seal Leak | DI | PLC-BNR | Off | Seal Fail | | | 1 | | |
| MF | 1120 | MF-1120 | Sludge Feed Pump #2. VFD Fail | DI | PLC-BNR | Off | Fail | | | 1 | | |
| MC | 1120 | MC-1120 | Sludge Feed Pump #2. Motor Control | DO | PLC-BNR | Stop | Start | | | | | 1 |
| SC | 1120 | SC-1120 | Sludge Feed Pump #2. Speed Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| **Sludge Feed Pump #3 - 11-SF-P-3** | | | | | | | | | | | | |
| SI | 1130 | SI-1130 | Sludge Feed Pump #3. Speed Indication | AI | PLC-BNR | 0 | 100 | % | 1 | | | |
| HMS | 1130 | MA-1130 | Sludge Feed Pump #3. Remote | DI | PLC-BNR | Off | Remote | | | 1 | | |
| MN | 1130 | MN-1130 | Sludge Feed Pump #3. Run Status | DI | PLC-BNR | Off | Run | | | 1 | | |
| TSH | 1130 | TH-1130 | Sludge Feed Pump #3. Hi Temperaure | DI | PLC-BNR | Off | Hi Temp | | | 1 | | |
| YF | 1130 | YF-1130 | Sludge Feed Pump #3. Seal Leak | DI | PLC-BNR | Off | Seal Fail | | | 1 | | |
| MF | 1130 | MF-1130 | Sludge Feed Pump #3. VFD Fail | DI | PLC-BNR | Off | Fail | | | 1 | | |
| MC | 1130 | MC-1130 | Sludge Feed Pump #3. Motor Control | DO | PLC-BNR | Stop | Start | | | | | 1 |
| SC | 1130 | SC-1130 | Sludge Feed Pump #3. Speed Control | AO | PLC-BNR | 0 | 100 | % | | | 1 | |
| | | | | | RIO-BNR IO Signals | | | | 3 | 15 | 3 | 3 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **WAS Blower #1 11-A-BL-1 (*)** | | | | | | | | | | | | |
| HMS | 1160 | MA-1160 | Blower #1. Remote | DI | RIO-H1 | Off | Remote | | Network | | | |
| PDT | 1161 | PD-1161 | Blower #1. Filter Alarm | DI | RIO-H1 | Off | Filter Alm | | Network | | | |
| MN | 1160 | MN-1160 | Blower #1. Run Status | DI | RIO-H1 | Off | Run | | Network | | | |
| PIT | 1162 | PI-1162 | Blower #1. Suction Pressure | AI | RIO-H1 | 0 | TBD | PSI | Network | | | |
| TIT | 1163 | TI-1163 | Blower #1. Oil Temperature | AI | RIO-H1 | 0 | TBD | F | Network | | | |
| PIT | 1164 | PI-1164 | Blower #1. Discharge Pressure | AI | RIO-H1 | 0 | TBD | PSI | Network | | | |
| TIT | 1165 | TI-1165 | Blower #1. Discharge Temperature | AI | RIO-H1 | 0 | TBD | F | Network | | | |
| XF | 1160 | XF-1160 | Blower #1. System Fail | DI | RIO-H1 | Off | Fail | | Network | | | |
| XW | 1160 | XW-1160 | Blower #1. System Warnig | DI | RIO-H1 | Off | Warning | | Network | | | |
| MC | 1160 | MC-1160 | Blower #1. Start/Stop | DO | RIO-H1 | Stop | Start | | Network | | | |
| **WAS Blower #2 11-A-BL-2 (*)** | | | | | | | | | | | | |
| HMS | 1170 | MA-1170 | Blower #2. Remote | DI | RIO-H1 | Off | Remote | | Network | | | |
| PDT | 1171 | PD-1171 | Blower #2. Filter Alarm | DI | RIO-H1 | Off | Filter Alm | | Network | | | |
| MN | 1170 | MN-1170 | Blower #2. Run Status | DI | RIO-H1 | Off | Run | | Network | | | |
| PIT | 1172 | PI-1172 | Blower #2. Suction Pressure | AI | RIO-H1 | 0 | TBD | PSI | Network | | | |
| TIT | 1173 | TI-1173 | Blower #2. Oil Temperature | AI | RIO-H1 | 0 | TBD | F | Network | | | |
| PIT | 1174 | PI-1174 | Blower #2. Discharge Pressure | AI | RIO-H1 | 0 | TBD | PSI | Network | | | |
| TIT | 1175 | TI-1175 | Blower #2. Discharge Temperature | AI | RIO-H1 | 0 | TBD | F | Network | | | |
| XF | 1170 | XF-1170 | Blower #2. System Fail | DI | RIO-H1 | Off | Fail | | Network | | | |
| XW | 1170 | XW-1170 | Blower #2. System Warnig | DI | RIO-H1 | Off | Warning | | Network | | | |
| MC | 1170 | MC-1170 | Blower #2. Start/Stop | DO | RIO-H1 | Stop | Start | | Network | | | |
| **WAS Blower #3 11-A-BL-3 (*)** | | | | | | | | | | | | |
| HMS | 1180 | MA-1180 | Blower #3. Remote | DI | RIO-H1 | Off | Remote | | Network | | | |
| PDT | 1181 | PD-1181 | Blower #3. Filter Alarm | DI | RIO-H1 | Off | Filter Alm | | Network | | | |
| MN | 1180 | MN-1180 | Blower #3. Run Status | DI | RIO-H1 | Off | Run | | Network | | | |
| PIT | 1182 | PI-1182 | Blower #3. Suction Pressure | AI | RIO-H1 | 0 | TBD | PSI | Network | | | |
| TIT | 1183 | TI-1183 | Blower #3. Oil Temperature | AI | RIO-H1 | 0 | TBD | F | Network | | | |
| PIT | 1184 | PI-1184 | Blower #3. Discharge Pressure | AI | RIO-H1 | 0 | TBD | PSI | Network | | | |
| TIT | 1185 | TI-1185 | Blower #3. Discharge Temperature | AI | RIO-H1 | 0 | TBD | F | Network | | | |
| XF | 1180 | XF-1180 | Blower #3. System Fail | DI | RIO-H1 | Off | Fail | | Network | | | |
| XW | 1180 | XW-1180 | Blower #3. System Warnig | DI | RIO-H1 | Off | Warning | | Network | | | |
| MC | 1180 | MC-1180 | Blower #3. Start/Stop | DO | RIO-H1 | Stop | Start | | Network | | | |
| (*) : Existing Blowers connected to ex LCP-H to become RIO-H | | | | RIO-H IO Signals | | | | | 0 | 0 | 0 | 0 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **Aerobic Digester Tank #1 Level - 12-AD-L-1** | | | | | | | | | | | | |
| LE/LIT | 1200 | LI-1200 | Aerobic Digester Tank 1. Level | AI | PLC-H | 0 | TBD | FT | 1 | | | |
| **Aerobic Digester Tank #1 Hi Level - 12-AD-LS-1** | | | | | | | | | | | | |
| LSH | 1201 | LH-1201 | Aerobic Digester Tank 1. Hi Level | AI | PLC-H | Off | Hi Lvl | | | 1 | | |
| **Aerobic Digester Tank #1 DO - 12-AD-DO-1** | | | | | | | | | | | | |
| AE/AIT | 1202A | AI-1202A | Aerobic Digester Tank 1 DO #1 | AI | PLC-H | 0 | 10 | mg/L | 1 | | | |
| **Aerobic Digester Tank #1 DO - 12-AD-DO-2** | | | | | | | | | | | | |
| AE/AIT | 1202B | AI-1202B | Aerobic Digester Tank 1 DO #2 | AI | PLC-H | 0 | 10 | mg/L | 1 | | | |
| **Aerobic Digester Tank 1 Air Pressure - 12-AD-PT-1** | | | | | | | | | | | | |
| PIT | 1236 | PI-1236 | Aerobic Digester Tk 2 Air Supply Press | AI | PLC-H | 0 | 20 | PSI | 1 | | | |
| **Aerobic Digester Blower #1 Valve 1 12-AD-V-1** | | | | | | | | | | | | |
| ZL | 1210 | ZL-1210 | Digester Blower #1 Air Valve 1. Closed | DI | PLC-H | Off | Open | | | 1 | | |
| ZH | 1210 | ZH-1210 | Digester Blower #1 Air Valve 1. Open | DI | PLC-H | Off | Close | | | 1 | | |
| ZI | 1210 | ZI-1210 | Digester Blower #1 Air Valve 1 Indication | AI | PLC-H | 0 | 100 | | 1 | | | |
| ZC | 1210 | ZC-1210 | Digester Blower #1 Air Valve 1 Control | AO | PLC-H | 0 | 100 | | | | 1 | |
| **Aerobic Digester Blower #1 12-A-BL-1** | | | | | | | | | | | | |
| HMS | 1210 | MA-1210 | Blower #1. Remote | DI | PLC-H | Off | Remote | | Network | | | |
| PDT | 1211 | PD-1211 | Blower #1. Filter Alarm | DI | PLC-H | Off | Filter Alm | | Network | | | |
| MN | 1210 | MN-1210 | Blower #1. Run Status | DI | PLC-H | Off | Run | | Network | | | |
| PIT | 1212 | PI-1212 | Blower #1. Suction Pressure | AI | PLC-H | 0 | TBD | PSI | Network | | | |
| TIT | 1212 | TI-1212 | Blower #1. Oil Temperature | AI | PLC-H | 0 | TBD | F | Network | | | |
| PIT | 1214 | PI-1214 | Blower #1. Discharge Pressure | AI | PLC-H | 0 | TBD | PSI | Network | | | |
| TIT | 1215 | TI-1215 | Blower #1. Discharge Temperature | AI | PLC-H | 0 | TBD | F | Network | | | |
| XF | 1210 | XF-1210 | Blower #1. System Fail | DI | PLC-H | Off | Fail | | Network | | | |
| XW | 1210 | XW-1210 | Blower #1. System Warnig | DI | PLC-H | Off | Warning | | Network | | | |
| SI | 1210 | SI-1210 | Blower #1. Speed Indication | AI | PLC-H | 0 | 100 | % | Network | | | |
| MC | 1210 | MC-1210 | Blower #1. Start/Stop | DO | PLC-H | Stop | Start | | Network | | | |
| SC | 1210 | SC-1210 | Blower #1. Speed Control | AO | PLC-H | 0 | 100 | % | Network | | | |
| **Aerobic Digester Tank #2 Level - 12-A-L-2** | | | | | | | | | | | | |
| LE/LIT | 1203 | LI-1203 | Aerobic Digester Tank 2. Level | AI | PLC-H | 0 | TBD | FT | 1 | | | |
| **Aerobic Digester Tank #2 Hi Level - 12-AD-LS-2** | | | | | | | | | | | | |
| LSH | 1204 | LH-1204 | Aerobic Digester Tank 2. Hi Level | AI | PLC-H | Off | Hi Lvl | | | 1 | | |
| **Aerobic Digester Tank #2 DO 3 - 12-AD-DO-3** | | | | | | | | | | | | |
| AE/AIT | 1205A | AI-1205A | Aerobic Digester Tank 2 DO #3 | AI | PLC-H | 0 | 10 | mg/L | 1 | | | |
| **Aerobic Digester Tank #4 DO - 12-AD-DO-4** | | | | | | | | | | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| AE/AIT | 1205B | AI-1205B | Aerobic Digester Tank 2 DO #4 | AI | PLC-H | 0 | 10 | mg/L | 1 | | | |
| **Aerobic Digester Tank 2 Air Pressure - 12-AD-PT-2** | | | | | | | | | | | | |
| PIT | 1237 | PI-1237 | Aerobic Digester Tk 2 Air Supply Press | AI | PLC-H | 0 | 20 | PSI | 1 | | | |
| **Aerobic Digester Blower #2 Valve 2 12-AD-V-2** | | | | | | | | | | | | |
| ZL | 1220 | ZL-1220 | Digester Blower #1 Air Valve 2. Closed | DI | PLC-H | Off | Open | | | 1 | | |
| ZH | 1220 | ZH-1220 | Digester Blower #1 Air Valve 2. Open | DI | PLC-H | Off | Close | | | 1 | | |
| ZI | 1220 | ZI-1220 | Digester Blower #1 Air Valve 2 Indication | AI | PLC-H | 0 | 100 | | 1 | | | |
| ZC | 1220 | ZC-1220 | Digester Blower #1 Air Valve 2 Control | AO | PLC-H | 0 | 100 | | | | 1 | |
| **Aerobic Digester Blower #2 12-AD-BL-2** | | | | | | | | | | | | |
| HMS | 1220 | MA-1220 | Blower #2. Remote | DI | PLC-H | Off | Remote | | Network | | | |
| PDT | 1221 | PD-1221 | Blower #2. Filter Alarm | DI | PLC-H | Off | Filter Alm | | Network | | | |
| MN | 1220 | MN-1220 | Blower #2. Run Status | DI | PLC-H | Off | Run | | Network | | | |
| PIT | 1222 | PI-1222 | Blower #2. Suction Pressure | AI | PLC-H | 0 | TBD | PSI | Network | | | |
| TIT | 1223 | TI-1223 | Blower #2. Oil Temperature | AI | PLC-H | 0 | TBD | F | Network | | | |
| PIT | 1224 | PI-1224 | Blower #2. Discharge Pressure | AI | PLC-H | 0 | TBD | PSI | Network | | | |
| TIT | 1225 | TI-1225 | Blower #2. Discharge Temperature | AI | PLC-H | 0 | TBD | F | Network | | | |
| XF | 1220 | XF-1220 | Blower #2. System Fail | DI | PLC-H | Off | Fail | | Network | | | |
| XW | 1220 | XW-1220 | Blower #2. System Warnig | DI | PLC-H | Off | Warning | | Network | | | |
| SI | 1220 | SI-1220 | Blower #2. Speed Indication | AI | PLC-H | 0 | 100 | % | Network | | | |
| MC | 1220 | MC-1220 | Blower #2. Start/Stop | DO | PLC-H | Stop | Start | | Network | | | |
| SC | 1220 | SC-1220 | Blower #2. Speed Control | AO | PLC-H | 0 | 100 | % | Network | | | |
| **Aerobic Digester Blower #3 Valve 3 12-AD-V-3** | | | | | | | | | | | | |
| ZL | 1230 | ZL-1230 | WAS Blower #2 Air Valvec3. Closed | DI | PLC-H | Off | Open | | | 1 | | |
| ZH | 1230 | ZH-1230 | WAS Blower #2 Air Valve 3. Open | DI | PLC-H | Off | Close | | | 1 | | |
| **Aerobic Digester Blower #3 12-AD-BL-3** | | | | | | | | | | | | |
| HMS | 1230 | MA-1230 | Blower #3. Remote | DI | PLC-H | Off | Remote | | Network | | | |
| PDT | 1231 | PD-1231 | Blower #3. Filter Alarm | DI | PLC-H | Off | Filter Alm | | Network | | | |
| MN | 1230 | MN-1230 | Blower #3. Run Status | DI | PLC-H | Off | Run | | Network | | | |
| PIT | 1232 | PI-1232 | Blower #3. Suction Pressure | AI | PLC-H | 0 | TBD | PSI | Network | | | |
| TIT | 1233 | TI-1233 | Blower #3. Oil Temperature | AI | PLC-H | 0 | TBD | F | Network | | | |
| PIT | 1234 | PI-1234 | Blower #3. Discharge Pressure | AI | PLC-H | 0 | TBD | PSI | Network | | | |
| TIT | 1235 | TI-1235 | Blower #3. Discharge Temperature | AI | PLC-H | 0 | TBD | F | Network | | | |
| XF | 1230 | XF-1230 | Blower #3. System Fail | DI | PLC-H | Off | Fail | | Network | | | |
| XW | 1230 | XW-1230 | Blower #3. System Warnig | DI | PLC-H | Off | Warning | | Network | | | |
| SI | 1230 | SI-1230 | Blower #3. Speed Indication | AI | PLC-H | 0 | 100 | % | Network | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| MC | 1230 | MC-1230 | Blower #3. Start/Stop | DO | PLC-H | Stop | Start | | Network | | | |
| SC | 1230 | SC-1230 | Blower #3. Speed Control | AO | PLC-H | 0 | 100 | % | Network | | | |
| **Aerobic Digester Blower Valve 4 12-AD-V-4** | | | | | | | | | | | | |
| ZL | 1216 | ZL-1216 | Digester Blower #2 Air Valve 1. Closed | DI | PLC-H | Off | Open | | | 1 | | |
| ZH | 1216 | ZH-1216 | Digester Blower #2 Air Valve 1. Open | DI | PLC-H | Off | Close | | | 1 | | |
| ZI | 1216 | ZI-1216 | Digester Blower #2 Air Valve 1 Indication | AI | PLC-H | 0 | 100 | | 1 | | | |
| ZC | 1216 | ZC-1216 | Digester Blower #2 Air Valve 1 Control | AO | PLC-H | 0 | 100 | | | | 1 | |
| | | | | | | | | | | | | |
| **Aerobic Digester Blower Valve 5 12-AD-V-5** | | | | | | | | | | | | |
| ZL | 1217 | ZL-1217 | Digester Blower #2 Air Valve 2. Closed | DI | PLC-H | Off | Open | | | 1 | | |
| ZH | 1217 | ZH-1217 | Digester Blower #2 Air Valve 2. Open | DI | PLC-H | Off | Close | | | 1 | | |
| ZI | 1217 | ZI-1217 | Digester Blower #2 Air Valve 2 Indication | AI | PLC-H | 0 | 100 | | 1 | | | |
| ZC | 1217 | ZC-1217 | Digester Blower #2 Air Valve 2 Control | AO | PLC-H | 0 | 100 | | | | 1 | |
| | | | | | PLC-H IO Signals | | | | 12 | 12 | 4 | 0 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **Compressed Air Mixing Receiver Tank Pressure Transmitter - 14-CA-PT-1** | | | | | | | | | | | | |
| PIT | 1900 | PI-1900 | Compressed Air Receiver Tank . Pressure | AI | PLC-BNR | 0 | 150 | PSI | Network | | | |
| **Compressed Air Mixing Receiver Tank Valve - 14-CA-RT-1** | | | | | | | | | | | | |
| ZH | 1900 | MF-1900 | Compressed Air Receiver Tank Valve. Open | DI | PLC-BNR | Off | Open | | Network | | | |
| ZL | 1900 | YN-1900 | Compressed Air Receiver Tank Valve. Close | DI | PLC-BNR | Off | Close | | Network | | | |
| ZF | 1900 | YX-1900 | Compressed Air Receiver Tank Valve. Fail | DO | PLC-BNR | Close | Open | | Network | | | |
| **Compressed Air Mixing Compresssor 1 - 14-CA-M-1** | | | | | | | | | | | | |
| MN | 1901 | MN-1901 | Compressed Air Compressor 1. Run | DI | PLC-BNR | Off | Run | | Network | | | |
| MF | 1901 | MF-1901 | Compressed Air Compressor 1. Fault | DI | PLC-BNR | Off | Fail | | Network | | | |
| YN | 1901 | YN-1901 | Compressed Air Compressor 1. Load | DI | PLC-BNR | Off | Load | | Network | | | |
| YX | 1901 | YX-1901 | Compressed Air Compressor 1. Enable/Disable | DO | PLC-BNR | Disable | Enable | | Network | | | |
| **Compressed Air Mixing Compresssor 2 - 14-CA-M-2** | | | | | | | | | | | | |
| MN | 1902 | MN-1902 | Compressed Air Compressor 2. Run | DI | PLC-BNR | Off | Run | | Network | | | |
| MF | 1902 | MF-1902 | Compressed Air Compressor 2. Fault | DI | PLC-BNR | Off | Fail | | Network | | | |
| YN | 1902 | YN-1902 | Compressed Air Compressor 2. Load | DI | PLC-BNR | Off | Load | | Network | | | |
| YX | 1902 | YX-1902 | Compressed Air Compressor 2. Enable/Disable | DO | PLC-BNR | Disable | Enable | | Network | | | |
| **Compressed Air Mixing Valve Module 1 - 14-CA-VM-1** | | | | | | | | | | | | |
| ZC | 1911 | ZC-1911 | Compressed Air VM-1. Valve 1 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1911 | PIT-1911 | Compressed Air VM-1. Valve 1 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1912 | ZC-1912 | Compressed Air VM-1. Valve 2 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1912 | PIT-1912 | Compressed Air VM-1. Valve 2 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1913 | ZC-1913 | Compressed Air VM-1. Valve 3 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1913 | PIT-1913 | Compressed Air VM-1. Valve 3 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1914 | ZC-1914 | Compressed Air VM-1. Valve 4 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1914 | PIT-1914 | Compressed Air VM-1. Valve 4 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1915 | ZC-1915 | Compressed Air VM-1. Valve 5 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1915 | PIT-1915 | Compressed Air VM-1. Valve 5 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1916 | ZC-1916 | Compressed Air VM-1. Valve 6 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1916 | PIT-1916 | Compressed Air VM-1. Valve 6 | AI | PLC-BNR | Close | Open | | Network | | | |
| **Compressed Air Mixing Valve Module 2 - 14-CA-VM-2** | | | | | | | | | | | | |
| ZC | 1921 | ZC-1921 | Compressed Air VM-2. Valve 1 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1921 | PIT-1921 | Compressed Air VM-2. Valve 1 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1922 | ZC-1922 | Compressed Air VM-2. Valve 2 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1922 | PIT-1922 | Compressed Air VM-2. Valve 2 | AI | PLC-BNR | Close | Open | | Network | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| ZC | 1923 | ZC-1923 | Compressed Air VM-2. Valve 3 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1923 | PIT-1923 | Compressed Air VM-2. Valve 3 | AI | PLC-BNR | Close | Open | | Network | | | |
| **Compressed Air Mixing Valve Module 3 - 14-CA-VM-3** | | | | | | | | | | | | |
| ZC | 1931 | ZC-1931 | Compressed Air VM-3. Valve 1 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1931 | PIT-1931 | Compressed Air VM-3. Valve 1 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1932 | ZC-1932 | Compressed Air VM-3. Valve 2 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1932 | PIT-1932 | Compressed Air VM-3. Valve 2 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1933 | ZC-1933 | Compressed Air VM-3. Valve 3 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1933 | PIT-1933 | Compressed Air VM-3. Valve 3 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1934 | ZC-1934 | Compressed Air VM-3. Valve 4 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1934 | PIT-1934 | Compressed Air VM-3. Valve 4 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1935 | ZC-1935 | Compressed Air VM-3. Valve 5 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1935 | PIT-1935 | Compressed Air VM-3. Valve 5 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1936 | ZC-1936 | Compressed Air VM-3. Valve 6 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1936 | PIT-1936 | Compressed Air VM-3. Valve 6 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1937 | ZC-1937 | Compressed Air VM-3. Valve 7 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1937 | PIT-1937 | Compressed Air VM-3. Valve 7 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1938 | ZC-1938 | Compressed Air VM-3. Valve 8 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1938 | PIT-1938 | Compressed Air VM-3. Valve 8 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1939 | ZC-1939 | Compressed Air VM-3. Valve 9 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1939 | PIT-1939 | Compressed Air VM-3. Valve 9 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1940 | ZC-1940 | Compressed Air VM-3. Valve 10 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1940 | PIT-1940 | Compressed Air VM-3. Valve 10 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1941 | ZC-1941 | Compressed Air VM-3. Valve 11 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1941 | PIT-1941 | Compressed Air VM-3. Valve 11 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1942 | ZC-1942 | Compressed Air VM-3. Valve 12 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1942 | PIT-1942 | Compressed Air VM-3. Valve 12 | AI | PLC-BNR | Close | Open | | Network | | | |
| **Compressed Air Mixing Valve Module 4 - 14-CA-VM-4** | | | | | | | | | | | | |
| ZC | 1951 | ZC-1951 | Compressed Air VM-4. Valve 1 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1951 | PIT-1951 | Compressed Air VM-4. Valve 1 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1952 | ZC-1952 | Compressed Air VM-4. Valve 2 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1952 | PIT-1952 | Compressed Air VM-4. Valve 2 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1953 | ZC-1953 | Compressed Air VM-4. Valve 3 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1953 | PIT-1953 | Compressed Air VM-4. Valve 3 | AI | PLC-BNR | Close | Open | | Network | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| ZC | 1954 | ZC-1954 | Compressed Air VM-4. Valve 4 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1954 | PIT-1954 | Compressed Air VM-4. Valve 4 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1955 | ZC-1955 | Compressed Air VM-4. Valve 5 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1955 | PIT-1955 | Compressed Air VM-4. Valve 5 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1956 | ZC-1956 | Compressed Air VM-4. Valve 6 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1956 | PIT-1956 | Compressed Air VM-4. Valve 6 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1957 | ZC-1957 | Compressed Air VM-4. Valve 7 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1957 | PIT-1957 | Compressed Air VM-4. Valve 7 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1958 | ZC-1958 | Compressed Air VM-4. Valve 8 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1958 | PIT-1958 | Compressed Air VM-4. Valve 8 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1959 | ZC-1959 | Compressed Air VM-4. Valve 9 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1959 | PIT-1959 | Compressed Air VM-4. Valve 9 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1960 | ZC-1960 | Compressed Air VM-4. Valve 10 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1960 | PIT-1960 | Compressed Air VM-4. Valve 10 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1961 | ZC-1961 | Compressed Air VM-4. Valve 11 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1961 | PIT-1961 | Compressed Air VM-4. Valve 11 | AI | PLC-BNR | Close | Open | | Network | | | |
| ZC | 1962 | ZC-1962 | Compressed Air VM-4. Valve 12 | DO | PLC-BNR | Close | Open | | Network | | | |
| PIT | 1962 | PIT-1962 | Compressed Air VM-4. Valve 12 | AI | PLC-BNR | Close | Open | | Network | | | |
| | | | | | PLC-BNR Signals | | | | 0 | 0 | 0 | 0 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **RDT # 1 Influent Flow 15-RDT-F-1** | | | | | | | | | | | | |
| FE/FIT | 1300 | FI-1300 | RDT # 1 Flow | AI | PLC-DW | 0 | TBD | GPM | 1 | | | |
| **RDT # 1 System - 15-RDT-1** | | | | | | | | | | | | |
| MA | 1310 | MA-1310 | RDT #1. Remote | DI | PLC-DW | Off | Remote | | Network | | | |
| MN | 1310 | MN-1310 | RDT #1. Run | DI | PLC-DW | Off | Run | | Network | | | |
| MF | 1310 | MF-1310 | RDT #1. Fail | DI | PLC-DW | Off | Fail | | Network | | | |
| SI | 1310 | SI-1310 | RDT #1. Speed Indication | AI | PLC-DW | 0 | 100 | % | Network | | | |
| MC | 1310 | MC-1310 | RDT #1. Motor Control | DO | PLC-DW | Stop | Start | | Network | | | |
| SC | 1310 | SC-1310 | RDT #1. Speed Control | AO | PLC-DW | 0 | 100 | % | Network | | | |
| FI | 1310 | FI-1300 | RDT #1. TWAS Pump Discharge Flow | AO | PLC-DW | 0 | 100 | % | Network | | | |
| YN | 1310 | YN-1300 | RDT #1. Permissive | DO | PLC-DW | Off | Permssive | | Network | | | |
| MC | 1310 | MC-1310 | RDT #1. TWAS Pump Start/Stop | DI | PLC-DW | Stop | Start | | Network | | | |
| SI | 1310 | SI-1310 | RDT #1. TWAS Pump Speed Control | AI | PLC-DW | 0 | 100 | % | Network | | | |
| SC | 1310 | SC-1310 | RDT #1. TWAS Pump Speed Indication | AO | PLC-DW | 0 | 100 | % | Network | | | |
| XN | 1310 | XN-1310 | RDT #1. TWAS Pump Run | DO | PLC-DW | Off | Run | | Network | | | |
| XF | 1310 | XF-1310 | RDT #1. TWAS Pump Fail | DO | PLC-DW | Off | Fail | | Network | | | |
| MC | 1310 | MC-1310 | RDT #1. Poly Pump Start/Stop | DI | PLC-DW | Stop | Start | | Network | | | |
| SI | 1310 | SI-1310 | RDT #1. Poly Pump Speed Control | AI | PLC-DW | 0 | 100 | % | Network | | | |
| SC | 1310 | SC-1310 | RDT #1. Poly Pump Speed Indication | AO | PLC-DW | 0 | 100 | % | Network | | | |
| XN | 1310 | XN-1310 | RDT #1. Poly Pump Run | DO | PLC-DW | Off | Run | | Network | | | |
| XF | 1310 | XF-1310 | RDT #1. Poly Pump Fail | DO | PLC-DW | Off | Fail | | Network | | | |
| **RDT # 2 Influent Flow 15-RDT-F-2** | | | | | | | | | | | | |
| FE/FIT | 1301 | FI-1301 | RDT # 2 Flow | AI | PLC-DW | 0 | TBD | GPM | 1 | | | |
| **RDT # 2 System - 15-RDT-2** | | | | | | | | | | | | |
| MA | 1320 | MA-1320 | RDT #2. Remote | DI | PLC-DW | Off | Remote | | Network | | | |
| MN | 1320 | MN-1320 | RDT #2. Run | DI | PLC-DW | Off | Run | | Network | | | |
| MF | 1320 | MF-1320 | RDT #2. Fail | DI | PLC-DW | Off | Fail | | Network | | | |
| SI | 1320 | SI-1320 | RDT #2. Speed Indication | AI | PLC-DW | 0 | 100 | % | Network | | | |
| MC | 1320 | MC-1320 | RDT #2. Motor Control | DO | PLC-DW | Stop | Start | | Network | | | |
| SC | 1320 | SC-1320 | RDT #2. Speed Control | AO | PLC-DW | 0 | 100 | % | Network | | | |
| FI | 1320 | FI-1300 | RDT #2. TWAS Pump Discharge Flow | AO | PLC-DW | 0 | 100 | % | Network | | | |
| YN | 1320 | YN-1300 | RDT #2. Permissive | DO | PLC-DW | Off | Permssive | | Network | | | |
| MC | 1320 | MC-1320 | RDT #2. TWAS Pump Start/Stop | DI | PLC-DW | Stop | Start | | Network | | | |
| SI | 1320 | SI-1320 | RDT #2. TWAS Pump Speed Control | AI | PLC-DW | 0 | 100 | % | Network | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| SC | 1320 | SC-1320 | RDT #2. TWAS Pump Speed Indication | AO | PLC-DW | 0 | 100 | % | Network | | | |
| XN | 1320 | XN-1320 | RDT #2. TWAS Pump Run | DO | PLC-DW | Off | Run | | Network | | | |
| XF | 1320 | XF-1320 | RDT #2. TWAS Pump Fail | DO | PLC-DW | Off | Fail | | Network | | | |
| MC | 1320 | MC-1320 | RDT #2. Poly Pump Start/Stop | DI | PLC-DW | Stop | Start | | Network | | | |
| SI | 1320 | SI-1320 | RDT #2. Poly Pump Speed Control | AI | PLC-DW | 0 | 100 | % | Network | | | |
| SC | 1320 | SC-1320 | RDT #2. Poly Pump Speed Indication | AO | PLC-DW | 0 | 100 | % | Network | | | |
| XN | 1320 | XN-1320 | RDT #2. Poly Pump Run | DO | PLC-DW | Off | Run | | Network | | | |
| XF | 1320 | XF-1320 | RDT #2. Poly Pump Fail | DO | PLC-DW | Off | Fail | | Network | | | |
| | | | | | PLC-DW | | | | 2 | 0 | 0 | 0 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **RDT Polymer Tank #1 Level - 15-TK-L-1** | | | | | | | | | | | | |
| LE/LIT | 1350 | LI-1350 | PolymerTank #1. Level | AI | PLC-DW | 0 | TBD | FT | 1 | | | |
| **RDT Polymer Tank Recirculation Pump - 15-TK-P-4** | | | | | | | | | | | | |
| HMS | 1360 | MA-1355 | Poly Recirc Pump #1. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1360 | MN-1355 | Poly Recirc Pump #1. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1360 | MF-1355 | Poly Recirc Pump #1. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| MC | 1360 | MC-1355 | Poly Recirc Pump #1. Control Motor | DO | PLC-DW | Stop | Start | | | | | 1 |
| **RDT Poly Skid Pump #1 - 15-POLY-P-1** | | | | | | | | | | | | |
| HMS | 1370 | MA-1370 | Poly Pump #1. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1370 | MN-1370 | Poly Pump #1. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1370 | MF-1370 | Poly Pump #1. Loss of Water | DI | PLC-DW | Off | Fail | | | 1 | | |
| MF | 1370 | MF-1370 | Poly Pump #1. Loss of Polymer | DI | PLC-DW | Off | Fail | | | 1 | | |
| SI | 1370 | SI-1370 | Poly Pump #1. Speed Indication | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| SC | 1370 | SC-1370 | Poly Pump #1. Speed Control | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| MC | 1370 | MC-1370 | Poly Pump #1. Control Motor | DO | PLC-DW | Stop | Start | | | | | 1 |
| **RDT Poly Skid Pump #2 - 15-POLY-P-2** | | | | | | | | | | | | |
| HMS | 1380 | MA-1380 | Poly Pump #2. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1380 | MN-1380 | Poly Pump #2. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1380 | MF-1380 | Poly Pump #2. Loss of Water | DI | PLC-DW | Off | Fail | | | 1 | | |
| MF | 1380 | MF-1380 | Poly Pump #2. Loss of Polymer | DI | PLC-DW | Off | Fail | | | 1 | | |
| SI | 1380 | SI-1380 | Poly Pump #2. Speed Indication | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| SC | 1380 | SC-1380 | Poly Pump #2. Speed Control | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| MC | 1380 | MC-1380 | Poly Pump #2. Control Motor | DO | PLC-DW | Stop | Start | | | | | 1 |
| **RDT Poly Skid Pump #3 - 15-POLY-P-3** | | | | | | | | | | | | |
| HMS | 1390 | MA-1390 | Poly Pump #3. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1390 | MN-1390 | Poly Pump #3. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1390 | MF-1390 | Poly Pump #3. Loss of Water | DI | PLC-DW | Off | Fail | | | 1 | | |
| MF | 1390 | MF-1390 | Poly Pump #3. Loss of Polymer | DI | PLC-DW | Off | Fail | | | 1 | | |
| SI | 1390 | SI-1390 | Poly Pump #3. Speed Indication | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| SC | 1390 | SC-1390 | Poly Pump #3. Speed Control | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| MC | 1390 | MC-1390 | Poly Pump #3. Control Motor | DO | PLC-DW | Stop | Start | | | | | 1 |
| | | | | | PLC-DW IO Signals | | | | 4 | 15 | 3 | 4 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **BFP Feed Pumps Flow 1 Discharge - 15-BFP-F-1** | | | | | | | | | | | | |
| FE/FEI | 1450 | FI-1450 | BFP Feed Pump Flow 1 | AI | PLC-DW | 0 | TBD | GPM | 1 | | | |
| **BFP Feed Pumps Flow 2 Discharge - 15-BFP-F-2** | | | | | | | | | | | | |
| FE/FEI | 1460 | FI-1460 | BFP Feed Pump Flow 2 | AI | PLC-DW | 0 | TBD | GPM | 1 | | | |
| **BFP Feed Pump #1 - 15-BFP-P-1** | | | | | | | | | | | | |
| SI | 1410 | SI-1410 | BFP Feed Pump #1. Speed Ind | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| HMS | 1410 | MA-1410 | BFP Feed Pump #1. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1410 | MN-1410 | BFP Feed Pump #1. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1410 | MF-1410 | BFP Feed Pump #1. Fail | DI | PLC-DW | Off | Lockout | | | 1 | | |
| MO | 1410 | MO-1410 | BFP Feed Pump #1. Hi Temp | DI | PLC-DW | Off | Hi Temp | | | 1 | | |
| YF | 1410 | YF-1410 | BFP Feed Pump #1. Hi Press | DI | PLC-DW | Off | Hi Press | | | 1 | | |
| MF | 1410 | MF-1410 | BFP Feed Pump #1. VFD Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| MC | 1410 | MC-1410 | BFP Feed Pump #1. Motor Control | DO | PLC-DW | Stop | Start | | | | | 1 |
| SC | 1410 | SC-1410 | BFP Feed Pump #1. Speed Ctr | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| **BFP Feed Pump #1 Discharge Pressure- 15-BFP-PT-1** | | | | | | | | | | | | |
| PIT | 1412 | PI-1412 | BFP Feed Pump #1. Disch Press | AI | PLC-DW | 0 | TBD | PSI | 1 | | | |
| **BFP Feed Pump #2 - 15-BFP-P-2** | | | | | | | | | | | | |
| SI | 1420 | SI-1420 | BFP Feed Pump #2. Speed Ind | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| HMS | 1420 | MA-1420 | BFP Feed Pump #2. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1420 | MN-1420 | BFP Feed Pump #2. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1420 | MF-1420 | BFP Feed Pump #2. Fail | DI | PLC-DW | Off | Lockout | | | 1 | | |
| MO | 1420 | MO-1420 | BFP Feed Pump #2. Hi Temp | DI | PLC-DW | Off | Hi Temp | | | 1 | | |
| YF | 1420 | YF-1420 | BFP Feed Pump #2. Hi Press | DI | PLC-DW | Off | Hi Press | | | 1 | | |
| MF | 1420 | MF-1420 | BFP Feed Pump #2. VFD Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| MC | 1420 | MC-1420 | BFP Feed Pump #2. Motor Control | DO | PLC-DW | Stop | Start | | | | | 1 |
| SC | 1420 | SC-1420 | BFP Feed Pump #2. Speed Ctr | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| **BFP Feed Pump #2 Discharge Pressure- 15-BFP-PT-2** | | | | | | | | | | | | |
| PIT | 1422 | PI-1422 | BFP Feed Pump #2. Disch Press | AI | PLC-DW | 0 | TBD | PSI | 1 | | | |
| **BFP Feed Pump #3 - 15-BFP-P-3** | | | | | | | | | | | | |
| SI | 1430 | SI-1430 | BFP Feed Pump #3. Speed Ind | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| HMS | 1430 | MA-1430 | BFP Feed Pump #3. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1430 | MN-1430 | BFP Feed Pump #3. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1430 | MF-1430 | BFP Feed Pump #3. Fail | DI | PLC-DW | Off | Lockout | | | 1 | | |
| MO | 1430 | MO-1430 | BFP Feed Pump #3. Hi Temp | DI | PLC-DW | Off | Hi Temp | | | 1 | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| YF | 1430 | YF-1430 | BFP Feed Pump #3. Hi Press | DI | PLC-DW | Off | Hi Press | | | 1 | | |
| MF | 1430 | MF-1430 | BFP Feed Pump #3. VFD Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| MC | 1430 | MC-1430 | BFP Feed Pump #3. Motor Control | DO | PLC-DW | Stop | Start | | | | | 1 |
| SC | 1430 | SC-1430 | BFP Feed Pump #3. Speed Ctr | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| **BFP Feed Pump #3 Discharge Pressure- 15-BFP-PT-3** | | | | | | | | | | | | |
| PIT | 1432 | PI-1432 | BFP Feed Pump #3. Disch Press | AI | PLC-DW | 0 | TBD | PSI | 1 | | | |
| | | | | | PLC-DW IO Signals | | | | 8 | 18 | 3 | 3 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **BFP #1 Valve 1 - 15-BFP-V-1** | | | | | | | | | | | | |
| HMS | 1561 | MA-1561 | BFP #1 Valve. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| ZL | 1561 | MN-1561 | BFP #1 Valve. Close | DI | PLC-DW | Off | Close | | | 1 | | |
| ZH | 1561 | MF-1561 | BFP #1 Valve. Open | DI | PLC-DW | Off | Open | | | 1 | | |
| ZF | 1561 | MC-1561 | BFP #1 Valve. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| ZO | 1561 | ZO-1561 | BFP #1 Valve. Valve Open | DO | PLC-DW | Off | Open | | | | | 1 |
| ZC | 1561 | ZC-1561 | BFP #1 Valve. Valve Closed | DO | PLC-DW | Off | Close | | | | | 1 |
| **BFP # 1 System - 15-BFP-1** | | | | | | | | | | | | |
| MA | 1510 | MA-1510 | BFP #1. Remote | DI | PLC-DW | Off | Remote | | Network | | | |
| MN | 1510 | MN-1510 | BFP #1. Run | DI | PLC-DW | Off | Run | | Network | | | |
| MF | 1510 | MF-1510 | BFP #1. Fail | DI | PLC-DW | Off | Fail | | Network | | | |
| SI | 1510 | SI-1510 | BFP #1. Speed Indication | AI | PLC-DW | 0 | 100 | % | Network | | | |
| MC | 1510 | MC-1510 | BFP #1. Motor Control | DO | PLC-DW | Stop | Start | | Network | | | |
| SC | 1510 | SC-1510 | BFP #1. Speed Control | AO | PLC-DW | 0 | 100 | % | Network | | | |
| YN | 1510 | YN-1200 | BFP #1. Permissive | DO | PLC-DW | Off | Permssive | | Network | | | |
| MC | 1510 | MC-1510 | BFP #1. Water Booster Pump Start/Stop | DI | PLC-DW | Stop | Start | | Network | | | |
| XN | 1510 | XN-1510 | BFP #1. Water Booster Pump Run | DO | PLC-DW | Off | Run | | Network | | | |
| XF | 1510 | XF-1510 | BFP #1. Water Booter Pump Fail | DO | PLC-DW | Off | Fail | | Network | | | |
| MC | 1510 | MC-1510 | BFP #1. Water Valve Open/Close | DI | PLC-DW | Close | Open | | Network | | | |
| SI | 1510 | SI-1510 | BFP #1. Water Valve Open | DO | PLC-DW | Off | Open | | Network | | | |
| SC | 1510 | SC-1510 | BFP #1. Water Valve Close | DO | PLC-DW | Off | Close | | Network | | | |
| XN | 1510 | XN-1510 | BFP #1. Hydraulic Pump Run | DO | PLC-DW | Off | Run | | Network | | | |
| XF | 1510 | XF-1510 | BFP #1. Hydraulic Pump Fail | DO | PLC-DW | Off | Fail | | Network | | | |
| **BFP #2 Valve 2 - 15-BFP-V-2** | | | | | | | | | | | | |
| HMS | 1562 | MA-1571 | BFP #2 Valve. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| ZL | 1562 | MN-1571 | BFP #2 Valve. Close | DI | PLC-DW | Off | Close | | | 1 | | |
| ZH | 1562 | MF-1571 | BFP #2 Valve. Open | DI | PLC-DW | Off | Open | | | 1 | | |
| ZF | 1562 | MC-1571 | BFP #2 Valve. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| ZO | 1562 | ZO-1571 | BFP #2 Valve. Valve Open | DO | PLC-DW | Off | Open | | | | | 1 |
| ZC | 1562 | ZC-1571 | BFP #2 Valve. Valve Closed | DO | PLC-DW | Off | Close | | | | | 1 |
| **BFP # 2 System - 15-BFP-2** | | | | | | | | | | | | |
| MA | 1520 | MA-1520 | BFP #2. Remote | DI | PLC-DW | Off | Remote | | Network | | | |
| MN | 1520 | MN-1520 | BFP #2. Run | DI | PLC-DW | Off | Run | | Network | | | |
| MF | 1520 | MF-1520 | BFP #2. Fail | DI | PLC-DW | Off | Fail | | Network | | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| SI | 1520 | SI-1520 | BFP #2. Speed Indication | AI | PLC-DW | 0 | 100 | % | Network | | | |
| MC | 1520 | MC-1520 | BFP #2. Motor Control | DO | PLC-DW | Stop | Start | | Network | | | |
| SC | 1520 | SC-1520 | BFP #2. Speed Control | AO | PLC-DW | 0 | 100 | % | Network | | | |
| YN | 1520 | YN-1200 | BFP #2. Permissive | DO | PLC-DW | Off | Permssive | | Network | | | |
| MC | 1520 | MC-1520 | BFP #2. Water Booster Pump Start/Stop | DI | PLC-DW | Stop | Start | | Network | | | |
| XN | 1520 | XN-1520 | BFP #2. Water Booster Pump Run | DO | PLC-DW | Off | Run | | Network | | | |
| XF | 1520 | XF-1520 | BFP #2. Water Booter Pump Fail | DO | PLC-DW | Off | Fail | | Network | | | |
| MC | 1520 | MC-1520 | BFP #2. Water Valve Open/Close | DI | PLC-DW | Close | Open | | Network | | | |
| SI | 1520 | SI-1520 | BFP #2. Water Valve Open | DO | PLC-DW | Off | Open | | Network | | | |
| SC | 1520 | SC-1520 | BFP #2. Water Valve Close | DO | PLC-DW | Off | Close | | Network | | | |
| XN | 1520 | XN-1520 | BFP #2. Hydraulic Pump Run | DO | PLC-DW | Off | Run | | Network | | | |
| XF | 1520 | XF-1520 | BFP #2. Hydraulic Pump Fail | DO | PLC-DW | Off | Fail | | Network | | | |
| **BFP Water Booster Pump 1 - 15-BFP-BP-1** | | | | | | | | | | | | |
| HMS | 1530 | MA-1530 | BFP Water Booster Pump #1. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1530 | MN-1530 | BFP Water Booster Pump #1. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1530 | MF-1530 | BFP Water Booster Pump #1. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| MC | 1530 | MC-1530 | BFP Water Booster Pump #1. Control Motor | DO | PLC-DW | Stop | Start | | | | | 1 |
| **BFP Water Booster Pump 2 - 15-BFP-BP-2** | | | | | | | | | | | | |
| HMS | 1540 | MA-1540 | BFP Water Booster Pump #2. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1540 | MN-1540 | BFP Water Booster Pump #2. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1540 | MF-1540 | BFP Water Booster Pump #2. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| MC | 1540 | MC-1540 | BFP Water Booster Pump #2. Control Motor | DO | PLC-DW | Stop | Start | | | | | 1 |
| **BFP Water Booster Pump 3 - 15-BFP-BP-3** | | | | | | | | | | | | |
| HMS | 1550 | MA-1550 | BFP Water Booster Pump #3. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1550 | MN-1550 | BFP Water Booster Pump #3. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1550 | MF-1550 | BFP Water Booster Pump #3. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| MC | 1550 | MC-1550 | | DO | PLC-DW | Stop | Start | | | | | 1 |
| **BFP Water Valve 1 - 15-BFP-V-3** | | | | | | | | | | | | |
| HMS | 1560 | MA-1560 | BFP Water Valve #1. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| ZL | 1560 | MN-1560 | BFP Water Valve #1. Close | DI | PLC-DW | Off | Close | | | 1 | | |
| ZH | 1560 | MF-1560 | BFP Water Valve #1. Open | DI | PLC-DW | Off | Open | | | 1 | | |
| ZF | 1560 | MC-1560 | BFP Water Valve #1. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| ZO | 1560 | ZO-1560 | BFP Water Valve #1. Valve Open | DO | PLC-DW | Off | Open | | | | | 1 |
| ZC | 1560 | ZC-1560 | BFP Water Valve #1. Valve Closed | DO | PLC-DW | Off | Close | | | | | 1 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **BFP Water Valve 2 - 15-BFP-V-4** | | | | | | | | | | | | |
| HMS | 1570 | MA-1570 | BFP Water Valve #2. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| ZL | 1570 | MN-1570 | BFP Water Valve #2. Close | DI | PLC-DW | Off | Close | | | 1 | | |
| ZH | 1570 | MF-1570 | BFP Water Valve #2. Open | DI | PLC-DW | Off | Open | | | 1 | | |
| ZF | 1570 | MC-1570 | BFP Water Valve #2. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| ZO | 1570 | ZO-1570 | BFP Water Valve #2. Valve Open | DO | PLC-DW | Off | Open | | | | | 1 |
| ZC | 1570 | ZC-1570 | BFP Water Valve #2. Valve Closed | DO | PLC-DW | Off | Close | | | | | 1 |
| **Dewatered Sludge Pump #1 - 15-DS-P-1** | | | | | | | | | | | | |
| MN | 1580 | MN-1580 | Dewatered Sludge Pump #1. Run | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1580 | MF-1580 | Dewatered Sludge Pump #1. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| HA | 1580 | HA-1580 | Dewatered Sludge Pump #1. Auto | DI | PLC-DW | Manual | Auto | | | 1 | | |
| MC | 1580 | MC-1580 | Dewatered Sludge Pump #1. Start/Stop | DO | PLC-DW | Stop | Start | | | | | 1 |
| TIC | 1580 | TIC-1580 | Dewatered Sludge Pump #1. Hi Temp | DO | PLC-DW | Interlock | Off | | | | | 1 |
| TE | 1580 | TE-1580 | Dewatered Sludge Pump #1. Temperature sensor | AI | PLC-DW | 0 | 250 | F | 1 | | | |
| SI | 1580 | SI-1580 | Dewatered Sludge Pump #1. Speed Ind | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| SC | 1580 | SC-1580 | Dewatered Sludge Pump #1. Speed Control | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| **Dewatered Sludge Pump #1 Pressure - 15-DS-PT-1** | | | | | | | | | | | | |
| PIT | 1581 | PI-1581 | Dewatered Sludge Pump #1. Pressure | AI | PLC-DW | 0 | 100 | PSI | 1 | | | |
| **Dewatered Sludge Pump #2 - 15-DS-P-2** | | | | | | | | | | | | |
| MN | 1590 | MN-1590 | Dewatered Sludge Pump #2. Run | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1590 | MF-1590 | Dewatered Sludge Pump #2. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| HA | 1590 | HA-1590 | Dewatered Sludge Pump #2. Auto | DI | PLC-DW | Manual | Auto | | | 1 | | |
| MC | 1590 | MC-1590 | Dewatered Sludge Pump #2. Start/Stop | DO | PLC-DW | Stop | Start | | | | | 1 |
| TIC | 1590 | TIC-1590 | Dewatered Sludge Pump #2. Hi Temp | DO | PLC-DW | Interlock | Off | | | | | 1 |
| TE | 1590 | TE-1590 | Dewatered Sludge Pump #2. Temperature sensor | AI | PLC-DW | 0 | 250 | F | 1 | | | |
| SI | 1590 | SI-1590 | Dewatered Sludge Pump #2. Speed Ind | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| SC | 1590 | SC-1590 | Dewatered Sludge Pump #2. Speed Control | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| **Dewatered Sludge Pump #1 Inlet Pressure - 15-DS-PT-1** | | | | | | | | | | | | |
| PIT | 1591 | PI-1591 | Dewatered Sludge Pump #2. Inlet Pressure | AI | PLC-DW | 0 | 100 | PSI | 1 | | | |
| | | | | | PLC-DW IO Signals | | | | 6 | 31 | 2 | 15 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **BFP Polymer Tank #2 Level - 15-TK-L-2** | | | | | | | | | | | | |
| LE/LIT | 1600 | LI-1600 | PolymerTank #1. Level | AI | PLC-DW | 0 | TBD | FT | 1 | | | |
| **RDT Polymer Tank Recirculation Pump - 15-TK-P-4** | | | | | | | | | | | | |
| HMS | 1605 | MA-1605 | Poly Recirc Pump #2. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1605 | MN-1605 | Poly Recirc Pump #2. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1605 | MF-1605 | Poly Recirc Pump #2. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| MC | 1605 | MC-1605 | Poly Recirc Pump #2. Control Motor | DO | PLC-DW | Stop | Start | | | | | 1 |
| **RDT Poly Skid Pump #1 - 15-POLY-P-1** | | | | | | | | | | | | |
| HMS | 1610 | MA-1610 | Poly Pump #1. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1610 | MN-1610 | Poly Pump #1. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1610 | MF-1610 | Poly Pump #1. Loss of Water | DI | PLC-DW | Off | Fail | | | 1 | | |
| MF | 1610 | MF-1610 | Poly Pump #1. Loss of Polymer | DI | PLC-DW | Off | Fail | | | 1 | | |
| SI | 1610 | SI-1610 | Poly Pump #1. Speed Indication | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| SC | 1610 | SC-1610 | Poly Pump #1. Speed Control | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| MC | 1610 | MC-1610 | Poly Pump #1. Control Motor | DO | PLC-DW | Stop | Start | | | | | 1 |
| **RDT Poly Skid Pump #2 - 15-POLY-P-2** | | | | | | | | | | | | |
| HMS | 1620 | MA-1620 | Poly Pump #2. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1620 | MN-1620 | Poly Pump #2. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1620 | MF-1620 | Poly Pump #2. Loss of Water | DI | PLC-DW | Off | Fail | | | 1 | | |
| MF | 1620 | MF-1620 | Poly Pump #2. Loss of Polymer | DI | PLC-DW | Off | Fail | | | 1 | | |
| SI | 1620 | SI-1620 | Poly Pump #2. Speed Indication | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| SC | 1620 | SC-1620 | Poly Pump #2. Speed Control | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| MC | 1620 | MC-1620 | Poly Pump #2. Control Motor | DO | PLC-DW | Stop | Start | | | | | 1 |
| **RDT Poly Skid Pump #3 - 15-POLY-P-3** | | | | | | | | | | | | |
| HMS | 1630 | MA-1630 | Poly Pump #3. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1630 | MN-1630 | Poly Pump #3. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1630 | MF-1630 | Poly Pump #3. Loss of Water | DI | PLC-DW | Off | Fail | | | 1 | | |
| MF | 1630 | MF-1630 | Poly Pump #3. Loss of Polymer | DI | PLC-DW | Off | Fail | | | 1 | | |
| SI | 1630 | SI-1630 | Poly Pump #3. Speed Indication | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| SC | 1630 | SC-1630 | Poly Pump #3. Speed Control | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| MC | 1630 | MC-1630 | Poly Pump #3. Control Motor | DO | PLC-DW | Stop | Start | | | | | 1 |
| | | | | | PLC-DW IO Signals | | | | 4 | 15 | 3 | 4 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **BFP Screw Conveyor #1 - 15-BFP-C-1** | | | | | | | | | | | | |
| HMS | 1710 | MA-1710 | BFP Screw Conveyor 1. Remote | DI | PLC-DW | Off | Comp | | | 1 | | |
| MN | 1710 | MN-1710 | BFP Screw Conveyor 1. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| TH | 1710 | TH-1710 | BFP Screw Conveyor 1. Hi Temp | DI | PLC-DW | Off | Hi Temp | | | 1 | | |
| MF | 1710 | MF-1710 | BFP Screw Conveyor 1. Starter Overload | DI | PLC-DW | Off | Fail | | | 1 | | |
| YN | 1710 | YN-1710 | BFP Screw Conveyor 1. E-Stop | DI | PLC-DW | Off | Fail | | | 1 | | |
| SL | 1710 | SL-1710 | BFP Screw Conveyor 1. Zero Speed | DI | PLC-DW | Off | Alarm | | | 1 | | |
| MC | 1710 | MC-1710 | BFP Screw Conveyor 1. Control Motor | DO | PLC-DW | Stop | Start | | | | | 1 |
| **BFP Inclined Screw Conveyor - 15-BFP-C-2** | | | | | | | | | | | | |
| HMS | 1720 | MA-1720 | BFP Inclined Screw Conveyor 2. Remote | DI | PLC-DW | Off | Comp | | | 1 | | |
| MN | 1720 | MN-1720 | BFP Inclined Screw Conveyor 2. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| TH | 1720 | TH-1720 | BFP Inclined Screw Conveyor 2. Hi Temp | DI | PLC-DW | Off | Hi Temp | | | 1 | | |
| MF | 1720 | MF-1720 | BFP Inclined Screw Conveyor 2. Starter Overload | DI | PLC-DW | Off | Fail | | | 1 | | |
| YN | 1720 | YN-1720 | BFP Inclined Screw Conveyor 2. E-Stop | DI | PLC-DW | Off | Fail | | | 1 | | |
| SL | 1720 | SL-1720 | BFP Inclined Screw Conveyor 2. Zero Speed | DI | PLC-DW | Off | Alarm | | | 1 | | |
| MC | 1720 | MC-1720 | BFP Inclined Screw Conveyor 2. Control Motor | DO | PLC-DW | Stop | Start | | | | | 1 |
| **Sludge Conveyor Knife Valve 1 - 15-SC-V-1** | | | | | | | | | | | | |
| HMS | 1721 | MA-1721 | Sludge Coveyor Valve #1. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| ZL | 1721 | MN-1721 | Sludge Coveyor Valve #1. Close | DI | PLC-DW | Off | Close | | | 1 | | |
| ZH | 1721 | MF-1721 | Sludge Coveyor Valve #1. Open | DI | PLC-DW | Off | Open | | | 1 | | |
| ZF | 1721 | MC-1721 | Sludge Coveyor Valve #1. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| ZO | 1721 | ZO-1721 | Sludge Coveyor Valve #1. Valve Open | DO | PLC-DW | Off | Open | | | | | 1 |
| ZC | 1721 | ZC-1721 | Sludge Coveyor Valve #1. Valve Closed | DO | PLC-DW | Off | Close | | | | | 1 |
| **Sludge Conveyor Knife Valve 2 - 15-SC-V-2** | | | | | | | | | | | | |
| HMS | 1722 | MA-1722 | Sludge Coveyor Valve #2. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| ZL | 1722 | MN-1722 | Sludge Coveyor Valve #2. Close | DI | PLC-DW | Off | Close | | | 1 | | |
| ZH | 1722 | MF-1722 | Sludge Coveyor Valve #2. Open | DI | PLC-DW | Off | Open | | | 1 | | |
| ZF | 1722 | MC-1722 | Sludge Coveyor Valve #2. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| ZO | 1722 | ZO-1722 | Sludge Coveyor Valve #2. Valve Open | DO | PLC-DW | Off | Open | | | | | 1 |
| ZC | 1722 | ZC-1722 | Sludge Coveyor Valve #2. Valve Closed | DO | PLC-DW | Off | Close | | | | | 1 |
| **Sludge Conveyor Knife Valve 3 - 15-SC-V-3** | | | | | | | | | | | | |
| HMS | 1723 | MA-1723 | Sludge Coveyor Valve #3. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| ZL | 1723 | MN-1723 | Sludge Coveyor Valve #3. Close | DI | PLC-DW | Off | Close | | | 1 | | |
| ZH | 1723 | MF-1723 | Sludge Coveyor Valve #3. Open | DI | PLC-DW | Off | Open | | | 1 | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| ZF | 1723 | MC-1723 | Sludge Coveyor Valve #3. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| ZO | 1723 | ZO-1723 | Sludge Coveyor Valve #3. Valve Open | DO | PLC-DW | Off | Open | | | | | 1 |
| ZC | 1723 | ZC-1723 | Sludge Coveyor Valve #3. Valve Closed | DO | PLC-DW | Off | Close | | | | | 1 |
| | | | | | PLC-DW IO Signals | | | | **0** | **24** | **0** | **8** |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **T/D Drain Wetwell Level 15-DP-L-1** | | | | | | | | | | | | |
| LE/LIT | 1750 | LI-1750 | T/D Drain Wetwell. Level | AI | PLC-DW | 0 | TBD | FT | 1 | | | |
| **T/D Drain Wetwell Hi Level - 15-DP-LS-1** | | | | | | | | | | | | |
| LSH | 1751 | LH-1751 | T/D Drain Wetwell. Hi Level | DI | PLC-DW | Off | Hi Level | | | 1 | | |
| **T/D Drain Wetwell Low Level - 15-DP-LS-2** | | | | | | | | | | | | |
| LSL | 1752 | LL-1752 | T/D Drain Wetwell. Low Level | DI | PLC-DW | Off | Low Level | | | 1 | | |
| **T/D Drain Wetwell Hatch Switch - 15-DP-ZS-1** | | | | | | | | | | | | |
| ZS | 1753 | ZC-1753 | T/D Drain Wetwell Hatch. Closed | DI | PLC-DW | Open | Closed | | | 1 | | |
| **T/D Drain PS Discharge Flow 15-DP-F-1** | | | | | | | | | | | | |
| FE/FIT | 1780 | FI-1780 | T/D Drain Dain PS. Flow | AI | PLC-DW | 0 | TBD | GPM | 1 | | | |
| **T/D Drain PS Pump #1 - 15-DP-P-1** | | | | | | | | | | | | |
| SI | 1760 | SI-1760 | DW Drain Pump #1. Speed Indication | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| HMS | 1760 | MA-1760 | DW Drain Pump #1. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1760 | MN-1760 | DW Drain Pump #1. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1760 | MF-1760 | DW Drain Pump #1. Fail | DI | PLC-DW | Off | Lockout | | | 1 | | |
| MO | 1760 | MO-1760 | DW Drain Pump #1. Hi Temp | DI | PLC-DW | Off | Hi Temp | | | 1 | | |
| YF | 1760 | YF-1760 | DW Drain Pump #1. Seal Leak | DI | PLC-DW | Off | Seal Fail | | | 1 | | |
| MF | 1760 | MF-1760 | DW Drain Pump #1. VFD Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| MC | 1760 | MC-1760 | DW Drain Pump #1. Motor Control | DO | PLC-DW | Stop | Start | | | | | 1 |
| SC | 1760 | SC-1760 | DW Drain Pump #1. Speed Control | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| **T/D Drain PS Pump #2 - 15-DP-P-2** | | | | | | | | | | | | |
| SI | 1770 | SI-1770 | DW Drain Pump #2. Speed Indication | AI | PLC-DW | 0 | 100 | % | 1 | | | |
| HMS | 1770 | MA-1770 | DW Drain Pump #2. Remote | DI | PLC-DW | Off | Remote | | | 1 | | |
| MN | 1770 | MN-1770 | DW Drain Pump #2. Run Status | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1770 | MF-1770 | DW Drain Pump #2. Fail | DI | PLC-DW | Off | Lockout | | | 1 | | |
| MO | 1770 | MO-1770 | DW Drain Pump #2. OverTemperaure | DI | PLC-DW | Off | Hi Temp | | | 1 | | |
| YF | 1770 | YF-1770 | DW Drain Pump #2. Seal Leak | DI | PLC-DW | Off | Seal Fail | | | 1 | | |
| MF | 1770 | MF-1770 | DW Drain Pump #2. VFD Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| MC | 1770 | MC-1770 | DW Drain Pump #2. Motor Control | DO | PLC-DW | Stop | Start | | | | | 1 |
| SC | 1820 | SC-1770 | DW Drain Pump #2. Speed Control | AO | PLC-DW | 0 | 100 | % | | | 1 | |
| | | | | | PLC-DW IO Signals | | | | 4 | 15 | 2 | 2 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **Plant Drain PS1 Wetwell Level 17-DPS1-L-1** | | | | | | | | | | | | |
| LE/LIT | 2100 | LI-2100 | Plant Drain PS1 Wetwell. Level | AI | PLC-A | 0 | TBD | FT | 1 | | | |
| **Plant Drain PS1 Wetwell Hi Level - 17-DPS1-LS-1** | | | | | | | | | | | | |
| LSH | 2101 | LH-2101 | Pant Drain PS1 Wetwell. Hi Level | DI | PLC-A | Off | Hi Level | | | 1 | | |
| **Plant Drain PS1 Wetwell Low Level - 17-DPS1-LS-2** | | | | | | | | | | | | |
| LSL | 2102 | LL-2102 | Pant Drain PS1 Wetwell. Low Level | DI | PLC-A | Off | Low Level | | | 1 | | |
| **Plant Drain PS1 Wetwell Hatch Switch - 17-DPS1-ZS-1** | | | | | | | | | | | | |
| ZS | 2103 | ZH-2103 | Pant Drain PS1 Wetwell Hatch. Closed | DI | PLC-A | Open | Closed | | | 1 | | |
| **Plant Drain PS1 Discharge Flow 15-DPS1-F-1** | | | | | | | | | | | | |
| FE/FIT | 2104 | FI-2104 | Pant Drain PS1. Flow | AI | PLC-A | 0 | TBD | GPM | 1 | | | |
| **Plant Drain PS1 Pump #1 - 17-DPS1-P-1** | | | | | | | | | | | | |
| SI | 2110 | SI-2110 | Pant Drain PS1 Pump #1. Speed Indication | AI | PLC-A | 0 | 100 | % | 1 | | | |
| HMS | 2110 | MA-2110 | Pant Drain PS1 Pump #1. Remote | DI | PLC-A | Off | Remote | | | 1 | | |
| MN | 2110 | MN-2110 | Pant Drain PS1 Pump #1. Run Status | DI | PLC-A | Off | Run | | | 1 | | |
| MF | 2110 | MF-2110 | Pant Drain PS1 Pump #1. Fail | DI | PLC-A | Off | Lockout | | | 1 | | |
| MO | 2110 | MO-2110 | Pant Drain PS1 Pump #1. Hi Temp | DI | PLC-A | Off | Hi Temp | | | 1 | | |
| YF | 2110 | YF-2110 | Pant Drain PS1 Pump #1. Seal Leak | DI | PLC-A | Off | Seal Fail | | | 1 | | |
| MF | 2110 | MF-2110 | Pant Drain PS1 Pump #1. VFD Fail | DI | PLC-A | Off | Fail | | | 1 | | |
| MC | 2110 | MC-2110 | Pant Drain PS1 Pump #1. Motor Control | DO | PLC-A | Stop | Start | | | | | 1 |
| SC | 2110 | SC-2110 | Pant Drain PS1 Pump #1. Speed Control | AO | PLC-A | 0 | 100 | % | | | 1 | |
| **Plant Drain PS1 Pump #2 - 17-DPS1-P-2** | | | | | | | | | | | | |
| SI | 2120 | SI-2120 | Pant Drain PS1 Pump #2. Speed Ind | AI | PLC-A | 0 | 100 | % | 1 | | | |
| HMS | 2120 | MA-2120 | Pant Drain PS1 Pump #2. Remote | DI | PLC-A | Off | Remote | | | 1 | | |
| MN | 2120 | MN-2120 | Pant Drain PS1 Pump #2. Run Status | DI | PLC-A | Off | Run | | | 1 | | |
| MF | 2120 | MF-2120 | Pant Drain PS1 Pump #2. Fail | DI | PLC-A | Off | Lockout | | | 1 | | |
| MO | 2120 | MO-2120 | Pant Drain PS1 Pump #2. OverTemp | DI | PLC-A | Off | Hi Temp | | | 1 | | |
| YF | 2120 | YF-2120 | Pant Drain PS1 Pump #2. Seal Leak | DI | PLC-A | Off | Seal Fail | | | 1 | | |
| MF | 2120 | MF-2120 | Pant Drain PS1 Pump #2. VFD Fail | DI | PLC-A | Off | Fail | | | 1 | | |
| MC | 2120 | MC-2120 | Pant Drain PS1 Pump #2. Motor Control | DO | PLC-A | Stop | Start | | | | | 1 |
| SC | 2120 | SC-2120 | Pant Drain PS1 Pump #2. Speed Control | AO | PLC-A | 0 | 100 | % | | | 1 | |
| | | | | | PLC-A IO Signals | | | | 4 | 15 | 2 | 2 |

| Tagname | | HMI | See Note 1 | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **Dryer Feed Pump #1 - 15-DF-P-1** | | | | | | | | | | | | |
| MN | 3001 | MN-3001 | Dryer Feed Pump #1. Run | DI | PLC-DRYER | Off | Run | | Network | | | |
| MF | 3001 | MF-3001 | Dryer Feed Pump #1. Fail | DI | PLC-DRYER | Off | Fail | | Network | | | |
| HA | 3001 | HA-3001 | Dryer Feed Pump #1. Auto | DI | PLC-DRYER | Manual | Auto | | Network | | | |
| MC | 3001 | MC-3001 | Dryer Feed Pump #1. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network | | | |
| TIC | 3001 | TIC-3001 | Dryer Feed Pump #1. Hi Temp | DO | PLC-DRYER | Interlock | Off | | Network | | | |
| TE | 3001 | TE-3001 | Dryer Feed Pump #1. Temperature sensor | AI | PLC-DRYER | 0 | 70 | F | Network | | | |
| SI | 3001 | SI-3001 | Dryer Feed Pump #1. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network | | | |
| SC | 3001 | SC-3001 | Dryer Feed Pump #1. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network | | | |
| **Dryer Feed Pump #1 Inlet Pressure - 15-DF-PT-1** | | | | | | | | | | | | |
| PIT | 3002A | PI-3002A | Dryer Feed Pump #1. Inlet Pressure | AI | PLC-DRYER | 0 | 350 | PSI | Network | | | |
| **Dryer Feed Pump #1 Outlet Pressure - 15-DF-PT-2** | | | | | | | | | | | | |
| PIT | 3002B | PI-3002B | Dryer Feed Pumps #1. Outlet Pressure | AI | PLC-DRYER | 0 | 350 | PSI | Network | | | |
| **Dryer Feed Mainfold 1 Valve 1 - 15-DF-V-1** | | | | | | | | | | | | |
| ZH | 3003 | ZH-3003 | Dryer Feed Pump Valve 1. Open | DI | PLC-DRYER | Off | Open | | Network | | | |
| ZL | 3003 | ZL-3003 | Dryer Feed Pump Valve 1. Close | DI | PLC-DRYER | Off | Close | | Network | | | |
| ZC | 3003 | ZC-3003 | Dryer Feed Pump Valve 1. Open/Close | DO | PLC-DRYER | Open | Close | | Network | | | |
| **Dryer Feed Pump #2 - 15-DF-P-2** | | | | | | | | | | | | |
| MN | 3004 | MN-3004 | Dryer Feed Pump #2. Run | DI | PLC-DRYER | Off | Run | | Network | | | |
| MF | 3004 | MF-3004 | Dryer Feed Pump #2. Fail | DI | PLC-DRYER | Off | Fail | | Network | | | |
| HA | 3004 | HA-3004 | Dryer Feed Pump #2. Auto | DI | PLC-DRYER | Manual | Auto | | Network | | | |
| MC | 3004 | MC-3004 | Dryer Feed Pump #2. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network | | | |
| TIC | 3004 | TIC-3004 | Dryer Feed Pump #2. Hi Temp | DO | PLC-DRYER | Interlock | Off | | Network | | | |
| TE | 3004 | TE-3004 | Dryer Feed Pump #2. Temperature sensor | AI | PLC-DRYER | 0 | 70 | F | Network | | | |
| SI | 3004 | SI-3004 | Dryer Feed Pump #2. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network | | | |
| SC | 3004 | SC-3004 | Dryer Feed Pump #2. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network | | | |
| **Dryer Feed Pump #2 Inlet Pressure - 15-DF-PT-3** | | | | | | | | | | | | |
| PIT | 3005A | PI-3005A | Dryer Feed Pump #2. Inlet Pressure | AI | PLC-DRYER | 0 | 350 | PSI | Network | | | |
| **Dryer Feed Pump #2 Outlet Pressure - 15-DF-PT-4** | | | | | | | | | | | | |
| PIT | 3005B | PI-3005B | Dryer Feed Pump #2. Outlet Pressure | AI | PLC-DRYER | 0 | 350 | PSI | Network | | | |
| **Dryer Feed Mainfold 2 Valve 1 - 15-DF-V-2** | | | | | | | | | | | | |
| ZH | 3006 | ZH-3006 | Dryer Feed Pump Valve 2. Open | DI | PLC-DRYER | Off | Open | | Network | | | |
| ZL | 3006 | ZL-3006 | Dryer Feed Pump Valve 2. Close | DI | PLC-DRYER | Off | Close | | Network | | | |
| ZC | 3006 | ZC-3006 | Dryer Feed Pump Valve 2. Open/Close | DO | PLC-DRYER | Open | Close | | Network | | | |
| **Dryer Bypass Valve - 15-DB-V-1** | | | | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ZH | 3007 | ZH-3007 | Dryer Bypass Valve. Open | DI | PLC-DRYER | Off | Open | | Network |
| ZL | 3007 | ZL-3007 | Dryer Bypass Valve. Close | DI | PLC-DRYER | Off | Close | | Network |
| **Manifold 1 NPW Flush Valve 1** | | | | | | | | | |
| ZC | 3008 | ZC-3008 | Manifold 1 NPW Valve 1. Open/Close | DO | PLC-DRYER | Close | Open | | Network |
| **Manifold 1 NPW Flush Valve 2** | | | | | | | | | |
| ZC | 3009 | ZC-3009 | Manifold 1 NPW Valve 2. Open/Close | DO | PLC-DRYER | Close | Open | | Network |
| **Manifold 1 Pressure Relieve Valve 1** | | | | | | | | | |
| ZH | 3010 | ZH-3010 | Manifold 1 Valve 1. Open | DI | PLC-DRYER | Off | Open | | Network |
| ZL | 3010 | ZL-3010 | Manifold 1 Valve 1. Close | DI | PLC-DRYER | Off | Close | | Network |
| ZC | 3010 | ZC-3010 | Manifold 1 Valve 1. Open/Close | DO | PLC-DRYER | Open | Close | | Network |
| **Manifold 1 Pressure Relieve Valve 2** | | | | | | | | | |
| ZH | 3011 | ZH-3011 | Manifold 1 Valve 2. Open | DI | PLC-DRYER | Off | Open | | Network |
| ZL | 3011 | ZL-3011 | Manifold 1 Valve 2. Close | DI | PLC-DRYER | Off | Close | | Network |
| ZC | 3011 | ZC-3011 | Manifold 1 Valve 2. Open/Close | DO | PLC-DRYER | Open | Close | | Network |
| **Manifold 1 Pressure - 15-MF1-PT-1** | | | | | | | | | |
| PIT | 3012 | PI-3012 | Manifold 1. Pressure | AI | PLC-DRYER | 0 | 70 | PSI | Network |
| **Manifold 2 NPW Valve 3** | | | | | | | | | |
| ZC | 3013 | ZC-3013 | Manifold 2 NPW Valve 3. Open/Close | DO | PLC-DRYER | Close | Open | | Network |
| **Manifold 2 NPW Valve 4** | | | | | | | | | |
| ZC | 3014 | ZC-3014 | Manifold 2 NPW Valve 4. Open/Close | DO | PLC-DRYER | Close | Open | | Network |
| **Manifold 2 Valve 1** | | | | | | | | | |
| ZH | 3015 | ZH-3015 | Manifold 2 Valve 1. Open | DI | PLC-DRYER | Off | Open | | Network |
| ZL | 3015 | ZL-3015 | Manifold 2 Valve 1. Close | DI | PLC-DRYER | Off | Close | | Network |
| ZC | 3015 | ZC-3015 | Manifold 2 Valve 1. Open/Close | DO | PLC-DRYER | Open | Close | | Network |
| **Manifold 2 Valve 2** | | | | | | | | | |
| ZH | 3016 | ZH-3016 | Manifold 2 Valve 2. Open | DI | PLC-DRYER | Off | Open | | Network |
| ZL | 3016 | ZL-3016 | Manifold 2 Valve 2. Close | DI | PLC-DRYER | Off | Close | | Network |
| ZC | 3016 | ZC-3016 | Manifold 2 Valve 2. Open/Close | DO | PLC-DRYER | Open | Close | | Network |
| **Manifold 2 Pressure - 15-MF2-PT-1** | | | | | | | | | |
| PIT | 3017 | PI-3017 | Manifold 2. Pressure | AI | PLC-DRYER | 0 | 70 | PSI | Network |
| **Dosing Pump #1 - 15-D-P-1** | | | | | | | | | |
| MN | 3021 | MN-3021 | Dosing Pump #1. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3021 | MF-3021 | Dosing Pump #1. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3021 | HA-3021 | Dosing Pump #1. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3021 | MC-3021 | Dosing Pump #1. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| TIC | 3021 | TIC-3021 | Dosing Pump #1. Hi Temp | DO | PLC-DRYER | Interlock | Off | | Network |
| TE | 3021 | TE-3021 | Dosing Pump #1. Temperature sensor | AI | PLC-DRYER | 0 | 70 | F | Network |

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|---|---|---|---|---|---|---|---|---|---|
| SI | 3021 | SI-3021 | Dosing Pump #1. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3021 | SC-3021 | Dosing Pump #1. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dosing Pump #1 Discharge Pressure - 15-D-PT-1** | | | | | | | | | |
| PIT | 3022 | PI-3022 | Dosing Pump #1. Pressure | AI | PLC-DRYER | 0 | 350 | PSI | Network |
| **Dosing Pump #2 - 15-D-P-2** | | | | | | | | | |
| MN | 3023 | MN-3023 | Dosing Pump #2. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3023 | MF-3023 | Dosing Pump #2. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3023 | HA-3023 | Dosing Pump #2. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3023 | MC-3023 | Dosing Pump #2. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| TIC | 3023 | TIC-3023 | Dosing Pump #2. Hi Temp | DO | PLC-DRYER | Interlock | Off | | Network |
| TE | 3023 | TE-3023 | Dosing Pump #2. Temperature sensor | AI | PLC-DRYER | 0 | 70 | F | Network |
| SI | 3023 | SI-3023 | Dosing Pump #2. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3023 | SC-3023 | Dosing Pump #2. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dosing Pump #2 Discharge Pressure - 15-D-PT-2** | | | | | | | | | |
| PIT | 3024 | PI-3024 | Dosing Pump #2. Pressure | AI | PLC-DRYER | 0 | 350 | PSI | Network |
| **Dosing Pump #3 - 15-D-P-3** | | | | | | | | | |
| MN | 3025 | MN-3023 | Dosing Pump #3. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3025 | MF-3023 | Dosing Pump #3. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3025 | HA-3023 | Dosing Pump #3. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3025 | MC-3023 | Dosing Pump #3. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| TIC | 3025 | TIC-3023 | Dosing Pump #3. Hi Temp | DO | PLC-DRYER | Interlock | Off | | Network |
| TE | 3025 | TE-3023 | Dosing Pump #3. Temperature sensor | AI | PLC-DRYER | 0 | 70 | F | Network |
| SI | 3025 | SI-3023 | Dosing Pump #3. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3025 | SC-3023 | Dosing Pump #3. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dosing Pump #3 Discharge Pressure - 15-D-PT-3** | | | | | | | | | |
| PIT | 3026 | PI-3026 | Dosing Pump #3. Pressure | AI | PLC-DRYER | 0 | 350 | PSI | Network |
| **Dosing Pump #4 - 15-D-P-4** | | | | | | | | | |
| MN | 3027 | MN-3027 | Dosing Pump #4. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3027 | MF-3027 | Dosing Pump #4. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3027 | HA-3027 | Dosing Pump #4. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3027 | MC-3027 | Dosing Pump #4. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| TIC | 3027 | TIC-3027 | Dosing Pump #4. Hi Temp | DO | PLC-DRYER | Interlock | Off | | Network |
| TE | 3027 | TE-3027 | Dosing Pump #4. Temperature sensor | AI | PLC-DRYER | 0 | 70 | F | Network |
| SI | 3027 | SI-3027 | Dosing Pump #4. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3027 | SC-3027 | Dosing Pump #4. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dosing Pump #4 Discharge Pressure - 15-D-PT-4** | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|
| PIT | 3028 | PI-3028 | Dosing Pump #4. Pressure | AI | PLC-DRYER | 0 | 350 | PSI | Network |
| **Dosing Pump #5 - 15-D-P-5** | | | | | | | | | |
| MN | 3029 | MN-3029 | Dosing Pump #5. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3029 | MF-3029 | Dosing Pump #5. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3029 | HA-3029 | Dosing Pump #5. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3029 | MC-3029 | Dosing Pump #5. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| TIC | 3029 | TIC-3029 | Dosing Pump #5. Hi Temp | DO | PLC-DRYER | Interlock | Off | | Network |
| TE | 3029 | TE-3029 | Dosing Pump #5. Temperature sensor | AI | PLC-DRYER | 0 | 70 | F | Network |
| SI | 3029 | SI-3029 | Dosing Pump #5. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3029 | SC-3029 | Dosing Pump #5. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dosing Pump #5 Discharge Pressure - 15-D-PT-5** | | | | | | | | | |
| PIT | 3030 | PI-3030 | Dosing Pump #5. Pressure | AI | PLC-DRYER | 0 | 350 | PSI | Network |
| **Dosing Pump #6 - 15-D-P-6** | | | | | | | | | |
| MN | 3031 | MN-3031 | Dosing Pump #6. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3031 | MF-3031 | Dosing Pump #6. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3031 | HA-3031 | Dosing Pump #6. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3031 | MC-3031 | Dosing Pump #6. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| TIC | 3031 | TIC-3031 | Dosing Pump #6. Hi Temp | DO | PLC-DRYER | Interlock | Off | | Network |
| TE | 3031 | TE-3031 | Dosing Pump #6. Temperature sensor | AI | PLC-DRYER | 0 | 70 | F | Network |
| SI | 3031 | SI-3031 | Dosing Pump #6. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3031 | SC-3031 | Dosing Pump #6. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dosing Pump #6 Discharge Pressure - 15-D-PT-6** | | | | | | | | | |
| PIT | 3032 | PI-3032 | Dosing Pump #6. Pressure | AI | PLC-DRYER | 0 | 350 | PSI | Network |
| **Dosing Pump #7 - 15-D-P-7** | | | | | | | | | |
| MN | 3033 | MN-3033 | Dosing Pump #7. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3033 | MF-3033 | Dosing Pump #7. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3033 | HA-3033 | Dosing Pump #7. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3033 | MC-3033 | Dosing Pump #7. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| TIC | 3033 | TIC-3033 | Dosing Pump #7. Hi Temp | DO | PLC-DRYER | Interlock | Off | | Network |
| TE | 3033 | TE-3033 | Dosing Pump #7. Temperature sensor | AI | PLC-DRYER | 0 | 70 | F | Network |
| SI | 3033 | SI-3033 | Dosing Pump #7. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3033 | SC-3033 | Dosing Pump #7. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dosing Pump #7 Discharge Pressure - 15-D-PT-7** | | | | | | | | | |
| PIT | 3034 | PI-3034 | Dosing Pump #7. Pressure | AI | PLC-DRYER | 0 | 350 | PSI | Network |
| **Dosing Pump #8 - 15-D-P-8** | | | | | | | | | |
| MN | 3035 | MN-3035 | Dosing Pump #8. Run | DI | PLC-DRYER | Off | Run | | Network |

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|---|---|---|---|---|---|---|---|---|---|
| MF | 3035 | MF-3035 | Dosing Pump #8. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3035 | HA-3035 | Dosing Pump #8. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3035 | MC-3035 | Dosing Pump #8. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| TIC | 3035 | TIC-3035 | Dosing Pump #8. Hi Temp | DO | PLC-DRYER | Interlock | Off | | Network |
| TE | 3035 | TE-3035 | Dosing Pump #8. Temperature sensor | AI | PLC-DRYER | 0 | 70 | F | Network |
| SI | 3035 | SI-3035 | Dosing Pump #8. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3035 | SC-3035 | Dosing Pump #8. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dosing Pump #8 Discharge Pressure - 15-D-PT-8** | | | | | | | | | |
| PIT | 3036 | PI-3036 | Dosing Pump #8. Pressure | AI | PLC-DRYER | 0 | 350 | PSI | Network |
| **Rotating Depositer Shaft - 15-RDS-M-1** | | | | | | | | | |
| MN | 3037 | MN-3037 | Rotating Depositer Shaft. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3037 | MF-3037 | Rotating Depositer Shaft. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3037 | HA-3037 | Rotating Depositer Shaft. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| ZS | 3037 | ZA-3037 | Rotating Depositer Shaft. Rev Over-Travel | DI | PLC-DRYER | Off | Rev O/T | | Network |
| ZS | 3037 | ZA-3037 | Rotating Depositer Shaft. Forward Over-Travel | DI | PLC-DRYER | Off | FWR O/T | | Network |
| MC | 3037 | MC-3037 | Rotating Depositer Shaft. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3037 | SI-3037 | Rotating Depositer Shaft. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3037 | SC-3037 | Rotating Depositer Shaft. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dryer Top Belt Drive - 15-DTB-D-1** | | | | | | | | | |
| MN | 3100 | MN-3100 | Dryer Top Belt Drive. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3100 | MF-3100 | Dryer Top Belt Drive. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3100 | HA-3100 | Dryer Top Belt Drive. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3100 | MC-3100 | Dryer Top Belt Drive. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3100 | SI-3100 | Dryer Top Belt Drive. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3100 | SC-3100 | Dryer Top Belt Drive. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dryer Top Belt Drive Slow Speed - 15-DTB-SL-1** | | | | | | | | | |
| SSL | 3100 | SL-3100 | Dryer Top Belt Drive. Slow Speed | DI | PLC-DRYER | Off | Slow Speed | | Network |
| **Dryer Pressure 1 - 15-D-PT-1** | | | | | | | | | |
| PIT | 3101 | PI-3101 | Dryer Pressure | AI | PLC-DRYER | 0 | XXX | PSI | Network |
| **Dryer Top Belt Drive Hi Temperature - 15-DTB-TS-1** | | | | | | | | | |
| TSH | 3103 | TH-3103 | Dryer Top Belt Drive. Hi Temperature 1 | DI | PLC-DRYER | Off | Hi Temp | | Network |
| **Dryer Top Belt Drive Hi Temperature - 15-DTB-TS-2** | | | | | | | | | |
| TSH | 3104 | TH-3104 | Dryer Top Belt Drive. Hi Temperature 2 | DI | PLC-DRYER | Off | Hi Temp | | Network |
| **Dryer Top Belt Drive Hi Temperature - 15-DTB-TS-3** | | | | | | | | | |
| TSH | 3105 | TH-3105 | Dryer Top Belt Drive. Hi Temperature 3 | DI | PLC-DRYER | Off | Hi Temp | | Network |
| **Dryer Top Belt Drive Hi Temperature - 15-DTB-TS-4** | | | | | | | | | |
| TSH | 3106 | TH-3106 | Dryer Top Belt Drive. Hi Temperature 4 | DI | PLC-DRYER | Off | Hi Temp | | Network |

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| **Dryer Top Belt Drive Hi Level - 15-DTB-LS-1&2** | | | | | | | | | |
| LSH | 3107 | LH-3107 | Dryer Top Belt Drive. Hi Level | DI | PLC-DRYER | Off | Hi Level | | Network |
| **Dryer Bottom Belt Drive - 15-DBB-D-1** | | | | | | | | | |
| MN | 3110 | MN-3110 | Dryer Bottom Belt Drive. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3110 | MF-3110 | Dryer Bottom Belt Drive. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3110 | HA-3110 | Dryer Bottom Belt Drive. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3110 | MC-3110 | Dryer Bottom Belt Drive. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3110 | SI-3110 | Dryer Bottom Belt Drive. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3110 | SC-3110 | Dryer Bottom Belt Drive. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dryer Bottom Belt Drive Slow Speed - 15-DBB-SL-1** | | | | | | | | | |
| SSL | 3110 | SL-3110 | Dryer Bottom Belt Drive. Slow Speed | DI | PLC-DRYER | Off | Slow Speed | | Network |
| **Dryer Bottom Belt Drive Hi Level - 15-DBB-LS-1&2** | | | | | | | | | |
| LSH | 3111 | LH-3111 | Dryer Bottom Belt Drive. Hi Level | DI | PLC-DRYER | Off | Hi Level | | Network |
| **Dryer Bottom Belt Drive Temperature Sensor - 15-DBB-TE-1** | | | | | | | | | |
| TE | 3113 | TE-3113 | Dryer Bottom Belt Drive. Temperature sensor 1 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Dryer Bottom Belt Drive Temperature Sensor - 15-DBB-TE-2** | | | | | | | | | |
| TE | 3114 | TE-3114 | Dryer Bottom Belt Drive. Temperature sensor 2 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Dryer Temerature 1 - 15-DBB-T-1** | | | | | | | | | |
| TIT | 3115 | TI-3115 | Dryer Bottom Belt Drive. Temperature 1 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Dryer Temerature 2 - 15-DBB-T-2** | | | | | | | | | |
| TIT | 3116 | TI-3116 | Dryer Bottom Belt Drive. Temperature 2 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Dryer Temerature 3 - 15-DBB-T-3** | | | | | | | | | |
| TIT | 3117 | TI-3117 | Dryer Bottom Belt Drive. Temperature 3 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Dryer Temerature 4 - 15-DBB-T-4** | | | | | | | | | |
| TIT | 3118 | TI-3118 | Dryer Bottom Belt Drive. Temperature 4 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Dryer Hi Temperature 1 - 15-D-TS-1** | | | | | | | | | |
| TSH | 3117 | TH-3117 | Dryer. Hi Temperature 1 | DI | PLC-DRYER | Off | Hi Temp | | Network |
| **Dryer Hi Temperature 2 - 15-D-TS-2** | | | | | | | | | |
| TSH | 3119 | TH-3119 | Dryer. Hi Temperature 2 | DI | PLC-DRYER | Off | Hi Temp | | Network |
| **Dryer Hi Level - 15-D-LS-1&2** | | | | | | | | | |
| LSH | 3121 | LH-3120 | Dryer. Hi Level 1&2 | DI | PLC-DRYER | Off | Hi Level | | Network |
| **Dryer Warn Zone Fan #1- 15-WZ-F-1** | | | | | | | | | |
| MN | 3123 | MN-3123 | Dryer Warm Zone Fan #1. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3123 | MF-3123 | Dryer Warm Zone Fan #1. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3123 | HA-3123 | Dryer Warm Zone Fan #1. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3123 | MC-3123 | Dryer Warm Zone Fan #1. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3123 | SI-3123 | Dryer Warm Zone Fan #1. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |

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|---|---|---|---|---|---|---|---|---|---|
| SC | 3123 | SC-3123 | Dryer Warm Zone Fan #1. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dryer Warn Zone Fan #2- 15-DWZ-F-2** | | | | | | | | | |
| MN | 3124 | MN-3124 | Dryer Warm Zone Fan #2. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3124 | MF-3124 | Dryer Warm Zone Fan #2. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3124 | HA-3124 | Dryer Warm Zone Fan #2. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3124 | MC-3124 | Dryer Warm Zone Fan #2. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3124 | SI-3124 | Dryer Warm Zone Fan #2. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3124 | SC-3124 | Dryer Warm Zone Fan #2. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dryer End Zone Fan #1- 15-DEZ-F-1** | | | | | | | | | |
| MN | 3125 | MN-3125 | Dryer End Zone Fan #1. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3125 | MF-3125 | Dryer End Zone Fan #1. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3125 | HA-3125 | Dryer End Zone Fan #1. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3125 | MC-3125 | Dryer End Zone Fan #1. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3125 | SI-3125 | Dryer End Zone Fan #1. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3125 | SC-3125 | Dryer End Zone Fan #1. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dryer End Zone Fan #2- 15-DEZ-F-2** | | | | | | | | | |
| MN | 3126 | MN-3126 | Dryer End Zone Fan #2. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3126 | MF-3126 | Dryer End Zone Fan #2. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3126 | HA-3126 | Dryer End Zone Fan #2. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3126 | MC-3126 | Dryer End Zone Fan #2. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3126 | SI-3126 | Dryer End Zone Fan #2. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3126 | SC-3126 | Dryer End Zone Fan #2. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Dryer Extraction Screw - 15-DES-M-1** | | | | | | | | | |
| MN | 3130 | MN-3130 | Dryer Extraction Screw. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3130 | MF-3130 | Dryer Extraction Screw. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3130 | HA-3130 | Dryer Extraction Screw. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3130 | MC-3130 | Dryer Extraction Screw. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3130 | SI-3130 | Dryer Extraction Screw. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3130 | SC-3130 | Dryer Extraction Screw. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| YN | 3130 | YN-3130 | Dryer Extraction Screw. Speed Control | DI | PLC-DRYER | Off | E-Stop | | Network |
| **Dryer Extraction Screw Temperature - 15-DES-T-1** | | | | | | | | | |
| TIT | 3131 | TI-3131 | Dryer Extraction Screw. Temperature 1 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Dryer Extraction Screw Temperature - 15-DES-T-2** | | | | | | | | | |
| TIT | 3132 | TI-3132 | Dryer Extraction Screw. Temperature 2 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Dryer Extraction Screw Temperature - 15-DES-T-3** | | | | | | | | | |
| TIT | 3133 | TI-3133 | Dryer Extraction Screw. Temperature 3 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Dryer Extraction Screw Hi Level - 15-DES-LS-1** | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|
| LSH | 3134 | LH-3134 | Dryer Extraction Screw. Hi Level | DI | PLC-DRYER | Off | Hi Level | | Network |
| **Dryer Extraction Screw Hi Level - 15-DES-LS-2** | | | | | | | | | |
| LSHH | 3135 | LH-3135 | Dryer Extraction Screw. Hi Hi Level | DI | PLC-DRYER | Off | Hi Hi Level | | Network |
| **Dryer Extraction Screw Hi Temperature - 15-DES-TS-1** | | | | | | | | | |
| TSH | 3136 | TH-3136 | Dryer Extraction Screw. Hi Temperature 1 | DI | PLC-DRYER | Off | Hi Temp | | Network |
| **Dryer Extraction Screw Hi Temperature - 15-DES-TS-2** | | | | | | | | | |
| TSH | 3137 | TH-3137 | Dryer Extraction Screw. Hi Temperature 2 | DI | PLC-DRYER | Off | Hi Temp | | Network |
| **Dryer Extraction Screw Valve 1 - 15-DES-V-1** | | | | | | | | | |
| ZH | 3138 | ZH-3138 | Dryer Extraction Screw Valve 1. Open | DI | PLC-MBR | Off | Open | | Network |
| ZL | 3138 | ZL-3138 | Dryer Extraction Screw Valve 1. Close | DI | PLC-MBR | Off | Close | | Network |
| ZA | 3138 | ZL-3138 | Dryer Extraction Screw Valve 1. Auto | DI | PLC-MBR | Off | Auto | | Network |
| ZC | 3138 | ZC-3138 | Dryer Extraction Screw Valve 1. Open/Close | DO | PLC-MBR | Open | Close | | Network |
| **Air Cooler Temperature 1 - 15-AC-T-1** | | | | | | | | | |
| TIT | 3150 | TI-3150 | Air Cooler. Temperature 1 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Condenser NPW Valve 5 - 15-NPW-V-5** | | | | | | | | | |
| ZC | 3151 | ZC-3151 | Condenser NPW Valve 5. Open/Close | DO | PLC-MBR | Close | Open | | Network |
| **Condenser NPW Flow 1 - 15-NPW-F-1** | | | | | | | | | |
| FE/FIT | 3152 | FI-3152 | Condenser NPW Flow | AI | PLC-DRYER | 0 | XXX | GPM | Network |
| **Condenser NPW Temperature 1 - 15-NPW-T-1** | | | | | | | | | |
| TIT | 3153 | TI-3153 | Condenser NPW. Temperature 1 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Condenser NPW Valve 6 - 15-NPW-V-6** | | | | | | | | | |
| ZC | 3154 | ZC-3154 | Condenser NPW Valve 6. Open/Close | DO | PLC-MBR | Close | Open | | Network |
| **Condenser Differential Pressure 1 - 15-COND-DP-1** | | | | | | | | | |
| DPIT | 3155 | DPI-3155 | Condenser. Differential Pressure 1 | AI | PLC-DRYER | 0 | XXX | PSI | Network |
| **Condenser Differential Pressure 2 - 15-COND-DP-2** | | | | | | | | | |
| DPIT | 3156 | DPI-3156 | Condenser. Differential Pressure 2 | AI | PLC-DRYER | 0 | XXX | PSI | Network |
| **Condenser Hi Level - 15-COND-LS-1** | | | | | | | | | |
| LSH | 3157 | LH-3157 | Condenser. Hi Level | DI | PLC-DRYER | Off | Hi Level | | Network |
| **Condenser Discharge Temperature - 15-COND-T-1** | | | | | | | | | |
| TIT | 3158 | TI-3158 | Condenser. Temperature 1 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Condenser Discharge Temperature - 15-COND-T-1** | | | | | | | | | |
| TIT | 3159 | TI-3159 | Condenser. Temperature 2 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Drying Air Treatment Fan- 15-DA-F-1** | | | | | | | | | |
| MN | 3160 | MN-3160 | Drying Air Treatment Fan. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3160 | MF-3160 | Drying Air Treatment Fan. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3160 | HA-3160 | Drying Air Treatment Fan. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3160 | MC-3160 | Drying Air Treatment Fan. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SI | 3160 | SI-3160 | Drying Air Treatment Fan. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3160 | SC-3160 | Drying Air Treatment Fan. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Vacuum Fan- 15-V-F-1** | | | | | | | | | |
| MN | 3161 | MN-3161 | Vacuum Fan. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3161 | MF-3161 | Vacuum Fan. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3161 | HA-3161 | Vacuum Fan. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3161 | MC-3161 | Vacuum Fan. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3161 | SI-3161 | Vacuum Fan. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3161 | SC-3161 | Vacuum Fan. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| **Heat Exchange Inlet Air Temperature 1 - 15-HE-T-1** | | | | | | | | | |
| TIT | 3162 | TI-3162 | Heat Exchange Inlet Air. Temperature 1 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Heat Exchange Temperature 2 - 15-HE-T-2** | | | | | | | | | |
| TIT | 3163 | TI-31623 | Heat Exchange. Temperature 2 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Heat Exchange Differential Pressure 1 - 15-HE-DP-1** | | | | | | | | | |
| DPIT | 3164 | DPI-3164 | Heat Exchange. Differential Pressure 1 | AI | PLC-DRYER | 0 | XXX | PSI | Network |
| **Heat Exchange Differential Pressure 2 - 15-HE-DP-2** | | | | | | | | | |
| DPIT | 3165 | DPI-3165 | Heat Exchange. Differential Pressure 2 | AI | PLC-DRYER | 0 | XXX | PSI | Network |
| **Heat Exchange Temperature 3 - 15-HE-T-3** | | | | | | | | | |
| TIT | 3166 | TI-3166 | Heat Exchange. Temperature 3 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Heat Exchange Outlet Air Temperature 4 - 15-HE-T-4** | | | | | | | | | |
| TIT | 3167 | TI-3167 | Heat Exchange. Temperature 4 | AI | PLC-DRYER | 0 | XXX | F | Network |
| **Dryer Warm Zone NPW Valve 7 - 15-NPW-V-7** | | | | | | | | | |
| ZC | 3168 | ZC-3168 | Dryer Warm Zone NPW Valve 7. Open/Close | DO | PLC-DRYER | Close | Open | | Network |
| **Dryer NPW Low Pressure - 15-NPW-PS-7** | | | | | | | | | |
| PSL | 3169 | PL-3169 | Dryer NPW. Low Pressure | DI | PLC-DRYER | Off | Low Press | | Network |
| **Dryer End Zone NPW Valve 8 - 15-NPW-V-8** | | | | | | | | | |
| ZC | 3170 | ZC-3170 | Dryer End Zone NPW Valve 8. Open/Close | DO | PLC-DRYER | Close | Open | | Network |
| **Wet Cake Bin Level 1 (15-WCB-LS-1)** | | | | | | | | | |
| LSH | 3201 | LH-3201 | Wet Cake Bin. Hi Level 1 | DI | PLC-DRYER | Off | Hi Level | | Network |
| **Wet Cake Bin Level 2 (15-WCB-LS-2)** | | | | | | | | | |
| LSH | 3202 | LH-3202 | Wet Cake Bin. Hi Level 2 | DI | PLC-DRYER | Off | Hi Level | | Network |
| **Wet Cake Bin Level 3 (15-WCB-LS-3)** | | | | | | | | | |
| LSH | 3203 | LH-3203 | Wet Cake Bin. Hi Level 3 | DI | PLC-DRYER | Off | Hi Level | | Network |
| **Wet Cake Bin Level 4 (15-WCB-LS-4)** | | | | | | | | | |
| LSH | 3204 | LH-3204 | Wet Cake Bin. Hi Level 4 | DI | PLC-DRYER | Off | Hi Level | | Network |
| **Wet Cake Bin Weight (15-WCB-W-1)** | | | | | | | | | |
| WIT | 3205 | WI-3205 | Wet Cake Bin. Weight | AI | PLC-DRYER | 0 | XXX | LBS | Network |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Wet Cake Bin Bottom Screw 1 (15-BBS-M-1)** | | | | | | | | | |
| MN | 3211 | MN-3211 | Wet Cake Bin Bottom Screw 1. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3211 | MF-3211 | Wet Cake Bin Bottom Screw 1. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3211 | HA-3211 | Wet Cake Bin Bottom Screw 1. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3211 | MC-3211 | Wet Cake Bin Bottom Screw 1. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3211 | SI-3211 | Wet Cake Bin Bottom Screw 1. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3211 | SC-3211 | Wet Cake Bin Bottom Screw 1. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| YN | 3211 | YN-3211A | Wet Cake Bin Bottom Screw 1. E-Stop | DI | PLC-DRYER | Off | E-Stop | | Network |
| YN | 3211 | YN-3211B | Wet Cake Bin Bottom Screw 1. E-Stop | DI | PLC-DRYER | Off | E-Stop | | Network |
| SSL | 3211 | SL-3211B | Wet Cake Bin Bottom Screw 1. Low Speed | DI | PLC-DRYER | Off | Lo Speed | | Network |
| **Wet Cake Bin Bottom Screw 2 (15-BBS-M-2)** | | | | | | | | | |
| MN | 3212 | MN-3212 | Wet Cake Bin Bottom Screw 2. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3212 | MF-3212 | Wet Cake Bin Bottom Screw 2. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3212 | HA-3212 | Wet Cake Bin Bottom Screw 2. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3212 | MC-3212 | Wet Cake Bin Bottom Screw 2. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3212 | SI-3212 | Wet Cake Bin Bottom Screw 2. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3212 | SC-3212 | Wet Cake Bin Bottom Screw 2. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| YN | 3212 | YN-3212A | Wet Cake Bin Bottom Screw 2. E-Stop | DI | PLC-DRYER | Off | E-Stop | | Network |
| YN | 3212 | YN-3212B | Wet Cake Bin Bottom Screw 2. E-Stop | DI | PLC-DRYER | Off | E-Stop | | Network |
| SSL | 3212 | SL-3212B | Wet Cake Bin Bottom Screw 2. Low Speed | DI | PLC-DRYER | Off | Lo Speed | | Network |
| **Wet Cake Bin Leveling Screw 1 (15-BLS-M-1)** | | | | | | | | | |
| MN | 3213 | MN-3213 | Wet Cake Bin Leveling Screw 1. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3213 | MF-3213 | Wet Cake Bin Leveling Screw 1. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3213 | HA-3213 | Wet Cake Bin Leveling Screw 1. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3213 | MC-3213 | Wet Cake Bin Leveling Screw 1. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3213 | SI-3213 | Wet Cake Bin Leveling Screw 1. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |
| SC | 3213 | SC-3213 | Wet Cake Bin Leveling Screw 1. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network |
| YN | 3213 | YN-3213A | Wet Cake Bin Leveling Screw 1. E-Stop | DI | PLC-DRYER | Off | E-Stop | | Network |
| YN | 3213 | YN-3213B | Wet Cake Bin Leveling Screw 1. E-Stop | DI | PLC-DRYER | Off | E-Stop | | Network |
| SSL | 3213 | SL-3213B | Wet Cake Bin Leveling Screw 1. Low Speed | DI | PLC-DRYER | Off | Lo Speed | | Network |
| **Wet Cake Bin Leveling Screw 2 (15-BLS-M-2)** | | | | | | | | | |
| MN | 3214 | MN-3214 | Wet Cake Bin Leveling Screw 2. Run | DI | PLC-DRYER | Off | Run | | Network |
| MF | 3214 | MF-3214 | Wet Cake Bin Leveling Screw 2. Fail | DI | PLC-DRYER | Off | Fail | | Network |
| HA | 3214 | HA-3214 | Wet Cake Bin Leveling Screw 2. Auto | DI | PLC-DRYER | Manual | Auto | | Network |
| MC | 3214 | MC-3214 | Wet Cake Bin Leveling Screw 2. Start/Stop | DO | PLC-DRYER | Stop | Start | | Network |
| SI | 3214 | SI-3214 | Wet Cake Bin Leveling Screw 2. Speed Ind | AI | PLC-DRYER | 0 | 100 | % | Network |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SC | 3214 | SC-3214 | Wet Cake Bin Leveling Screw 2. Speed Control | AO | PLC-DRYER | 0 | 100 | % | Network | |
| YN | 3214 | YN-3214A | Wet Cake Bin Leveling Screw 2. E-Stop | DI | PLC-DRYER | Off | E-Stop | | Network | |
| YN | 3214 | YN-3214B | Wet Cake Bin Leveling Screw 2. E-Stop | DI | PLC-DRYER | Off | E-Stop | | Network | |
| SSL | 3214 | SL-3214B | Wet Cake Bin Leveling Screw 2. Low Speed | DI | PLC-DRYER | Off | Lo Speed | | Network | |
| | | | | | PLC-DRYER Signals | | | | 0 | 0 | 0 | 0 |

Notes:

**1.- IO Based on Kreger Jun 26, 2020 Submittal, only one PLC panel shown, Coordinate with Manufacturer, number of PLC & RIO enclosures.**
**Dryer IO signals are hardwired to Dryer PLC MCP (15-Dryer MCP). 15-Dryer MCP is connected to PLC-DW via network**

| Tagname | | HMI | See Note 1 | Signal | PLC | Data Field Range | | ENG | IO Signals | | | | MBR System |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO | Tagname |
| **Membrane Blower #1 - 7-A-BL-1** | | | | | | | | | | | | | **20-B-201-A** |
| MN | 2010 | MN-2010 | MBR Blower #1. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-201-A |
| MC | 2010 | MC-2010 | MBR Blower #1. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 20-KQI-201-A |
| SC | 2010 | SC-2010 | MBR Blower #1. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-B-201-A |
| **Membrane Blower #1 High Temperature - 7-BL-TS-1** | | | | | | | | | | | | | **20-LSH-201-A** |
| TSH | 2010 | TH-2010 | MBR Blower #1. Hi Temp | DI | PLC-MBR | Off | Hi Temp | | | Network | | | 20-TAH-201-A |
| **Membrane Blower #1 Low Flow - 7-BL-FS-1** | | | | | | | | | | | | | **20-FSL-201-A** |
| FSL | 2011 | FL-2011 | MBR Blower #1. Low Flow | DI | PLC-MBR | Off | Lo Flow | | | Network | | | 20-FAL-201-A |
| **Membrane Blower #2 - 7-A-BL-2** | | | | | | | | | | | | | **20-B-201-B** |
| MN | 2020 | MN-2020 | MBR Blower #2. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-201-B |
| MC | 2020 | MC-2020 | MBR Blower #2. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 20-KQI-201-B |
| SC | 2020 | SC-2020 | MBR Blower #2. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-B-201-B |
| **Membrane Blower #2 High Temperature - 7-BL-TS-2** | | | | | | | | | | | | | **20-LSH-201-B** |
| TSH | 2020 | TH-2020 | MBR Blower #2. Hi Temp | DI | PLC-MBR | Off | Hi Temp | | | Network | | | 20-TAH-201-B |
| **Membrane Blower #2 Low Flow - 7-BL-FS-2** | | | | | | | | | | | | | **20-FSL-201-B** |
| FSL | 2021 | FL-2011 | MBR Blower #2. Low Flow | DI | PLC-MBR | Off | Lo Flow | | | Network | | | 20-FAL-201-B |
| **Membrane Blower #3 - 7-A-BL-3** | | | | | | | | | | | | | **20-C-201-C** |
| MN | 2030 | MN-2030 | MBR Blower #3. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-201-C |
| MC | 2030 | MC-2030 | MBR Blower #3. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 20-KQI-201-C |
| SC | 2030 | SC-2030 | MBR Blower #3. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-C-201-C |
| **Membrane Blower #3 High Temperature - 7-BL-TS-3** | | | | | | | | | | | | | **20-LSH-201-C** |
| TSH | 2030 | TH-2030 | MBR Blower #3. Hi Temp | DI | PLC-MBR | Off | Hi Temp | | | Network | | | 20-TAH-201-C |
| **Membrane Blower #3 Low Flow - 7-BL-FS-3** | | | | | | | | | | | | | **20-FSL-201-C** |
| FSL | 2031 | FL-2031 | MBR Blower #3. Low Flow | DI | PLC-MBR | Off | Lo Flow | | | Network | | | 20-FAL-201-C |
| **Membrane Blower #4 - 7-A-BL-4** | | | | | | | | | | | | | **20-D-201-D** |
| MN | 2040 | MN-2040 | MBR Blower #4. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-201-D |
| MC | 2040 | MC-2040 | MBR Blower #4. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 20-KQI-201-D |
| SC | 2040 | SC-2040 | MBR Blower #4. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-D-201-D |
| **Membrane Blower #4 High Temperature - 7-BL-TS-4** | | | | | | | | | | | | | **20-LSH-201-D** |
| TSH | 2040 | TH-2040 | MBR Blower #4. Hi Temp | DI | PLC-MBR | Off | Hi Temp | | | Network | | | 20-TAH-201-D |
| **Membrane Blower #4 Low Flow - 7-BL-FS-4** | | | | | | | | | | | | | **20-FSL-201-D** |
| FSL | 2041 | FL-2041 | MBR Blower #4. Low Flow | DI | PLC-MBR | Off | Lo Flow | | | Network | | | 20-FAL-201-D |
| **Membrane Blower #5 - 7-A-BL-5** | | | | | | | | | | | | | **20-E-201-E** |
| MN | 2050 | MN-2050 | MBR Blower #5. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-201-E |
| MC | 2050 | MC-2050 | MBR Blower #5. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 20-KQI-201-E |

| Tagname | | HMI | See Note 1 | Signal | PLC | Data Field Range | | ENG | IO Signals | | | | MBR System |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO | Tagname |
| SC | 2050 | SC-2050 | MBR Blower #5. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-E-201-E |
| **Membrane Blower #5 High Temperature - 7-BL-TS-5** | | | | | | | | | | | | | **20-LSH-201-E** |
| TSH | 2050 | TH-2050 | MBR Blower #5. Hi Temp | DI | PLC-MBR | Off | Hi Temp | | | Network | | | 20-TAH-201-E |
| **Membrane Blower #5Low Flow - 7-BL-FS-5** | | | | | | | | | | | | | **20-FSL-201-E** |
| FSL | 2051 | FL-2051 | MBR Blower #5. Low Flow | DI | PLC-MBR | Off | Lo Flow | | | Network | | | 20-FAL-201-E |
| **Membrane Tank #1 Air Blower Valve- 7-TK1-V-1** | | | | | | | | | | | | | **20-FV-205-1** |
| ZH | 2100 | ZH-2100 | Mambrane Tank 1 Air Valve. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-ZAO-205-1 |
| ZL | 2100 | ZL-2100 | Mambrane Tank 1 Air Valve. Close | DI | PLC-MBR | Off | Close | | | Network | | | 20-ZAC-205-1 |
| ZC | 2100 | ZC-2100 | Mambrane Tank 1 Air Valve. Open/Close | DO | PLC-MBR | Close | Open | | | Network | | | 20-FV-205-1 |
| **Membrane Tank #1 Sluice Gate 1- 7-TK1-SG-1** | | | | | | | | | | | | | **20-FV-209-1** |
| ZH | 2101 | ZH-2101 | Mambrane Tank 1 Sluice Gate 1. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-ZAO-209-1 |
| ZL | 2101 | ZL-2101 | Mambrane Tank 1 Sluice Gate 1. Close | DI | PLC-MBR | Off | Close | | | Network | | | 20-ZAC-209-1 |
| ZOC | 2101 | ZCO-2101 | Mambrane Tank 1 Sluice Gate 1. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-FV-209-1 |
| ZCC | 2101 | ZCC-2101 | Mambrane Tank 1 Sluice Gate 1. Close | DI | PLC-MBR | Off | Open | | | Network | | | 20-FV-209-1 |
| **Membrane Tank #1 Hi Level - 7-TK1-LS-1** | | | | | | | | | | | | | **20-LSHH-201-1** |
| LSH | 2102 | LSH-2102 | Membran Tank #1. Hi Level | DI | PLC-MBR | Off | Hi Level | | | Network | | | 20-LAHH-201-1 |
| **Membrane Tank #1 Low Level - 7-TK1-LS-2** | | | | | | | | | | | | | **20-LSLL-201-1** |
| LSL | 2103 | LSL-2103 | Membran Tank #1. Low Level | DI | PLC-MBR | Off | Low Level | | | Network | | | 20-LALL-201-1 |
| **Membrane Tank #1 Level- 7-TK1-L-1** | | | | | | | | | | | | | **20-LIT-203-1** |
| LIT | 2104 | LI-2104 | Membran Tank #1. Level | AI | PLC-MBR | 0 | 13 | FT | | Network | | | 20-LI-203-1 |
| **Membrane Tank #1 RAS/Drain Valve- 7-TK1-V-2** | | | | | | | | | | | | | **20-FV-502-1** |
| ZC | 2105 | ZC-2105 | Mambrane Tank 1 RAS/Drain Valve. Open/Close | DI | PLC-MBR | Close | Open | | | Network | | | 20-FV-502-1 |
| **Membrane Tank #1 Instrumentation Air Solenoid Valve- 7-TK1-SV-1** | | | | | | | | | | | | | **20-SV-802-1** |
| ZC | 2106 | ZC-2106 | Mambrane Tank 1 Inst Solenoid Valve. Open/Clos | DO | PLC-MBR | Close | Open | | | Network | | | 20-SV-802-1 |
| **Membrane Tank #1 Permeate/Backpulse Pressure - 7-TK1-PT-1** | | | | | | | | | | | | | **20-PIT-301-1** |
| ZC | 2107 | ZC-2107 | Mambrane Tank 1 Permeante/Backpulse. Press | AI | PLC-MBR | -15 | 15 | PSI | | Network | | | 20-PI-301-1 |
| **Membrane Tank #1 Citric Acid Valve - 7-TK1-V-3** | | | | | | | | | | | | | **23-FV-302-1** |
| ZC | 2108 | ZC-2108 | Mambrane Tank 1 Citric acid Valve. Open/Close | DO | PLC-MBR | Close | Open | | | Network | | | 23-FV-302-1 |
| **Membrane Tank #1 Sodium HypoCl Valve - 7-TK1-V-4** | | | | | | | | | | | | | **23-FV-102-1** |
| ZC | 2109 | ZC-2109 | Mambrane Tank 1 Sodiu HypoCl Valve. Open/Clos | DO | PLC-MBR | Close | Open | | | Network | | | 23-FV-102-1 |
| **Membrane Process Pump #1 Flow- 7-PR-F-1** | | | | | | | | | | | | | **20-FIT-307-1** |
| FE/FIT | 2110 | FI-2110 | Mambrane Process Pump #1. Flow | AI | PLC-MBR | 0 | 3000 | GPM | | Network | | | 20-FIC-307-1 |
| **Membrane Tank #1 Process Pump 1- 7-PR-P-1** | | | | | | | | | | | | | **20-P-301-1** |
| MN | 2111 | MN-2111 | Process Pump #1. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-301-1 |
| MC | 2111 | MC-2111 | Process Pump #1.. Start Forward/Stop | DO | PLC-MBR | Stop | Forward | | | Network | | | 20-KQI-301-1 |

| Tagname | | HMI | See Note 1 | Signal | PLC | Data Field Range | | ENG | IO Signals | | | | MBR System |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO | Tagname |
| MC | 2111 | MC-2111 | Process Pump #1.. Start Reverse/Stop | DO | PLC-MBR | Stop | Reverse | | | Network | | | 20-KQI-301-1 |
| SC | 2111 | SC-2111 | Process Pump #1.. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-P-301-1 |
| **Membrane Tank #1 Turbidity- 7-TK1-TU-1** | | | | | | | | | | | | | **20-AIT-320-1** |
| AE/AIT | 2115 | AI-2115 | Mambrane Tank 1 Permeate Discharge.Turbidity | AI | PLC-MBR | 0 | 10 | NTU | | Network | | | 20-AI-320-1 |
| **Membrane Tank #1 Permeate Discharge Valve - 7-TK1-V-5** | | | | | | | | | | | | | **23-FV-302-1** |
| ZH | 2117 | ZH-2117 | Mambrane Tank 1 Permeate Dish Valve. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-ZAO-302-1 |
| ZL | 2117 | ZL-2117 | Mambrane Tank 1 Permeate Dish Valve. Close | DI | PLC-MBR | Off | Close | | | Network | | | 20-ZAC-302-1 |
| ZC | 2117 | ZC-2117 | Mambrane Tank 1 Permeate Dish Valve. Open/Clo | DO | PLC-MBR | Close | Open | | | Network | | | 20-FV-302-1 |
| **Membrane Tank #1 RAS Pump 1- 7-RAS-P-1** | | | | | | | | | | | | | **20-P-501-1** |
| MN | 2118 | MN-2118 | Process Pump #1. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-501-1 |
| MC | 2118 | MC-2118 | Process Pump #1.. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 20-KQI-501-1 |
| SC | 2118 | SC-2118 | Process Pump #1.. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-P-501-1 |
| **Membrane Tank #1 RAS Flow- 7-RAS-F-1** | | | | | | | | | | | | | **20-FIT-307-1** |
| FE/FIT | 2119 | FI-2119 | Mambrane Tank 1 RAS Discharge. Flow | AI | PLC-MBR | 0 | TBD | GPM | | Network | | | 20-FIC-507-1 |
| **Membrane Process Collector Temperature - 7-PC-T-1** | | | | | | | | | | | | | **20-TIT-001** |
| TE/TIT | 2125 | FI-2119 | Mambrane Process Collector. Temperature | AI | PLC-MBR | 0 | 122 | F | | Network | | | 20-TI-001 |
| **Membrane Process Collector Low Level - 7-PC-LS-1** | | | | | | | | | | | | | **20-LSL-001** |
| TE/TIT | 2126 | FI-2119 | Mambrane Process Collector. LoW Level | AI | PLC-MBR | Off | Lo Level | | | Network | | | 20-LSL-001 |
| **Membrane Citric Acid Pump 1 - 7-CA-P-1** | | | | | | | | | | | | | **23-P-301-A** |
| MN | 2131 | MN-2131 | Citric Acid Pump #1. Run | DI | PLC-MBR | Off | Run | | | Network | | | 23-YA-301-A |
| MC | 2131 | MC-2131 | Citric Acid Pump #1.. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 23-KQI-301-A |
| SC | 2131 | SC-2131 | Citric Acid Pump #1.. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 23-P-301-A |
| **Membrane Citric Acid Pump 2 - 7-CA-P-2** | | | | | | | | | | | | | **23-P-301-B** |
| MN | 2132 | MN-2132 | Citric Acid Pump #2. Run | DI | PLC-MBR | Off | Run | | | Network | | | 23-YA-301-B |
| MC | 2132 | MC-2132 | Citric Acid Pump #2.. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 23-KQI-301-B |
| SC | 2132 | SC-2132 | Citric Acid Pump #2.. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 23-P-301-B |
| **Membrane Citric Acid Pumps Discharge Flow - 7-CA-F-1** | | | | | | | | | | | | | **23-FIT-301-1** |
| FE/FIT | 2133 | FI-2133 | Citric Acid Pump Discharge. Flow | AI | PLC-MBR | 0 | 10 | GPM | | Network | | | 23-FI-301 |
| **Membrane Citric Acid Valve - 7-CA-V-1** | | | | | | | | | | | | | **23-FV-301** |
| ZC | 2134 | ZC-2134 | Mambrane Citric Acid Valve. Open/Close | DO | PLC-MBR | Close | Open | | | Network | | | 23-FV-301 |
| **Membrane Sodium HypoChlorite Pump 1 - 7-SHC-P-1** | | | | | | | | | | | | | **23-P-101-A** |
| MN | 2141 | MN-2141 | Sodium HypoChlorite Pump #1. Run | DI | PLC-MBR | Off | Run | | | Network | | | 23-YA-101-A |
| MC | 2141 | MC-2141 | Sodium HypoChlorite Pump #1.. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 23-KQI-101-A |
| SC | 2141 | SC-2141 | Sodium HypoChlorite Pump #1.. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 23-P-101-A |
| **Membrane Sodium HypoChlorite Pump 2 - 7-SHC-P-2** | | | | | | | | | | | | | **23-P-101-B** |

| Tagname | | HMI | See Note 1 | Signal | PLC | Data Field Range | | ENG | IO Signals | | | | MBR System |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO | Tagname |
| MN | 2142 | MN-2142 | Sodium HypoChlorite Pump #2. Run | DI | PLC-MBR | Off | Run | | | Network | | | 23-YA-101-B |
| MC | 2142 | MC-2142 | Sodium HypoChlorite Pump #2.. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 23-KQI-101-B |
| SC | 2142 | SC-2142 | Sodium HypoChlorite Pump #2.. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 23-P-101-B |
| **Membrane Sodium HypoChlorite Pumps Discharge Flow - 7-SHC-F-1** | | | | | | | | | | | | | **23-FIT-101-1** |
| FE/FIT | 2143 | FI-2143 | Sodium HypoChlorite Pump Discharge. Flow | AI | PLC-MBR | 0 | 15 | GPM | | Network | | | 23-FI-101 |
| **Membrane Sodium HypoChlorite Valve - 7-SHC-V-1** | | | | | | | | | | | | | **23-FV-101** |
| ZC | 2144 | ZC-2144 | Mambrane Sodium HypoChlorite Valve. Open/Clos | DO | PLC-MBR | Close | Open | | | Network | | | 23-FV-101 |
| **Membrane Air Compressor 1 - 7-AC-M-1** | | | | | | | | | | | | | **90-AC-001-A** |
| MN | 2151 | MN-2151 | Mambrane Air Compressor 1. Run | DI | PLC-MBR | Off | Run | | | Network | | | 90-YA-001-A |
| MF | 2151 | MF-2151 | Mambrane Air Compressor 1. Fail | DI | PLC-MBR | Off | Fail | | | Network | | | 90-AC-001-A |
| MC | 2151 | MC-2151 | Mambrane Air Compressor 1. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 90-AC-001-A |
| **Membrane Air Compressor 2 - 7-AC-M-2** | | | | | | | | | | | | | **90-AC-001-B** |
| MN | 2152 | MN-2152 | Mambrane Air Compressor 2. Run | DI | PLC-MBR | Off | Run | | | Network | | | 90-YA-001-B |
| MF | 2152 | MF-2152 | Mambrane Air Compressor 2. Fail | DI | PLC-MBR | Off | Fail | | | Network | | | 90-AC-001-B |
| MC | 2152 | MC-2152 | Mambrane Air Compressor 2. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 90-AC-001-B |
| **Membrane Air Compressor 1 Low Pressure - 7-AC-PS-1** | | | | | | | | | | | | | **90-PSL-001** |
| PSL | 2153 | PL-2153 | Mambrane Air Compressors Disch. Low Press | DI | PLC-MBR | Off | Lo Press | | | Network | | | 90-PAL-001 |
| **Membrane Air Compressor 1 Low Low Pressure - 7-AC-PS-2** | | | | | | | | | | | | | **90-PSLL-002** |
| PSLL | 2154 | PLL-2154 | Mambrane Air Compressors Disch. Lo Low Press | DI | PLC-MBR | Off | Lo Lo Press | | | Network | | | 90-PALL-002 |
| **Membrane Tank #2 Air Blower Valve- 7-TK2-V-1** | | | | | | | | | | | | | **20-FV-205-2** |
| ZH | 2200 | ZH-2200 | Mambrane Tank 2 Air Valve. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-ZAO-205-2 |
| ZL | 2200 | ZL-2200 | Mambrane Tank 2 Air Valve. Close | DI | PLC-MBR | Off | Close | | | Network | | | 20-ZAC-205-2 |
| ZC | 2200 | ZC-2200 | Mambrane Tank 2 Air Valve. Open/Close | DO | PLC-MBR | Close | Open | | | Network | | | 20-FV-205-2 |
| **Membrane Tank #2 Sluice Gate 1- 7-TK2-SG-1** | | | | | | | | | | | | | **20-FV-209-2** |
| ZH | 2201 | ZH-2201 | Mambrane Tank 2 Sluice Gate 1. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-ZAO-209-2 |
| ZL | 2201 | ZL-2201 | Mambrane Tank 2 Sluice Gate 1. Close | DI | PLC-MBR | Off | Close | | | Network | | | 20-ZAC-209-2 |
| ZOC | 2201 | ZCO-2201 | Mambrane Tank 2 Sluice Gate 1. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-FV-209-2 |
| ZCC | 2201 | ZCC-2201 | Mambrane Tank 2 Sluice Gate 1. Close | DI | PLC-MBR | Off | Open | | | Network | | | 20-FV-209-2 |
| **Membrane Tank #2 Hi Level - 7-TK2-LS-1** | | | | | | | | | | | | | **20-LSHH-201-2** |
| LSH | 2202 | LSH-2202 | Membran Tank #2. Hi Level | DI | PLC-MBR | Off | Hi Level | | | Network | | | 20-LAHH-201-2 |
| **Membrane Tank #2 Low Level - 7-TK2-LS-2** | | | | | | | | | | | | | **20-LSLL-201-2** |
| LSL | 2203 | LSL-2203 | Membran Tank #2. Low Level | DI | PLC-MBR | Off | Low Level | | | Network | | | 20-LALL-201-2 |
| **Membrane Tank #2 Level- 7-TK2-L-1** | | | | | | | | | | | | | **20-LIT-203-2** |
| LIT | 2204 | LI-2204 | Membran Tank #2. Level | AI | PLC-MBR | 0 | 13 | FT | | Network | | | 20-LI-203-2 |

| Tagname | | HMI | See Note 1 | Signal | PLC | Data Field Range | | ENG | IO Signals | | | | MBR System |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO | Tagname |
| **Membrane Tank #2 RAS/Drain Valve- 7-TK2-V-2** | | | | | | | | | | | | | **20-FV-502-2** |
| ZC | 2205 | ZC-2205 | Mambrane Tank 2 RAS/Drain Valve. Open/Close | DI | PLC-MBR | Close | Open | | | Network | | | 20-FV-502-2 |
| **Membrane Tank #2 Instrumentation Air Solenoid Valve- 7-TK2-SV-1** | | | | | | | | | | | | | **20-SV-802-2** |
| ZC | 2206 | ZC-2206 | Mambrane Tank 2 Inst Solenoid Valve. Open/Clos | DO | PLC-MBR | Close | Open | | | Network | | | 20-SV-802-2 |
| **Membrane Tank #2 Permeate/Backpulse Pressure - 7-TK2-PT-1** | | | | | | | | | | | | | **20-PIT-301-2** |
| ZC | 2207 | ZC-2207 | Mambrane Tank 2 Permeante/Backpulse. Press | AI | PLC-MBR | -15 | 15 | PSI | | Network | | | 20-PI-301-2 |
| **Membrane Tank #2 Citric Acid Valve - 7-TK2-V-3** | | | | | | | | | | | | | **23-FV-302-2** |
| ZC | 2208 | ZC-2208 | Mambrane Tank 2 Citric acid Valve. Open/Close | DO | PLC-MBR | Close | Open | | | Network | | | 23-FV-302-2 |
| **Membrane Tank #2 Sodium HypoCl Valve - 7-TK2-V-4** | | | | | | | | | | | | | **23-FV-202-2** |
| ZC | 2209 | ZC-2209 | Mambrane Tank 2 Sodiu HypoCl Valve. Open/Clos | DO | PLC-MBR | Close | Open | | | Network | | | 23-FV-202-2 |
| **Membrane Process Pump #2 Flow- 7-PR-F-2** | | | | | | | | | | | | | **20-FIT-307-2** |
| FE/FIT | 2210 | FI-2210 | Mambrane Process Pump #2. Flow | AI | PLC-MBR | 0 | 3000 | GPM | | Network | | | 20-FIC-307-2 |
| **Membrane Tank #2 Process Pump 1- 7-PR-P-2** | | | | | | | | | | | | | **20-P-301-2** |
| MN | 2211 | MN-2211 | Process Pump #2. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-301-2 |
| MC | 2211 | MC-2211 | Process Pump #2.. Start Forward/Stop | DO | PLC-MBR | Stop | Forward | | | Network | | | 20-KQI-301-2 |
| MC | 2211 | MC-2211 | Process Pump #2.. Start Reverse/Stop | DO | PLC-MBR | Stop | Reverse | | | Network | | | 20-KQI-301-2 |
| SC | 2211 | SC-2211 | Process Pump #2.. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-P-301-2 |
| **Membrane Tank #2 Turbidity- 7-TK2-TU-1** | | | | | | | | | | | | | **20-AIT-320-2** |
| AE/AIT | 2215 | AI-2215 | Mambrane Tank 2 Permeate Discharge.Turbidity | AI | PLC-MBR | 0 | 10 | NTU | | Network | | | 20-AI-320-2 |
| **Membrane Tank #2 Permeate Discharge Valve - 7-TK2-V-5** | | | | | | | | | | | | | **23-FV-302-2** |
| ZH | 2217 | ZH-2217 | Mambrane Tank 2 Permeate Dish Valve. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-ZAO-302-2 |
| ZL | 2217 | ZL-2217 | Mambrane Tank 2 Permeate Dish Valve. Close | DI | PLC-MBR | Off | Close | | | Network | | | 20-ZAC-302-2 |
| ZC | 2217 | ZC-2217 | Mambrane Tank 2 Permeate Dish Valve. Open/Clo | DO | PLC-MBR | Close | Open | | | Network | | | 20-FV-302-2 |
| **Membrane Tank #2 RAS Pump 1- 7-RAS-P-2** | | | | | | | | | | | | | **20-P-501-2** |
| MN | 2218 | MN-2218 | Process Pump #2. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-501-2 |
| MC | 2218 | MC-2218 | Process Pump #2.. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 20-KQI-501-2 |
| SC | 2218 | SC-2218 | Process Pump #2.. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-P-501-2 |
| **Membrane Tank #2 RAS Flow- 7-RAS-F-2** | | | | | | | | | | | | | **20-FIT-307-2** |
| FE/FIT | 2219 | FI-2219 | Mambrane Tank 2 RAS Discharge. Flow | AI | PLC-MBR | 0 | TBD | GPM | | Network | | | 20-FIC-507-2 |
| **Membrane Tank #3 Air Blower Valve- 7-TK3-V-1** | | | | | | | | | | | | | **20-FV-305-3** |
| ZH | 2300 | ZH-2300 | Mambrane Tank 3 Air Valve. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-ZAO-305-3 |
| ZL | 2300 | ZL-2300 | Mambrane Tank 3 Air Valve. Close | DI | PLC-MBR | Off | Close | | | Network | | | 20-ZAC-305-3 |
| ZC | 2300 | ZC-2300 | Mambrane Tank 3 Air Valve. Open/Close | DO | PLC-MBR | Close | Open | | | Network | | | 20-FV-305-3 |
| **Membrane Tank #3 Sluice Gate 1- 7-TK3-SG-1** | | | | | | | | | | | | | **20-FV-309-3** |

| Tagname | | HMI | See Note 1 | Signal | PLC | Data Field Range | | ENG | IO Signals | | | | MBR System |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO | Tagname |
| ZH | 2301 | ZH-2301 | Mambrane Tank 3 Sluice Gate 1. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-ZAO-309-3 |
| ZL | 2301 | ZL-2301 | Mambrane Tank 3 Sluice Gate 1. Close | DI | PLC-MBR | Off | Close | | | Network | | | 20-ZAC-309-3 |
| ZOC | 2301 | ZCO-2301 | Mambrane Tank 3 Sluice Gate 1. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-FV-309-3 |
| ZCC | 2301 | ZCC-2301 | Mambrane Tank 3 Sluice Gate 1. Close | DI | PLC-MBR | Off | Open | | | Network | | | 20-FV-309-3 |
| **Membrane Tank #3 Hi Level - 7-TK3-LS-1** | | | | | | | | | | | | | **20-LSHH-301-3** |
| LSH | 2302 | LSH-2302 | Membran Tank #3. Hi Level | DI | PLC-MBR | Off | Hi Level | | | Network | | | 20-LAHH-301-3 |
| **Membrane Tank #3 Low Level - 7-TK3-LS-2** | | | | | | | | | | | | | **20-LSLL-301-3** |
| LSL | 2303 | LSL-2303 | Membran Tank #3. Low Level | DI | PLC-MBR | Off | Low Level | | | Network | | | 20-LALL-301-3 |
| **Membrane Tank #3 Level- 7-TK3-L-1** | | | | | | | | | | | | | **20-LIT-303-3** |
| LIT | 2304 | LI-2304 | Membran Tank #3. Level | AI | PLC-MBR | 0 | 13 | FT | | Network | | | 20-LI-303-3 |
| **Membrane Tank #3 RAS/Drain Valve- 7-TK3-V-2** | | | | | | | | | | | | | **20-FV-502-3** |
| ZC | 2305 | ZC-2305 | Mambrane Tank 3 RAS/Drain Valve. Open/Close | DI | PLC-MBR | Close | Open | | | Network | | | 20-FV-502-3 |
| **Membrane Tank #3 Instrumentation Air Solenoid Valve- 7-TK3-SV-1** | | | | | | | | | | | | | **20-SV-802-3** |
| ZC | 2306 | ZC-2306 | Mambrane Tank 3 Inst Solenoid Valve. Open/Clos | DO | PLC-MBR | Close | Open | | | Network | | | 20-SV-802-3 |
| **Membrane Tank #3 Permeate/Backpulse Pressure - 7-TK3-PT-1** | | | | | | | | | | | | | **20-PIT-301-3** |
| ZC | 2307 | ZC-2307 | Mambrane Tank 3 Permeante/Backpulse. Press | AI | PLC-MBR | -15 | 15 | PSI | | Network | | | 20-PI-301-3 |
| **Membrane Tank #3 Citric Acid Valve - 7-TK3-V-3** | | | | | | | | | | | | | **23-FV-302-3** |
| ZC | 2308 | ZC-2308 | Mambrane Tank 3 Citric acid Valve. Open/Close | DO | PLC-MBR | Close | Open | | | Network | | | 23-FV-302-3 |
| **Membrane Tank #3 Sodium HypoCl Valve - 7-TK3-V-4** | | | | | | | | | | | | | **23-FV-302-3** |
| ZC | 2309 | ZC-2309 | Mambrane Tank 3 Sodiu HypoCl Valve. Open/Clos | DO | PLC-MBR | Close | Open | | | Network | | | 23-FV-302-3 |
| **Membrane Process Pump #3 Flow- 7-PR-F-3** | | | | | | | | | | | | | **20-FIT-307-3** |
| FE/FIT | 2310 | FI-2310 | Mambrane Process Pimp #3. Flow | AI | PLC-MBR | 0 | 3000 | GPM | | Network | | | 20-FIC-307-3 |
| **Membrane Tank #3 Process Pump 1- 7-PR-P-3** | | | | | | | | | | | | | **20-P-301-3** |
| MN | 2311 | MN-2311 | Process Pump #3. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-301-3 |
| MC | 2311 | MC-2311 | Process Pump #3.. Start Forward/Stop | DO | PLC-MBR | Stop | Forward | | | Network | | | 20-KQI-301-3 |
| MC | 2311 | MC-2311 | Process Pump #3.. Start Reverse/Stop | DO | PLC-MBR | Stop | Reverse | | | Network | | | 20-KQI-301-3 |
| SC | 2311 | SC-2311 | Process Pump #3.. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-P-301-3 |
| **Membrane Tank #3 Turbidity- 7-TK3-TU-1** | | | | | | | | | | | | | **20-AIT-320-3** |
| AE/AIT | 2315 | AI-2315 | Mambrane Tank 3 Permeate Discharge.Turbidity | AI | PLC-MBR | 0 | 10 | NTU | | Network | | | 20-AI-320-3 |
| **Membrane Tank #3 Permeate Discharge Valve - 7-TK3-V-5** | | | | | | | | | | | | | **23-FV-302-3** |
| ZH | 2317 | ZH-2317 | Mambrane Tank 3 Permeate Dish Valve. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-ZAO-302-3 |
| ZL | 2317 | ZL-2317 | Mambrane Tank 3 Permeate Dish Valve. Close | DI | PLC-MBR | Off | Close | | | Network | | | 20-ZAC-302-3 |
| ZC | 2317 | ZC-2317 | Mambrane Tank 3 Permeate Dish Valve. Open/Clo | DO | PLC-MBR | Close | Open | | | Network | | | 20-FV-302-3 |
| **Membrane Tank #3 RAS Pump 1- 7-RAS-P-3** | | | | | | | | | | | | | **20-P-501-3** |

| Tagname | | HMI | See Note 1 | Signal | PLC | Data Field Range | | ENG | IO Signals | | | | MBR System |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO | Tagname |
| MN | 2318 | MN-2318 | Process Pump #3. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-501-3 |
| MC | 2318 | MC-2318 | Process Pump #3.. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 20-KQI-501-3 |
| SC | 2318 | SC-2318 | Process Pump #3.. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-P-501-3 |
| **Membrane Tank #3 RAS Flow- 7-RAS-F-3** | | | | | | | | | | | | | **20-FIT-307-3** |
| FE/FIT | 2319 | FI-2319 | Mambrane Tank 3 RAS Discharge. Flow | AI | PLC-MBR | 0 | TBD | GPM | | Network | | | 20-FIC-507-3 |
| **Membrane Tank #4 Air Blower Valve- 7-TK4-V-1** | | | | | | | | | | | | | **20-FV-305-3** |
| ZH | 2400 | ZH-2400 | Mambrane Tank 4 Air Valve. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-ZAO-305-3 |
| ZL | 2400 | ZL-2400 | Mambrane Tank 4 Air Valve. Close | DI | PLC-MBR | Off | Close | | | Network | | | 20-ZAC-305-3 |
| ZC | 2400 | ZC-2400 | Mambrane Tank 4 Air Valve. Open/Close | DO | PLC-MBR | Close | Open | | | Network | | | 20-FV-305-3 |
| **Membrane Tank #4 Sluice Gate 1- 7-TK4-SG-1** | | | | | | | | | | | | | **20-FV-309-3** |
| ZH | 2401 | ZH-2401 | Mambrane Tank 4 Sluice Gate 1. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-ZAO-309-3 |
| ZL | 2401 | ZL-2401 | Mambrane Tank 4 Sluice Gate 1. Close | DI | PLC-MBR | Off | Close | | | Network | | | 20-ZAC-309-3 |
| ZOC | 2401 | ZCO-2401 | Mambrane Tank 4 Sluice Gate 1. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-FV-309-3 |
| ZCC | 2401 | ZCC-2401 | Mambrane Tank 4 Sluice Gate 1. Close | DI | PLC-MBR | Off | Open | | | Network | | | 20-FV-309-3 |
| **Membrane Tank #4 Hi Level - 7-TK4-LS-1** | | | | | | | | | | | | | **20-LSHH-301-3** |
| LSH | 2402 | LSH-2402 | Membran Tank #4. Hi Level | DI | PLC-MBR | Off | Hi Level | | | Network | | | 20-LAHH-301-3 |
| **Membrane Tank #4 Low Level - 7-TK4-LS-2** | | | | | | | | | | | | | **20-LSLL-301-3** |
| LSL | 2403 | LSL-2403 | Membran Tank #4. Low Level | DI | PLC-MBR | Off | Low Level | | | Network | | | 20-LALL-301-3 |
| **Membrane Tank #4 Level- 7-TK4-L-1** | | | | | | | | | | | | | **20-LIT-303-3** |
| LIT | 2404 | LI-2404 | Membran Tank #4. Level | AI | PLC-MBR | 0 | 13 | FT | | Network | | | 20-LI-303-3 |
| **Membrane Tank #4 RAS/Drain Valve- 7-TK4-V-2** | | | | | | | | | | | | | **20-FV-502-3** |
| ZC | 2405 | ZC-2405 | Mambrane Tank 4 RAS/Drain Valve. Open/Close | DI | PLC-MBR | Close | Open | | | Network | | | 20-FV-502-3 |
| **Membrane Tank #4 Instrumentation Air Solenoid Valve- 7-TK4-SV-1** | | | | | | | | | | | | | **20-SV-802-3** |
| ZC | 2406 | ZC-2406 | Mambrane Tank 4 Inst Solenoid Valve. Open/Clos | DO | PLC-MBR | Close | Open | | | Network | | | 20-SV-802-3 |
| **Membrane Tank #4 Permeate/Backpulse Pressure - 7-TK4-PT-1** | | | | | | | | | | | | | **20-PIT-301-3** |
| ZC | 2407 | ZC-2407 | Mambrane Tank 4 Permeante/Backpulse. Press | AI | PLC-MBR | -15 | 15 | PSI | | Network | | | 20-PI-301-3 |
| **Membrane Tank #4 Citric Acid Valve - 7-TK4-V-3** | | | | | | | | | | | | | **24-FV-302-3** |
| ZC | 2408 | ZC-2408 | Mambrane Tank 4 Citric acid Valve. Open/Close | DO | PLC-MBR | Close | Open | | | Network | | | 24-FV-302-3 |
| **Membrane Tank #4 Sodium HypoCl Valve - 7-TK4-V-4** | | | | | | | | | | | | | **24-FV-302-3** |
| ZC | 2409 | ZC-2409 | Mambrane Tank 4 Sodiu HypoCl Valve. Open/Clos | DO | PLC-MBR | Close | Open | | | Network | | | 24-FV-302-3 |
| **Membrane Permeate/Backpulse Flow- 7-PR-F-4** | | | | | | | | | | | | | **20-FIT-307-3** |
| FE/FIT | 2410 | FI-2410 | Mambrane Process Pump #4. Flow | AI | PLC-MBR | 0 | 3000 | GPM | | Network | | | 20-FIC-307-3 |
| **Membrane Tank #4 Process Pump 1- 7-PR-P-4** | | | | | | | | | | | | | **20-P-301-3** |
| MN | 2411 | MN-2411 | Process Pump #4. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-301-3 |

| Tagname | | HMI | See Note 1 | Signal | PLC | Data Field Range | | ENG | IO Signals | | | | MBR System |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO | Tagname |
| MC | 2411 | MC-2411 | Process Pump #4.. Start Forward/Stop | DO | PLC-MBR | Stop | Forward | | | Network | | | 20-KQI-301-3 |
| MC | 2411 | MC-2411 | Process Pump #4.. Start Reverse/Stop | DO | PLC-MBR | Stop | Reverse | | | Network | | | 20-KQI-301-3 |
| SC | 2411 | SC-2411 | Process Pump #4.. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-P-301-3 |
| **Membrane Tank #4 Turbidity- 7-TK4-TU-1** | | | | | | | | | | | | | **20-AIT-320-3** |
| AE/AIT | 2415 | AI-2415 | Mambrane Tank 4 Permeate Discharge.Turbidity | AI | PLC-MBR | 0 | 10 | NTU | | Network | | | 20-AI-320-3 |
| **Membrane Tank #4 Permeate Discharge Valve - 7-TK4-V-5** | | | | | | | | | | | | | **24-FV-302-3** |
| ZH | 2417 | ZH-2417 | Mambrane Tank 4 Permeate Dish Valve. Open | DI | PLC-MBR | Off | Open | | | Network | | | 20-ZAO-302-3 |
| ZL | 2417 | ZL-2417 | Mambrane Tank 4 Permeate Dish Valve. Close | DI | PLC-MBR | Off | Close | | | Network | | | 20-ZAC-302-3 |
| ZC | 2417 | ZC-2417 | Mambrane Tank 4 Permeate Dish Valve. Open/Clo | DO | PLC-MBR | Close | Open | | | Network | | | 20-FV-302-3 |
| **Membrane Tank #4 RAS Pump 1- 7-RAS-P-4** | | | | | | | | | | | | | **20-P-501-3** |
| MN | 2418 | MN-2418 | Process Pump #4. Run | DI | PLC-MBR | Off | Run | | | Network | | | 20-YA-501-3 |
| MC | 2418 | MC-2418 | Process Pump #4.. Start/Stop | DO | PLC-MBR | Stop | Start | | | Network | | | 20-KQI-501-3 |
| SC | 2418 | SC-2418 | Process Pump #4.. Speed Control | AO | PLC-MBR | 0 | 100 | % | | Network | | | 20-P-501-3 |
| **Membrane Tank #4 RAS Flow- 7-RAS-F-4** | | | | | | | | | | | | | **20-FIT-307-3** |
| FE/FIT | 2419 | FI-2419 | Mambrane Tank 4 RAS Discharge. Flow | AI | PLC-MBR | 0 | TBD | GPM | | Network | | | 20-FIC-507-3 |
| **Membrane Miscelaneous** | | | | | | | | | | | | | |
| YN | 2060 | YN-2060 | Mambrane System. E-Stop | DI | PLC-MBR | E-Stop | Off | | | Network | | | Note 2 |
| YN | 2070 | YN-2070 | Mambrane System. Surge Suppressor | DI | PLC-MBR | Off | Alarm | | | Network | | | Note 2 |
| Notes: | | | | | PLC-MBR Signals | | | | 0 | 0 | 0 | 0 | |

1.- IO Based on  Suez June 2020 Submittal, only one PLC panel shown, Coordinate with Manufacturer, number of PLC & RIO enclosures

2.- Only (1) E-Stop and Surge Suppressor IO signals shown, Total IO to be Coordinate with Manufacture.

3.- Obtain all analog ranges from Suez for implementation into plant control system.

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **DW Hi Sump Float Switch** | | | | | | | | | | | | |
| LSH | 1800 | LH-1800 | DW Flooding Alarm | DI | PLC-DW | 0 | Hi Level | | | 1 | | |
| **Emergency Eyewash Safety Shower 1** | | | | | | | | | | | | |
| FSH | 1804 | FH-1804 | Emergency Eyewash 1. Hi Flow | DI | PLC-DW | 0 | Hi Flow | | | 1 | | |
| **Emergency Eyewash Safety Shower 2** | | | | | | | | | | | | |
| FSH | 1805 | FH-1805 | Emergency Eyewash 2. Hi Flow | DI | PLC-DW | 0 | Hi Flow | | | 1 | | |
| **Emergency Eyewash Safety Shower 3** | | | | | | | | | | | | |
| FSH | 1806 | FH-1806 | Emergency Eyewash 3. Hi Flow | DI | PLC-DW | 0 | Hi Flow | | | 1 | | |
| **Emergency Eyewash Safety Shower 4** | | | | | | | | | | | | |
| FSH | 1807 | FH-1807 | Emergency Eyewash 4. Hi Flow | DI | PLC-DW | 0 | Hi Flow | | | 1 | | |
| **Electrical Room High Temperature Switch 1 (15-DW-TS-1)** | | | | | | | | | | | | |
| TSH | 1812 | TH-1812 | Electrical Room High Temp | DI | PLC-DW | 0 | Hi Temp | | | 1 | | |
| **Electrical Room Low Temperature Switch 2 (15-DW-TS-2)** | | | | | | | | | | | | |
| TSL | **1813** | **TL-1813** | Electrical Room Low Temp | DI | PLC-DW | 0 | Low Temp | | | 1 | | |
| **DW Gas Monitor System** | | | | | | | | | | | | |
| AF | 1801 | AF-1801 | BFP Area Combustible Trouble | DI | PLC-DW | 0 | Trouble | | | 1 | | |
| AW | 1801 | AW-1801 | BFP Area Combustible Warning | DI | PLC-DW | 0 | Warning | | | 1 | | |
| AA | 1801 | AA-1801 | BFP Area Combustible Alarm | DI | PLC-DW | 0 | Alarm | | | 1 | | |
| AF | 1802 | AF-1802 | BFP Area Oxygen Trouble | DI | PLC-DW | 0 | Trouble | | | 1 | | |
| AW | 1802 | AW-1802 | BFP Area Oxygen Warning | DI | PLC-DW | 0 | Warning | | | 1 | | |
| AA | 1802 | AA-1802 | BFP Area Oxygen Alarm | DI | PLC-DW | 0 | Alarm | | | 1 | | |
| AF | 1803 | AF-1803 | BFP Area H2S Trouble | DI | PLC-DW | 0 | Trouble | | | 1 | | |
| AW | 1803 | AW-1803 | BFP Area H2S Warning | DI | PLC-DW | 0 | Warning | | | 1 | | |
| AA | 1803 | AA-1803 | BFP Area H2S Alarm | DI | PLC-DW | 0 | Alarm | | | 1 | | |
| AF | 1808 | AF-1808 | Dryer Area Combustible Trouble | DI | PLC-DW | 0 | Trouble | | | 1 | | |
| AW | 1808 | AW-1808 | Dryer Area Combustible Warning | DI | PLC-DW | 0 | Warning | | | 1 | | |
| AA | 1808 | AA-1808 | Dryer Area Combustible Alarm | DI | PLC-DW | 0 | Alarm | | | 1 | | |
| AF | 1809 | AF-1809 | Dryer Area Oxygen Trouble | DI | PLC-DW | 0 | Trouble | | | 1 | | |
| AW | 1809 | AW-1809 | Dryer Area Oxygen Warning | DI | PLC-DW | 0 | Warning | | | 1 | | |
| AA | 1809 | AA-1809 | Dryer Area Oxygen Alarm | DI | PLC-DW | 0 | Alarm | | | 1 | | |
| AF | 1810 | AF-1810 | Dryer Area H2S Trouble | DI | PLC-DW | 0 | Trouble | | | 1 | | |
| AW | 1810 | AW-1810 | Dryer Area H2S Warning | DI | PLC-DW | 0 | Warning | | | 1 | | |
| AA | 1810 | AA-1810 | Dryer Area H2S Alarm | DI | PLC-DW | 0 | Alarm | | | 1 | | |
| AF | 1811 | AF-1811 | Truck Loading CO Trouble | DI | PLC-DW | 0 | Trouble | | | 1 | | |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| AW | 1811 | AW-1811 | Truck Loading CO Warning | DI | PLC-DW | 0 | Warning | | | 1 | | |
| AA | 1811 | AA-1811 | Truck Loading CO Alarm | DI | PLC-DW | 0 | Alarm | | | 1 | | |
| **NPW Solenoid Valve 1 15-NPW-SV-1** | | | | | | | | | | | | |
| ZC | 1819 | ZC-1819 | NPW Solenoid Valve 1. Open/Close | DI | PLC-DW | Close | Open | | | | | 1 |
| **Air Compressor 1 15-CA-M-1** | | | | | | | | | | | | |
| MN | 1820 | MN-1820 | Air Compressor 1. Run | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1820 | MF-1820 | Air Compressor 1. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| MC | 1820 | MC-1820 | Air Compressor 1. Start/Stop | DI | PLC-DW | Stop | Start | | | | | 1 |
| **Air Compressor 2 15-CA-M-2** | | | | | | | | | | | | |
| MN | 1821 | MN-1821 | Air Compressor 2. Run | DI | PLC-DW | Off | Run | | | 1 | | |
| MF | 1821 | MF-1821 | Air Compressor 2. Fail | DI | PLC-DW | Off | Fail | | | 1 | | |
| MC | 1821 | MC-1821 | Air Compressor 2. Start/Stop | DI | PLC-DW | Stop | Start | | | | | 1 |
| | | | | | PLC-DW IO Signals | | | | 0 | 32 | 0 | 3 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **Odor Control System** | | | | | | | | | | | | |
| MN | 2000 | MN-2000 | Odor Control System Run | DI | PLC-IH | Off | Run | | Network | | | |
| MF | 2000 | MF-2000 | Odor Control System Fail | DI | PLC-IH | Off | Fail | | Network | | | |
| MC | 2000 | MC-2000 | Odor Control System Start/Stop | DO | PLC-IH | Stop | Start | | Network | | | |
| | | | | | PLC-IH IO Signals | | | | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| **Wet Cake Bin Level 1 (15-WCB-LS-1)** | | | | | | | | | | | | |
| LSH | 3201 | LH-3201 | Wet Cake Bin. Hi Level 1 | DI | PLC-HOPPER | Off | Hi Level | | Network | | | |
| **Wet Cake Bin Level 2 (15-WCB-LS-2)** | | | | | | | | | | | | |
| LSH | 3202 | LH-3202 | Wet Cake Bin. Hi Level 2 | DI | PLC-HOPPER | Off | Hi Level | | Network | | | |
| **Wet Cake Bin Level 3 (15-WCB-LS-3)** | | | | | | | | | | | | |
| LSH | 3203 | LH-3203 | Wet Cake Bin. Hi Level 3 | DI | PLC-HOPPER | Off | Hi Level | | Network | | | |
| **Wet Cake Bin Level 4 (15-WCB-LS-4)** | | | | | | | | | | | | |
| LSH | 3204 | LH-3204 | Wet Cake Bin. Hi Level 4 | DI | PLC-HOPPER | Off | Hi Level | | Network | | | |
| **Wet Cake Bin Weight (15-WCB-W-1)** | | | | | | | | | | | | |
| WIT | 3205 | WI-3205 | Wet Cake Bin. Weight | AI | PLC-HOPPER | 0 | 2000 | LBS | Network | | | |
| **Wet Cake Bin Bottom Screw 1 (15-BBS-M-1)** | | | | | | | | | | | | |
| MN | 3211 | MN-3211 | Wet Cake Bin Bottom Screw 1. Run | DI | PLC-HOPPER | Off | Run | | Network | | | |
| MF | 3211 | MF-3211 | Wet Cake Bin Bottom Screw 1. Fail | DI | PLC-HOPPER | Off | Fail | | Network | | | |
| HA | 3211 | HA-3211 | Wet Cake Bin Bottom Screw 1. Auto | DI | PLC-HOPPER | Manual | Auto | | Network | | | |
| MC | 3211 | MC-3211 | Wet Cake Bin Bottom Screw 1. Start/Stop | DO | PLC-HOPPER | Stop | Start | | Network | | | |
| SI | 3211 | SI-3211 | Wet Cake Bin Bottom Screw 1. Speed Ind | AI | PLC-HOPPER | 0 | 100 | % | Network | | | |
| SC | 3211 | SC-3211 | Wet Cake Bin Bottom Screw 1. Speed Control | AO | PLC-HOPPER | 0 | 100 | % | Network | | | |
| YN | 3211 | YN-3211A | Wet Cake Bin Bottom Screw 1. E-Stop | DI | PLC-HOPPER | Off | E-Stop | | Network | | | |
| YN | 3211 | YN-3211B | Wet Cake Bin Bottom Screw 1. E-Stop | DI | PLC-HOPPER | Off | E-Stop | | Network | | | |
| SSL | 3211 | SL-3211B | Wet Cake Bin Bottom Screw 1. Low Speed | DI | PLC-HOPPER | Off | Lo Speed | | Network | | | |
| **Wet Cake Bin Bottom Screw 2 (15-BBS-M-2)** | | | | | | | | | | | | |
| MN | 3212 | MN-3212 | Wet Cake Bin Bottom Screw 2. Run | DI | PLC-HOPPER | Off | Run | | Network | | | |
| MF | 3212 | MF-3212 | Wet Cake Bin Bottom Screw 2. Fail | DI | PLC-HOPPER | Off | Fail | | Network | | | |
| HA | 3212 | HA-3212 | Wet Cake Bin Bottom Screw 2. Auto | DI | PLC-HOPPER | Manual | Auto | | Network | | | |
| MC | 3212 | MC-3212 | Wet Cake Bin Bottom Screw 2. Start/Stop | DO | PLC-HOPPER | Stop | Start | | Network | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| SI | 3212 | SI-3212 | Wet Cake Bin Bottom Screw 2. Speed Ind | AI | PLC-HOPPER | 0 | 100 | % | Network | | | |
| SC | 3212 | SC-3212 | Wet Cake Bin Bottom Screw 2. Speed Control | AO | PLC-HOPPER | 0 | 100 | % | Network | | | |
| YN | 3212 | YN-3212A | Wet Cake Bin Bottom Screw 2. E-Stop | DI | PLC-HOPPER | Off | E-Stop | | Network | | | |
| YN | 3212 | YN-3212B | Wet Cake Bin Bottom Screw 2. E-Stop | DI | PLC-HOPPER | Off | E-Stop | | Network | | | |
| SSL | 3212 | SL-3212B | Wet Cake Bin Bottom Screw 2. Low Speed | DI | PLC-HOPPER | Off | Lo Speed | | Network | | | |
| **Wet Cake Bin Leveling Screw 1 (15-BLS-M-1)** | | | | | | | | | | | | |
| MN | 3213 | MN-3213 | Wet Cake Bin Leveling Screw 1. Run | DI | PLC-HOPPER | Off | Run | | Network | | | |
| MF | 3213 | MF-3213 | Wet Cake Bin Leveling Screw 1. Fail | DI | PLC-HOPPER | Off | Fail | | Network | | | |
| HA | 3213 | HA-3213 | Wet Cake Bin Leveling Screw 1. Auto | DI | PLC-HOPPER | Manual | Auto | | Network | | | |
| MC | 3213 | MC-3213 | Wet Cake Bin Leveling Screw 1. Start/Stop | DO | PLC-HOPPER | Stop | Start | | Network | | | |
| SI | 3213 | SI-3213 | Wet Cake Bin Leveling Screw 1. Speed Ind | AI | PLC-HOPPER | 0 | 100 | % | Network | | | |
| SC | 3213 | SC-3213 | Wet Cake Bin Leveling Screw 1. Speed Control | AO | PLC-HOPPER | 0 | 100 | % | Network | | | |
| YN | 3213 | YN-3213A | Wet Cake Bin Leveling Screw 1. E-Stop | DI | PLC-HOPPER | Off | E-Stop | | Network | | | |
| YN | 3213 | YN-3213B | Wet Cake Bin Leveling Screw 1. E-Stop | DI | PLC-HOPPER | Off | E-Stop | | Network | | | |
| SSL | 3213 | SL-3213B | Wet Cake Bin Leveling Screw 1. Low Speed | DI | PLC-HOPPER | Off | Lo Speed | | Network | | | |
| **Wet Cake Bin Leveling Screw 2 (15-BLS-M-2)** | | | | | | | | | | | | |
| MN | 3214 | MN-3214 | Wet Cake Bin Leveling Screw 2. Run | DI | PLC-HOPPER | Off | Run | | Network | | | |
| MF | 3214 | MF-3214 | Wet Cake Bin Leveling Screw 2. Fail | DI | PLC-HOPPER | Off | Fail | | Network | | | |
| HA | 3214 | HA-3214 | Wet Cake Bin Leveling Screw 2. Auto | DI | PLC-HOPPER | Manual | Auto | | Network | | | |
| MC | 3214 | MC-3214 | Wet Cake Bin Leveling Screw 2. Start/Stop | DO | PLC-HOPPER | Stop | Start | | Network | | | |
| SI | 3214 | SI-3214 | Wet Cake Bin Leveling Screw 2. Speed Ind | AI | PLC-HOPPER | 0 | 100 | % | Network | | | |
| SC | 3214 | SC-3214 | Wet Cake Bin Leveling Screw 2. Speed Control | AO | PLC-HOPPER | 0 | 100 | % | Network | | | |
| YN | 3214 | YN-3214A | Wet Cake Bin Leveling Screw 2. E-Stop | DI | PLC-HOPPER | Off | E-Stop | | Network | | | |
| YN | 3214 | YN-3214B | Wet Cake Bin Leveling Screw 2. E-Stop | DI | PLC-HOPPER | Off | E-Stop | | Network | | | |
| SSL | 3214 | SL-3214B | Wet Cake Bin Leveling Screw 2. Low Speed | DI | PLC-HOPPER | Off | Lo Speed | | Network | | | |
| | | | PLC-HOPPER Signals | | | | | | 0 | 0 | 0 | 0 |

| Tagname | | HMI | | Signal | PLC | Data Field Range | | ENG | IO Signals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Funct | Loop No. | Tagname | Description | Type | Cabinet | Low | High | Units | AI | DI | AO | DO |
| **Odorous Air Fan 15-OC-OF-1** | | | | | | | | | | | | |
| MN | 3300 | MN-3300 | Odorous Air Fan. Auto | DI | PLC-HSOC | Off | Run | | Network | | | |
| MN | 3300 | MN-3300 | Odorous Air Fan. Run | DI | PLC-HSOC | Off | Run | | Network | | | |
| MF | 3300 | MF-3300 | Odorous Air Fan. Fail | DI | PLC-HSOC | Off | Fail | | Network | | | |
| MC | 3300 | MC-3300 | Odorous Air Fan. Start/Stop | DO | PLC-HSOC | Stop | Start | | Network | | | |
| SI | 3300 | SI-3300 | Odorous Air Fan. Speed Ind | AI | PLC-HSOC | 0 | 100 | % | Network | | | |
| SC | 3300 | SC-3300 | Odorous Air Fan. Speed Control | AO | PLC-HSOC | 0 | 100 | % | Network | | | |
| **Nutrient Pump 15-OC-NP-1** | | | | | | | | | | | | |
| MN | 3301 | MN-3301 | Nutrient Pump. Auto | DI | PLC-HSOC | Off | Run | | Network | | | |
| MN | 3301 | MN-3301 | Nutrient Pump. Run | DI | PLC-HSOC | Off | Run | | Network | | | |
| MF | 3301 | MF-3301 | Nutrient Pump. Fail | DI | PLC-HSOC | Off | Fail | | Network | | | |
| MC | 3301 | MC-3301 | Nutrient Pump. Start/Stop | DO | PLC-HSOC | Stop | Start | | Network | | | |
| SI | 3301 | SI-3301 | Nutrient Pump. Speed Ind | AI | PLC-HSOC | 0 | 100 | % | Network | | | |
| SC | 3301 | SC-3301 | Nutrient Pump. Speed Control | AO | PLC-HSOC | 0 | 100 | % | Network | | | |
| MC | 3301 | MC-3301 | Nutrient Pump Start/Stop | DO | PLC-HSOC | Stop | Start | | Network | | | |
| **Odor Control Flow 1 15-OC-F-1** | | | | | | | | | | | | |
| FE/FIT | 3302 | FI-3302 | Odor Control. Flow 1 | AI | PLC-HSOC | 0 | XXX | GPM | Network | | | |
| **Odor Control Flow 1 15-OC-F-2** | | | | | | | | | | | | |
| FE/FIT | 3303 | FI-3303 | Odor Control. Flow 3 | AI | PLC-HSOC | 0 | XXX | GPM | Network | | | |
| **Odor Control Valve 1 15-OC-SV-1** | | | | | | | | | | | | |
| ZC | 3304 | MC-3304 | Odor Control. Valve 1 Open/Close | DO | PLC-HSOC | Close | Open | | Network | | | |
| | | | | | PLC-HSOC IO Signals | | | | 0 | 0 | 0 | 0 |

**ULTRASONIC LEVEL TRANSMITTER**

| Items | Equipment Tag | IO Tag # | Calibration Range (ft) | Mounting | Service | Specification Section | Supplier | Electrical Requirements | Model/Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 8-RAS-L-1 | LE/LIT-0561 | 0-8 FT | XMTR on Equipment Rack | RAS Spplitter Box Level | 16920 - 2.08 | Contractor/System Integrator | 120 VAC LP-BNR | Prosonic FMU90 / E&H; Or equal |
| 2 | 10-IUV-F-1 | LE/LIT-1000 | XXX FT | Sensor on grating / Xmtr on wall | Influent UV Channel Parshall Flume | | | 120 VAC LP-UV | |
| 3 | 11-WT-L-1 | LE/LIT-1100 | 0-24 FT | Sensor above tank / Xmtr on wall | WAS Storage Tank Level | | | 120 VAC LP-H1 | |
| 4 | 12-AD-L-1 | LE/LIT-1200 | 0-24 FT | Sensor above tank / Xmtr on Handrail | Aerobic Digester Tank 1 Level | | | 120 VAC LP-H | |
| 5 | 12-AD-L-2 | LE/LIT-1203 | 0-24 FT | Sensor above tank / Xmtr on Handrail | Aerobic Digester Tank 2 Level | | | 120 VAC LP-H | |
| 6 | 15-POLY-L-1 | LE/LIT-1350 | 0-8 FT | Sensor above tank / Xmtr on Tank | RDT Polymer Tank 1 Level | | | 120 VAC / LP-DW | |
| 7 | 15-POLY-L-2 | LE/LIT-1600 | 0-8 FT | Sensor above tank / Xmtr on Tank | BFP Polymer Tank 1 Level | | | 120 VAC / LP-DW | |
| 8 | 17-AL-L-1 | LE/LIT-0701 | 0-24 FT | Sensor above tank / Xmtr on Tank | Alum Tank 1 Level | | | 120 VAC LP-AL | |
| 9 | 17-AL-L-2 | LE/LIT-0702 | 0-24 FT | Sensor above tank / Xmtr on Tank | Alum Tank 2 Level | | | 120 VAC LP-AL | |

**TURBIDITY ANALYZER**

| Item | Equipment Tag | IO Tag # | Calibration Range (NTU) | Mounting | Service | Specification Section | Supplier | Electrical Requirements | Model/Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| 9 | 10-PA-TURB-1 | AE/-1040 & AIT-1040 | 0-50 NTU | Sensor Inmersion Post Aeration Tank Dropbox / XMTR on Equipment Rack | Post Aeration Tanks Dropbox | 16920-2.14 | Contractor/System Integrator | 120 VAC LP-UV | Immersion Solitax SC probe with SC-200 Transmitter Manufacturer by Hach or Equal |

**ORP ANALYZER**

| Item | Equipment Tag | IO Tag # | Calibration Range (mV) | Mounting | Service | Specification Section | Supplier | Electrical Requirements | Model/Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| 10 | 5-AT1-ORP-1 | AE/-0505 & AIT-0505 | -600 to +600 mV | Sensor Inmersion at Zone AX-1-1 / XMTR on Handrail | Basin 1 / Zone AX-1-1 | 16920-2.13 | Contractor/System Integrator | 120 VAC LP-BNR | Immersion Convertible Digital Combination ORP probe with and SC-200 Transmitter manufactured by Hach or Equal |
| 11 | 5-AT2-ORP-1 | AE/-0525 & AIT-0525 | -600 to +600 mV | Sensor Inmersion at Zone AX-2-1 / XMTR on Handrail | Basin 2 / Zone AX-2-1 | | | 120 VAC LP-BNR | |
| 12 | 5-AT3-ORP-1 | AE/-0545 & AIT-0545 | -600 to +600 mV | Sensor Inmersion at Zone AX-3-1 / XMTR on Handrail | Basin 3 / Zone AX-3-1 | | | 120 VAC LP-BNR | |
| 13 | 6-AT4-ORP-1 | AE/-0565 & AIT-0565 | -600 to +600 mV | Sensor Inmersion at Zone AX-4-1 / XMTR on Handrail | Basin 4 / Zone AX-4-1 | | | 120 VAC LP-H1 | |

**DO ANALYZER**

| Item | Equipment Tag | IO Tag # | Calibration Range (mg/L) | Mounting | Service | Specification Section | Supplier | Electrical Requirements | Model/Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| 14 | 5-AT1-DO-1 & 2 | AE-0502 A&B AIT-0502 | 0 to 10 mg/L | Sensor Inmersion at Zone OX-1-1 / XMTR on Handrail | Basin 1 / Zone OX-1-1 | 16920 - 2.11 | Contractor/System Integrator | 120 VAC LP-BNR | Probe LDO Probe, Xtmr SC-1000 manufactured by Hach, or Equal |
| 15 | 5-AT1-DO-3 & 4 | AE-0508 A&B AIT-0508 | 0 to 10 mg/L | Sensor Inmersion at Zone OX-1-2 / XMTR on Handrail | Basin 1 / Zone OX-1-2 | | | 120 VAC LP-BNR | |
| 16 | 5-AT2-DO-1 & 2 | AE-0522 A&B AIT-0522 | 0 to 10 mg/L | Sensor Inmersion at Zone OX-2-1 / XMTR on Handrail | Basin 2 / Zone OX-2-1 | | | 120 VAC LP-BNR | |
| 17 | 5-AT2-DO-3 & 4 | AE-0528 A&B AIT-0528 | 0 to 10 mg/L | Sensor Inmersion at Zone OX-2-2 / XMTR on Handrail | Basin 2 / Zone OX-2-2 | | | 120 VAC LP-BNR | |

**DO ANALYZER**

| Item | Equipment Tag | IO Tag # | Calibration Range (mg/L) | Mounting | Service | Specification Section | Supplier | Electrical Requirements | Model/Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| 18 | 5-AT3-DO-1 & 2 | AE-0542 A&B AIT-0542 | 0 to 10 mg/L | Sensor Inmersion at Zone OX-3-1 / XMTR on Handrail | Basin 3 / Zone OX-3-1 | 16920 - 2.11 | Contractor/System Integrator | 120 VAC LP-BNR | Probe LDO Probe, Xtmr SC-1000 manufactured by Hach, or Equal |
| 19 | 5-AT3-DO-3 & 4 | AE-0548 A&B AIT-0548 | 0 to 10 mg/L | Sensor Inmersion at Zone OX-3-2 / XMTR on Handrail | Basin 3 / Zone OX-3-2 | | | 120 VAC LP-BNR | |
| 20 | 6-AT4-DO-1 & 2 | AE-0562 A&B AIT-0562 | 0 to 10 mg/L | Sensor Inmersion at Zone OX-4-1 / XMTR on Handrail | Basin 4 / Zone OX-4-1 | | | 120 VAC LP-H1 | |
| 21 | 6-AT4-DO-3 & 4 | AE-0568 A&B AIT-0568 | 0 to 10 mg/L | Sensor Inmersion at Zone OX-4-2 / XMTR on Handrail | Basin 4 / Zone OX-4-2 | | | 120 VAC LP-H1 | |
| 22 | 10-PA-DO-1 | AE/AIT-1020 | 0 to 10 mg/L | Sensor Inmersion at Post Aeration Tank 1 XMTR on Handrail | Post Aeration Tank 1 DO | | | 120 VAC LP-UV | |
| 23 | 10-PA-DO-2 | AE/AIT-1030 | 0 to 10 mg/L | Sensor Inmersion at Post Aeration Tank 2 XMTR on Handrail | Post Aeration Tank 2 DO | | | 120 VAC LP-UV | |
| 24 | 12-AD-DO-1A&B | AE/AIT-1202A&B | 0 to 10 mg/L | Sensor Inmersion At Digester Tank 1 XMTR on Handrail | Digester Tank 1 DO | | | 120 VAC LP-H1 | |
| 25 | 12-AD-DO-2A&B | AE/AIT-1205A&B | 0 to 10 mg/L | Sensor Inmersion At Digester Tank 2 XMTR on Handrail | Digester Tank 2 DO | | | 120 VAC LP-H1 | |
| **ELECTROMANETIC FLOW METER** | | | | | | | | | |
| **Item** | **Equipment Tag** | **IO Tag #** | **Calibration Range (GPM)** | **Mounting** | **Service** | **Specification Section** | **Supplier** | **Electrical Requirements** | **Model/Manufacturer** |
| 26 | 5-AT1-F-5 | FE/FIT-0516 | 0-2400 GPM | Flow Tube - Flange / XMTR on Equipment Rack | Basin 1 / Zone AX-1-1 | 16920 - 2.06 | Contractor/System Integrator | 120 VAC LP-BNR | Endress & Hauser Model Promag 53 W, Rosemount Series 8750, or Equal |
| 27 | 5-AT1-F-6 | FE/FIT-0556 | 0-2400 GPM | Flow Tube - Flange / XMTR on Equipment Rack | Basin 1 / Zone AN-1-1 | | | 120 VAC LP-BNR | |
| 28 | 5-AT2-F-5 | FE/FIT-0582 | 0-2400 GPM | Flow Tube - Flange / XMTR on Equipment Rack | Basin 2 / Zone AX-2-1 | | | 120 VAC LP-BNR | |
| 29 | 5-AT2-F-6 | FE/FIT-0584 | 0-2400 GPM | Flow Tube - Flange / XMTR on Equipment Rack | Basin 2 / Zone AN-2-1 | | | 120 VAC LP-BNR | |
| 30 | 5-AT3-F-5 | FE/FIT-0588 | 0-2400 GPM | Flow Tube - Flange / XMTR on Equipment Rack | Basin 3 / Zone AX-3-1 | | | 120 VAC LP-BNR | |
| 31 | 5-AT3-F-6 | FE/FIT-0586 | 0-2400 GPM | Flow Tube - Flange / XMTR on Equipment Rack | Basin 3 / Zone AN-3-1 | | | 120 VAC LP-BNR | |
| 32 | 6-AT4-F-5 | FE/FIT-0594 | 0-2400 GPM | Flow Tube - Flange / XMTR on Equipment Rack | Basin 4 / Zone AX-4-1 | | | 120 VAC LP-H1 | |
| 33 | 6-AT4-F-6 | FE/FIT-0596 | 0-2400 GPM | Flow Tube - Flange / XMTR on Equipment Rack | Basin 4 / Zone AN-4-1 | | | 120 VAC LP-H1 | |
| 34 | 15-RDT-F-1 | FE/FIT-1300 | 0-500 GPM | Flow Tube - Flange / XMTR on Equipment Rack | RDT 1 Influent Flow | | | 120 VAC LP-H1 | |
| 35 | 15-RDT-F-2 | FE/FIT-1301 | 0-500 GPM | Flow Tube - Flange / XMTR on Equipment Rack | RDT 2 Influent Flow | | | 120 VAC LP-H1 | |
| 36 | 15-BFP-F-1 | FE/FIT-1450 | 0-250 GPM | Flow Tube - Flange / XMTR on Equipment Rack | BFP 1 Influent Flow | | | 120 VAC / LP-DW | |
| **ELECTROMANETIC FLOW METER** | | | | | | | | | |

| Item | Equipment Tag | IO Tag # | Calibration Range (GPM) | Mounting | Service | Specification Section | Supplier | Electrical Requirements | Model/Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| 37 | 15-BFP-F-2 | FE/FIT-1460 | 0-250 GPM | Flow Tube - Flange / XMTR on Equipment Rack | BFP 2 Influent Flow | 16920 - 2.06 | Contractor/System Integrator | 120 VAC / LP-DW | Endress & Hauser Model Promag 53 W, Rosemount Series 8750, or Equal |
| 38 | 15-DP-F-1 | FE/FIT-1780 | 0-1500 GPM | Flow Tube - Flange / XMTR on Equipment Rack | Drain Pumping Station Discharge Flow | | | 120 VAC / LP-DW | |
| 39 | 15-NPW-F-1 | FE/FIT-1780 | Verify with Pump Mfr. | Flow Tube - Flange / XMTR on Equipment Rack | Drain Pumping Station Discharge Flow | | | 120 VAC / LP-DW | |

**PRESSURE TRANSMITTER**

| Item | Equipment Tag | IO Tag # | Calibration Range (psi) | Mounting | Service | Specification Section | Supplier | Electrical Requirements | Model/Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| 40 | 5-A-PT-1 | PIT-0601 | 0-15 psi | 1/2" NPT on pipe | BNR Blower 1 Discharge Pressure | 16920 - 2.10 | Contractor/System Integrator | Loop Power | 3051 Smart manufactured by Rosemount, PMP71 manufactured by Endress and Hauser, or Equal |
| 41 | 5-A-PT-2 | PIT-0602 | 0-15 psi | | BNR Blower 2 Discharge Pressure | | | | |
| 42 | 5-A-PT-3 | PIT-0603 | 0-15 psi | | BNR Blower 3 Discharge Pressure | | | | |
| 43 | 5-A-PT-4 | PIT-0604 | 0-15 psi | | BNR Blower 4 Discharge Pressure | | | | |
| 44 | 10-A-PT-1 | PIT-1047 | 0-15 psi | | UVPA Blower Discharge Pressure To PA Tank 1 | | | | |
| 45 | 10-A-PT-2 | PIT-1057 | 0-15 psi | | UVPA Blower Discharge Pressure to PA Tank 2 | | | | |

**FLOW SWITCH**

| Item | Equipment Tag | IO Tag # | Calibration Range (GPM) | Mounting | Service | Specification Section | Supplier | | Model/Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| 46 | 5-PW-FS-1 | FSL-0662 | 10 GPM SP | On Pipe | Scum Collection Box Spray Water | 16920 - 2.20 | Contractor/System Integrator | | W.E. Anderson Model V6 or equal. |
| 47 | 7-MBR-FS-1 | FSH-2081 | Verify with Eyewash Mfr. | On Pipe | MBR Emer Eyewas & Safety Shower 1 High Flow | | | | |
| 48 | 7-MBR-FS-2 | FSH-2081 | Verify with Eyewash Mfr. | On Pipe | MBR Emer Eyewas & Safety Shower 2 High Flow | | | | |
| 49 | 15-DW-FS-1 | FSH-1804 | Verify with Eyewash Mfr. | On Pipe | Solid Handling Bldg Emer Eyewas & Safety Shower 1 High Flow | | | | |
| 50 | 15-DW-FS-2 | FSH-1805 | Verify with Eyewash Mfr. | On Pipe | Solid Handling Bldg Emer Eyewas & Safety Shower 2 High Flow | | | | |
| 51 | 15-DW-FS-3 | FSH-1806 | Verify with Eyewash Mfr. | On Pipe | Solid Handling Bldg Emer Eyewas & Safety Shower 3 High Flow | | | | |
| 52 | 15-DW-FS-4 | FSH-1807 | Verify with Eyewash Mfr. | On Pipe | Solid Handling Bldg Emer Eyewas & Safety Shower 4 High Flow | | | | |
| 53 | 17-AL-FS-1 | FSH-0702 | Verify with Eyewash Mfr. | On Pipe | Alum Facility Emer Eyewas & Safety Shower 1 High Flow | | | | |

**PRESSURE SWITCH**

| Item | Equipment Tag | IO Tag # | Calibration (psi) | Mounting | Service | Specification Section | Supplier | | Model/Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| 54 | 5-SC-PS-1 | PSL-671 | 1 psi SP | On Pipe | Scum Pump 1 Inlet Low Pressure | 16920-2.17 | Contractor/System Integrator | | Ashcroft, United Electric Controls Co, Mercoid Corp, Or equal |

**LIMIT SWITCH**

| Item | Equipment Tag | IO Tag # | Range/Type | Mounting | Service | Specification Section | Supplier | | Model/Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| 55 | 5-AT-ISG-1 | ZSH/ZSL-0511 | Open and Close Valve status | On Sluice Gate or Valve | BNR Basin Influent Feed Channel | 16920-2.21 | Contractor/System Integrator / Coordinate with Valve/Gate | | Coordinate System Supplier and Valve Manufacturer |
| 56 | 5-AT1-SG-1 | ZSH/ZSL-0511 | | | BNR Basin 1 / Zone AN-1-1 | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 57 | 5-AT2-SG-1 | ZSH/ZSL-0531 | | | BNR Basin 2 / Zone AN-2-1 | | Valve/Gate Manufacturer | | |
| **LIMIT SWITCH** | | | | | | | | | |
| **Item** | **Equipment Tag** | **IO Tag #** | **Range/Type** | **Mounting** | **Service** | **Specification Section** | **Supplier** | | **Model/Manufacturer** |
| 58 | 5-AT3-SG-1 | ZSH/ZSL-0555 | Open and Close Valve status | On Sluice Gate or Valve | BNR Basin 3 / Zone AN-3-1 | 16920-2.21 | Contractor/System Integrator / Coordinate with Valve/Gate Manufacturer | | Coordinate System Supplier and Valve Manufacturer |
| 59 | 5-A-V-1 | ZSH/ZSL-0610 | | | BNR Blower 1 & 2 Valve status | | | | |
| 60 | 5-A-V-2 | ZSH/ZSL-0620 | | | BNR Blower 2 Valve status | | | | |
| 61 | 5-A-V-3 | ZSH/ZSL-0630 | | | BNR Blower 2 & 3 Valve status | | | | |
| 62 | 5-A-V-4 | ZSH/ZSL-0640 | | | BNR Blower 3 Valve status | | | | |
| 63 | 5-A-V-5 | ZSH/ZSL-0650 | | | BNR Blower 3, 4 & 5 Valve status | | | | |
| 64 | 5-A-V-6 | ZSH/ZSL-0660 | | | BNR Blower 4 Valve status | | | | |
| **LIMIT SWITCH** | | | | | | | | | |
| **Item** | **Equipment Tag** | **IO Tag #** | **Range/Type** | **Mounting** | **Service** | **Specification Section** | **Supplier** | | **Model/Manufacturer** |
| 65 | 10-A-V-1 | ZSH/ZSL-1040 | Open and Close Valve status | On Sluice Gate or Valve | UVPA Blower 1 Valve 1 Status | 16920-2.21 | Contractor/System Integrator / Coordinate with Valve/Gate Manufacturer | | Coordinate System Supplier and Valve Manufacturer |
| 66 | 10-A-V-2 | ZSH/ZSL-1050 | | | UVPA Blower 2 Valve 2 Status | | | | |
| 67 | 10-A-V-3 | ZSH/ZSL-1069 | | | UVPA Blower 3 Valve 3 Status | | | | |
| 68 | 10-A-V-4 | ZSH/ZSL-1069 | | | UVPA Blower 3 Valve 4 Status | | | | |
| 69 | 10-AD-V-1 | ZSH/ZSL-1210 | | | Aeration Digester Blower 1 Discharge Valve 1 Status | | | | |
| 70 | 10-AD-V-2 | ZSH/ZSL-1220 | | | Aeration Digester Blower 2 Discharge Valve 2 Status | | | | |
| 71 | 10-AD-V-3 | ZSH/ZSL-1230 | | | Aeration Digester Blower 3 Discharge Valve 3 Status | | | | |
| 72 | 10-AD-V-4 | ZSH/ZSL-1216 | | | Aeration Digester Blowers 1 & 3 Discharge Valve 4 Status | | | | |
| 73 | 10-AD-V-5 | ZSH/ZSL-1217 | | | Aeration Digester Blowers 2 & 3 Discharge Valve 5 Status | | | | |
| **FLOAT LEVEL SWITCH** | | | | | | | | | |
| **Item** | **Equipment Tag** | **IO Tag #** | **Elevation/Type** | **Mounting** | **Service** | **Specification Section** | **Supplier** | | **Model/Manufacturer** |
| 74 | 5-SC-LS-1 | LSH-0661 | El. 882.0 | Scum Colletion Box | Scum Colletion Box High Float Level | 16920-2.18 | Contractor/System Integrator | | Eco Float Manufactured by Anchor Scientific, Model 7030 Manufactured by MJK Automation, SM Manufactured by Ames/Messco - SM, or Equal |
| 75 | 8-RAS-LS-1 | LSH-0560 | El. 898.0 | RAS Spplitter Box | RAS Spplitter Box High Float Level | | | | |
| 76 | 11-WT-LS-1 | LSH-1101 | El. 881.0 | WAS Storage Tank | WAS Storage Tank High Float Level | | | | |
| 77 | 11-RP-LS-1 | LSH-1155 | El. 876.5 | Reuse Puming Station | Reuse Pumping Station High Float Level | | | | |
| 78 | 12-AD-LS-1 | LSH-1201 | El. 880.0 | Aerobic Digester Tank 1 | Aerobic Digester Tank 1 High Level | 16920-2.18 | Contractor/System Integrator | | Eco Float Manufactured by Anchor Scientific, Model 7030 Manufactured by MJK |
| 79 | 12-AD-LS-2 | LSH-1204 | El. 880.0 | Aerobic Digester Tank 2 | Aerobic Digester Tank 2 High Level | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 80 | 15-DP-LS-1 | LSH-1751 | El. 875.0 | Drain Well Float Switch | Solids Handling Bldg Drain Pumping Station High Level | 16920-2.18 | Contractor/System Integrator | | Eco Float Manufactured by Anchor Scientific, Model 7030 Manufactured by MJK Automation, SM Manufactured by Ames/Messco - SM, or Equal |
| 81 | 15-DP-LS-2 | LSL-1752 | El. 866.0 | Drain WellFloat Switch | Solids Handling Bldg Drain Pumping Station Low Level | | | | |
| 82 | 15-DW-LS-2 | LSH-1800 | El. 865.0 | High Sump Float Switch | Solid Handling Bldg Sump Pump High Level | | | | |
| **HYDROSTATIC LEVEL TRANSDUCER** | | | | | | | | | |
| **Item** | **Equipment Tag** | **IO Tag #** | | **Mounting** | **Service** | **Specification Section** | **Supplier** | **Electrical Requirements** | **Model/Manufacturer** |
| 83 | 5-SC-L-1 | LI-0660 | | Scum Collection Box in Stilling-well pipe | Scum Colletion Box Level | 16920-2.09 | Contractor/System Integrator | Loop Power | Provide Endress & Hauser Model Water Pilot FMX21, or equal. |
| 84 | 11-RP-L-1 | LI-1155 | | Reuse Pumping Station Tank in Stilling-well pipe | Reuse Pumping Station | | | | |
| 85 | 15-DP-L-1 | LI-1750 | | Drain Pumping Station Well in Stilling-well pipe | Solids Drain Pumping Station | | | | |
| **REFRIGERATED SAMPLER** | | | | | | | | | |
| **Item** | **Equipment Tag** | **IO Tag #** | | | **Service** | **Specification Section** | **Supplier** | **Electrical Requirements** | **Model/Manufacturer** |
| 86 | 10-PA-SP-1 | | | | Post Aeration Sampler | 16920-2.04 | Contractor/System Integrator | 120 VAC LP-UV | Refrigerated sampler – 5800 series by Isco or equal |
| 87 | 11-WAS-SP-1 | | | | Reuse Pumping Station Sampler | | | 120 VAC LP-H1 | |
| **GAS MONITOR SYSTEM** | | | | | | | | | |
| **Item** | **Equipment Tag** | **IO Tag #** | | **Mounting** | **Service** | **Specification Section** | **Supplier** | **Electrical Requirements** | **Model/Manufacturer** |
| 88 | 15-DW-GT-1 | AE/AIT-1801 | | On Wall | Gas Monitor Solid Handing Bldg BFP Area Comb Sensor | 16920-2.15 | Contractor/System Integrator | 120 VAC LP-DW Power Gas Monitor MCP | Model Ultima X5000 series sensor and Gasgard Receiver Manufacturer by MSA |
| 89 | 15-DW-GT-2 | AE/AIT-1802 | | On Wall | Gas Monitor Solid Handing Bldg BFP Area O2 Sensor | | | | |
| 90 | 15-DW-GT-3 | AE/AIT-1803 | | On Wall | Gas Monitor Solid Handing Bldg BFP Area H2S Sensor | | | | |
| 91 | 15-DW-GT-4 | AE/AIT-1808 | | On Wall | Gas Monitor Solid Handing Bldg Dryer Area Comb Sensor | | | | |
| **GAS MONITOR SYSTEM** | | | | | | | | | |
| **Item** | **Equipment Tag** | **IO Tag #** | | **Mounting** | **Service** | **Specification Section** | **Supplier** | **Electrical Requirements** | **Model/Manufacturer** |
| 92 | 15-DW-GT-5 | AE/AIT-1809 | | On Wall | Gas Monitor Solid Handing Bldg Dryer Area O2 Sensor | 16920-2.15 | Contractor/System Integrator | 120 VAC LP-DW Power Gas Monitor MCP | Model Ultima X5000 series sensor and Gasgard Receiver Manufacturer by MSA |
| 93 | 15-DW-GT-6 | AE/AIT-1810 | | On Wall | Gas Monitor Solid Handing Bldg Dryer Area H2S Sensor | | | | |
| 94 | 15-DW-GT-7 | AE/AIT-1811 | | On Wall | Gas Monitor Solid Handing Bldg Truck Loading Area CO Sensor | | | | |
| **TEMPERATURE SWITCH** | | | | | | | | | |
| **Item** | **Equipment Tag** | **IO Tag #** | | **Mounting** | **Service** | **Specification Section** | **Supplier** | **Electrical Requirements** | **Model/Manufacturer** |
| 95 | 5-BNR-TS-1 | TH-2183 | | On Wall | Solids Bldg Electrical Room Temperaute Switch | 16920-2.19 | Contractor/System Integrator | | Manufacturer by Johnson Controls, Dayton, Honeywell or equal |
| 96 | 5-BNR-TS-2 | TL-2184 | | On Wall | BNR Electrical Room Temperaute Switch | | | | |
| 97 | 15-DW-TS-1 | TH-1808 | | On Wall | Solids Bldg Electrical Room Temperaute Switch | | | | |
| 98 | 15-DW-TS-2 | TL-1809 | | On Wall | BNR Electrical Room Temperaute Switch | | | | |

**NOTES**

1. All ranges shall be verified with the other manufacturers, suppliers, and existing and proposed conditions.
2. Submittal shall include written verification that all ranges are verified and accurate.
3. Not All instruments may be included. Verify with all contract documents and submit complete list.

| Item | Panel ID | Description / Location | Mounting | NEMA | Minimum Size HxWxD (inch) (See Note 1 and 2) | Power | Supplier |
|---|---|---|---|---|---|---|---|
| **INFLUENT AND HEADWORKS FACILITY (1)** | | | | | | | |
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1and 2)** | **Power** | **Supplier** |
| 1 | PLC-IH | Headworks PCS PLC Enclosure / Next to SWGR-OC | Freestanding | NEMA 4X SST | 60x36x24 | 120VAC LP-OC | Contractor/SI |
| 2 | 1-GR-MCP | Grit Removal Main Control Panel / Grit Removal Facility | Freestanding | NEMA 4X SST | 72x48x16 | 480VAC, 3PH SWGR-OC | Grir Removal Manufacture |
| 3 | 1-OC-MCP | Odor Control Main Control Panel/ Headworks Odor Control Facility | Freestanding | NEMA 4X SST | Verify with Manufactuer | 480VAC, 3PH SWGR-OC | Odor Control Manufacture |
| **SOLID HANDLING BUILDING (15)** | | | | | | | |
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1 and 2)** | **Power** | **Supplier** |
| 4 | PLC-DW | Solid Handling PCS PLC Enclosure / Solid Handling Bldg Electrical Room | Freestanding | NEMA 12 | 80x112x20 | 120VAC LP-DW | Contractor/SI |
| 5 | 15-RDT-1 MCP | RDT 1 Main Control Panel / Digester Tanks Area | On Equipment Rack | NEMA 4X SST | 30x24x12 | 480VAC, 3PH MCC-DW | RDT Manufacturer |
| 6 | 15-RDT-2 MCP | RDT 2 Main Control Panel / Digester Tanks Area | On Equipment Rack | NEMA 4X SST | 30x24x12 | 480VAC, 3PH MCC-DW | RDT Manufacturer |
| 7 | 15-BFP 1&2 MCP | BFP 1 & 2 Main Control Panel / Solid Handling Bldg/Process Area | Freestanding | NEMA 4X SST | 72x70x12 | 480VAC, 3PH MCC-DW | BNR Manufacturer |
| 8 | 15 DRYER MCP | Dryer Main Control Panel / Solid Handling Bldg/Process Area | Freestanding | NEMA 4X SST | 90x72x24 | 480VAC, 3PH MCC-DW | DRYER Manufacturer |
| 9 | 15-BFP-P-1,2 & 3 LCP | BFP Feed Pumps 1 thur 3 LCP / Solid Handling Bldg/Process Area | On Equipment Rack | NEMA 4X SST | 24x20x8 | 480VAC, 3PH MCC-DW | Contractor/SI |
| 10 | 15-POLY-T-1 LCP | Polymer Tank 1 Fill Tank LCP / Solid Handling Bldg/Process Area | On Equipment Rack | NEMA 4X SST | 16x16x8 | 120VAC LP-DW Ckt 4 | Contractor/SI |
| 11 | 15-POLY-RP-1 LCS | Polymer Tank Recirculation Pump 1 LCS / Solid Handling Bldg/Process Area | On Equipment Rack | NEMA 4X SST | 8x4x4-3/4 | 480VAC, 3PH MCC-DW | Contractor/SI |
| 11 | 15-BFP-BP-1,2 & 3 LCP | BFP Booster Pumps 1 thur 3 LCP / Solid Handling Bldg/Process Area | Freestanding | NEMA 4X SST | 24x20x8 | 480VAC, 3PH MCC-DW | Contractor/SI |
| 12 | 15-POLY-T-2 LCP | Polymer Tank 2 Fill Tank LCP / Solid Handling Bldg/Process Area | On Equipment Rack | NEMA 4X SST | 16x16x8 | 120VAC LP-DW Ckt 5 | Contractor/SI |
| 13 | 15-POLY-RP-2 LCS | Polymer Tank Recirculation Pump 2 LCS / Solid Handling Bldg/Process Area | On Equipment Rack | NEMA 4X SST | 8x4x4-3/4 | 480VAC, 3PH MCC-DW | Contractor/SI |
| 13 | 15-S-C-1 LCP | Sludge Conveyor 1 LCP / Solid Handling Bldg/Process Area | On Wall | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-DW | Contractor/SI |
| 14 | 15-S-C-2 LCP | Sludge Conveyor 2 LCP / Solid Handling Bldg/Process Area | On Wall | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-DW | Contractor/SI |
| 15 | 15-DP-2 LCP | SH Drain Pumping Station 2 LCP / Solid Handling Bldg/Process Area | On Equipment Rack | NEMA 4X SST | 20x16x8 | 480VAC, 3PH MCC-DW | Contractor/SI |
| 16 | 15-SC-P-1 &2 LCP | SH Drain Pumping Station 2 LCP / Solid Handling Bldg/Process Area | On Equipment Rack | NEMA 4X SST | 20x16x8 | 480VAC, 3PH MCC-DW | Contractor/SI |
| 17 | 15-DW-GM MCP | Solid Handling Bldg/Main Entry | On Wall | NEMA 4X SST | 30x24x10 | 120VAC LP-DW | Contractor/SI |
| 18 | 15-DW-OC MCP | SH Odor Control Main Control Panel / Solid Handling Bldg/Outdoor | Verify with Manufactuer | NEMA 4X SST | Verify with Manufactuer | 480VAC, 3PH MCC-DW | Odor Control Manufacturer |
| 19 | 15-TO MCP | Thermal Oil Manin Control Panel/Solid Handling building | Verify with Manufactuer | NEMA 4X SST | Verify with Manufactuer | 480VAC, 3PH MCC-DW | Thermal Oil Manufacturer |
| 20 | 15-HOPPER MCP | Sludge Hopper Main Control Panel / Solid Handling Bldg | On Equipment Rack | NEMA 4X SST | 36x30x12 | 120VAC LP-DW | Sludge Hopper Manufacturer |
| **BNR/MBR ELEC BUILDING** | | | | | | | |
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1 and 2)** | **Power** | **Supplier** |
| 21 | PLC-BNR | BNR PCS PLC Enclosures / Electrical Room | Freestanding | NEMA 12 | (2) 90x72x24 (Note 8) | 120VAC LP-BNR | Contractor/SI |

| Item | Panel ID | Description / Location | Mounting | NEMA | Minimum Size HxWxD (inch) (See Note 1 and 2) | Power | Supplier |
|---|---|---|---|---|---|---|---|
| 22 | 7-MBR MCP | MBR Main Contro Panel / Electrical Room | Wall Mount | NEMA 12 | 72x36x12 | 120VAC LP-BNR | MBR Manufacturer |
| **WAS STORAGE FACILITY (11)** | | | | | | | |
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1 and 2)** | **Power** | **Supplier** |
| 23 | RIO -BNR1 | RIO BNR PCS Enclosure / WAS Storage Facility | Freestanding | NEMA 4X SST | 60x36x24 | 120VAC LP-H1 | Contractor/SI |
| 24 | 14-CA MCP | Compressed Air Main Control Panel / WAS Storage Facility | On Equipment Rack | NEMA 4X SST | 42x36x13 | 120VAC LP-H1 | Compressed Air Manufacturer |
| 25 | 11-SF-P-1 LCP | Sldge Feed Pump 1 LCP / WAS Storage Facility | On Equipment Rack | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-BNR | Contractor/SI |
| 26 | 11-SF-P-2 LCP | Sldge Feed Pump 2 LCP / WAS Storage Facility | On Equipment Rack | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-BNR | Contractor/SI |
| 27 | 11-SF-P-3 LCP | Sldge Feed Pump 3 LCP / WAS Storage Facility | On Equipment Rack | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-BNR | Contractor/SI |
| **FINE SCREENING FACILITY (4)** | | | | | | | |
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1 and 2)** | **Power** | **Supplier** |
| 28 | RIO-BNR2 | RIO BNR2 PCS Enclosure / Fine Screening Facility | Freestanding | NEMA 4X SST | 72x48x24 | 120VAC LP-BNR | Contractor/SI |
| 29 | 4-FS-1 MCP | Fine Screening 1 Main Control Panel / Fine Screening Facility | On Equipment Rack | NEMA 4X SST | 36"x30"12" | 480VAC, 3PH MCC-BNR | Fine Screening Manufacturer |
| 30 | 4-FS-2 MCP | Fine Screening 2 Main Control Panel / Fine Screening Facility | On Equipment Rack | NEMA 4X SST | 36"x30"12" | 480VAC, 3PH MCC-BNR | Fine Screening Manufacturer |
| 31 | 4-FS-C-1 LCP | Fine Screening Conveyor LCP / Fine Screening Facility | On Equipment Rack | NEMA 4X SST | 13x9x10 | 480VAC, 3PH MCC-BNR | Fine Screening Manufacturer |
| **MBR FACILITY (7)** | | | | | | | |
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1 and 2)** | **Power** | **Supplier** |
| 32 | 7-MBR-RIO-1 (CP-11) | MBR RIO 1 Enclosure / MBR Facility | Wall Mount | NEMA 4X SST | 36x36x10 | 120VAC LP-MBR | MBR Manufacturer |
| 33 | 7-MBR-RIO-2 (CP-12) | MBR RIO 2 Enclosure / MBR Facility | Wall Mount | NEMA 4X SST | 36x36x10 | 120VAC LP-MBR | MBR Manufacturer |
| 34 | 7-MBR-RIO-3 (CP-13) | MBR RIO 3 Enclosure / MBR Facility | Wall Mount | NEMA 4X SST | 36x36x10 | 120VAC LP-MBR | MBR Manufacturer |
| 35 | 7-MBR-RIO-4 (CP-14) | MBR RIO 4 Enclosure / MBR Facility | Wall Mount | NEMA 4X SST | 36x36x10 | 120VAC LP-MBR | MBR Manufacturer |
| **MCC-H BUILDING (14)** | | | | | | | |
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1 and 2)** | **Power** | **Supplier** |
| 36 | PLC-H | PCS PLC H / MCC-H Area | Freestanding | NEMA 4X SST | 72x72x24 | 120VAC LP-H | Contractor/SI |
| 37 | RIO-H1 | Existing LCP-H / MCC-H Area | Freestanding | NEMA 4X SST | 48x36x12 (Note 3) | Ex 120VAC LP-H | Modified by Contractor/SI |
| **UV/POST AERATION AREA (10)** | | | | | | | |
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1 and 2)** | **Power** | **Supplier** |
| 38 | PLC-UVPA | PCS PLC UVPA Enclosure / UV Control Room | Freestanding | NEMA 12 | 72x36x24 | 120VAC LP-UV | Contractor/SI |
| 39 | 10-UV-MCP | UV System Main Control Panel / UV Control Room | Freestanding | NEMA 12 | 72x48x24 | N/A | UV Manufacture |
| **MAIN SWITCHGEAR (23)** | | | | | | | |

| Item | Panel ID | Description / Location | Mounting | NEMA | Minimum Size HxWxD (inch) (See Note 1 and 2) | Power | Supplier |
|---|---|---|---|---|---|---|---|
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1 and 2)** | **Power** | **Supplier** |
| 40 | PLC-MSG | PCS PLC Main Switchgear Enclosure / Main Switchgear | Inside SWGR Enclouser | NEMA 12 | See Note 7 | 120VAC LP-MSG | Contractor/SI |
| 41 | PLC-MMSG | Main Switchgear PLC / Main Switchgear | Inside SWGR Enclouser | NEMA 12 | See Note 6 | 120VAC LP-MSG | SGWR Manufacturer |
| **EX ADMIN BUILDING** | | | | | | | |
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1 and 2)** | **Power** | **Supplier** |
| 42 | PLC-A | Existing Adm Building | Ex Freestanding | NEMA 12 | 42x30x10 (Note 4) | Ex 120VAC LP-A | Modified by Contractor/SI |
| **BNR BASIN FACILITY (5)** | | | | | | | |
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1 and 2)** | **Power** | **Supplier** |
| 43 | 5-AT1-P-1 LCP | AT1 Recycle Pump 1 / BNR Basin 1 | On Equipment Rack | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-BNR | Contractor/SI |
| 44 | 5-AT1-P-2 LCP | AT1 Recycle Pump 2 / BNR Basin 1 | On Equipment Rack | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-BNR | Contractor/SI |
| 45 | 5-AT2-P-1 LCP | AT2 Recycle Pump 1 / BNR Basin 2 | On Equipment Rack | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-BNR | Contractor/SI |
| 46 | 5-AT2-P-2 LCP | AT2 Recycle Pump 2 / BNR Basin 2 | On Equipment Rack | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-BNR | Contractor/SI |
| 47 | 5-AT3-P-1 LCP | AT3 Recycle Pump 1 / BNR Basin 3 | On Equipment Rack | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-BNR | Contractor/SI |
| 48 | 5-AT3-P-2 LCP | AT3 Recycle Pump 2 / BNR Basin 3 | On Equipment Rack | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-BNR | Contractor/SI |
| 49 | 6-AT4-P-1 LCP | AT4 Recycle Pump 1 / BNR Basin 4 | On Equipment Rack | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-BNR | Contractor/SI |
| 50 | 6-AT4-P-2 LCP | AT4 Recycle Pump 2 / BNR Basin 4 | On Equipment Rack | NEMA 4X SST | 16x16x8 | 480VAC, 3PH MCC-BNR | Contractor/SI |
| 51 | 5-SC-P-1 &2 LCS | Scum Pumps LCS / Scum Pumping Station | On Equipment Rack | NEMA 4X SST | 8x4x4-3/4 | 480VAC, 3PH MCC-BNR | Contractor/SI |
| **ALUM FACILITY (17)** | | | | | | | |
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1 and 2)** | **Power** | **Supplier** |
| 52 | 17-AL-T-1 LCP | Alum Tank 1 Fill LCP / Alum Facility | On Equipment Rack | NEMA 4X SST | 16x16x8 | 120VAC LP-AL | Contractor/SI |
| 53 | 17-AL-T-2 LCP | Alum Tank 2 Fill LCP / Alum Facility | On Equipment Rack | NEMA 4X SST | 16x16x8 | 120VAC LP-AL | Contractor/SI |
| **PLANT DRAIN PUMPING STATION 1 (17)** | | | | | | | |
| **Item** | **Panel ID** | **Description / Location** | **Mounting** | **NEMA** | **Minimum Size HxWxD (inch) (See Note 1 and 2)** | **Power** | **Supplier** |
| 54 | 17-DP-1 LCP | Plant Drain Pumping Station 1 LCP / Drain Pumping Station 1 Area | On Equipment Rack | NEMA 4X SST | 36x24x12 | Ex 120VAC LP-A | Contractor/SI |

Notes:

1.- Minimum Panels size shown. The panel size shall be determined by panel manufacturer or Contractor per contract specifications. Contractor to coordinate panel dimensions with space available for panel installation.

2.- Provide Air Conditioning Units for all Contractor/SI PLC and RIO control panels which are NEMA 4X.

3.- Contractor shall modified existing LCP-H enclosure removing IO signals of equipment to be demolished and adding terminal blocks for new signals. Provide conduits and wires for connections to new PLC enclosures.

4.- Replace existing PLC-A, Install new PLC A Enclosure next to existing. Change existing PLC-A enclosure to Terminal Cabinet (TC). Provide wire/conduit from new TC to new PLC-A.

5.- The Control List is not all inclusive of all required Control Panels for the project. Refer to P&IDs, Contract Drawings, and other Specifications for control panel requirements.

6.- PLC to operate breakers in Main Switchgear to be provided by the Switchgear manufacturer as part of the equipment.

7.- PLC-MSG provided by System Integrator, coordinate with Switchgear manufacturer to provide adequate space for isntallation back panel in switchgear or seperated NEMA 12 enclosure inside of walk in switchgear.

8.- PLC-BNR is designed with 2 panels due to the amount of IO. Provide 2 seperate 120 volt feeds to the panel and label IO accordingly. Contractor may submit single panel if space available for all IO.

# Canton, GA Preliminary I/O List

**5700110005**

**PLC CP**

| | | Equipment Tag | | | | | Instrument Tag | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Equipment | Prefix | Number | Suffix | Tag | Signal | Prefix | Number | Suffix | Tag | I/O Type | Signal | Range/Off Status | Units/On Status | Suggested Field Wiring | Source | Destination | Notes |
| WCH | Wet Cake Bin 25CY Level Alarm 1 | BN | | | BN | High Level | LSH | 1101 | | LSH-1101 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Switch | PLC CP | |
| WCH | Wet Cake Bin 25CY Level Alarm 2 | BN | | | BN | High Level | LSH | 1102 | | LSH-1102 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Switch | PLC CP | |
| WCH | Wet Cake Bin 25CY Level Alarm 3 | BN | | | BN | High Level | LSH | 1201 | | LSH-1201 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Switch | PLC CP | |
| WCH | Wet Cake Bin 25CY Level Alarm 4 | BN | | | BN | High Level | LSH | 1202 | | LSH-1202 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Switch | PLC CP | |
| WCH | Wet Cake Bin 25CY Weight (Level) | WE | | | WE | Weight | WI | 1000 | | WI-1000 | AI | 4-20 mA | - | lbs | Cable/Twisted Shielded Pair 18 Gauge | Weigh Scale Panel | PLC CP | |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 1 | M | 1101 | | M1101 | Run Status | YS | 1101 | | YS-1101 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 1 | M | 1101 | | M1101 | Fail Status | XS | 1101 | | XS-1101 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 1 | M | 1101 | | M1101 | Auto Status | HS | 1101 | | HS-1101 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 1 | M | 1101 | | M1101 | Run Command | HC | 1101 | | HC-1101 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 1 | M | 1101 | | M1101 | Speed Reference | SC | 1101 | | SC-1101 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 1 | M | 1101 | | M1101 | Speed Feedback | SI | 1101 | | SI-1101 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 1 | M | 1101 | | M1101 | E-Stop | XSA | 1101 | | XSA-1101 | DI | Contact | Running | Stopped | Two #14 Stranded Wire | Pull Cord | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 1 | M | 1101 | | M1101 | E-Stop | XSB | 1101 | | XSB-1101 | DI | Contact | Running | Stopped | Two #14 Stranded Wire | Pull Cord | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 1 | M | 1101 | | M1101 | Speed Switch Low | SSL | 1101 | | SSL-1101 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Speed Switch | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 2 | M | 1102 | | M1102 | Run Status | YS | 1102 | | YS-1102 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 2 | M | 1102 | | M1102 | Fail Status | XS | 1102 | | XS-1102 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 2 | M | 1102 | | M1102 | Auto Status | HS | 1102 | | HS-1102 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 2 | M | 1102 | | M1102 | Run Command | HC | 1102 | | HC-1102 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 2 | M | 1102 | | M1102 | Speed Reference | SC | 1102 | | SC-1102 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 2 | M | 1102 | | M1102 | Speed Feedback | SI | 1102 | | SI-1102 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 2 | M | 1102 | | M1102 | E-Stop | XSA | 1102 | | XSA-1102 | DI | Contact | Running | Stopped | Two #14 Stranded Wire | Pull Cord | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 2 | M | 1102 | | M1102 | E-Stop | XSB | 1102 | | XSB-1102 | DI | Contact | Running | Stopped | Two #14 Stranded Wire | Pull Cord | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 2 | M | 1102 | | M1102 | Speed Switch Low | SSL | 1102 | | SSL-1102 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Speed Switch | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 3 | M | 1201 | | M1201 | Run Status | YS | 1201 | | YS-1201 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 3 | M | 1201 | | M1201 | Fail Status | XS | 1201 | | XS-1201 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 3 | M | 1201 | | M1201 | Auto Status | HS | 1201 | | HS-1201 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 3 | M | 1201 | | M1201 | Run Command | HC | 1201 | | HC-1201 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 3 | M | 1201 | | M1201 | Speed Reference | SC | 1201 | | SC-1201 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 3 | M | 1201 | | M1201 | Speed Feedback | SI | 1201 | | SI-1201 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 3 | M | 1201 | | M1201 | E-Stop | XSA | 1201 | | XSA-1201 | DI | Contact | Running | Stopped | Two #14 Stranded Wire | Pull Cord | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 3 | M | 1201 | | M1201 | E-Stop | XSB | 1201 | | XSB-1201 | DI | Contact | Running | Stopped | Two #14 Stranded Wire | Pull Cord | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 3 | M | 1201 | | M1201 | Speed Switch Low | SSL | 1201 | | SSL-1201 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Speed Switch | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 4 | M | 1202 | | M1202 | Run Status | YS | 1202 | | YS-1202 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 4 | M | 1202 | | M1202 | Fail Status | XS | 1202 | | XS-1202 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 4 | M | 1202 | | M1202 | Auto Status | HS | 1202 | | HS-1202 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 4 | M | 1202 | | M1202 | Run Command | HC | 1202 | | HC-1202 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 4 | M | 1202 | | M1202 | Speed Reference | SC | 1202 | | SC-1202 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 4 | M | 1202 | | M1202 | Speed Feedback | SI | 1202 | | SI-1202 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 4 | M | 1202 | | M1202 | E-Stop | XSA | 1202 | | XSA-1202 | DI | Contact | Running | Stopped | Two #14 Stranded Wire | Pull Cord | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 4 | M | 1202 | | M1202 | E-Stop | XSB | 1202 | | XSB-1202 | DI | Contact | Running | Stopped | Two #14 Stranded Wire | Pull Cord | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Live Bottom Screw 4 | M | 1202 | | M1202 | Speed Switch Low | SSL | 1202 | | SSL-1202 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Speed Switch | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 1 | M | 1001 | | M1001 | Run Status | YS | 1001 | | YS-1001 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 1 | M | 1001 | | M1001 | Fail Status | XS | 1001 | | XS-1001 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 1 | M | 1001 | | M1001 | Auto Status | HS | 1001 | | HS-1001 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 1 | M | 1001 | | M1001 | Run Command | HC | 1001 | | HC-1001 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 1 | M | 1001 | | M1001 | E-Stop | XSA | 1001 | | XSA-1001 | DI | Contact | Running | Stopped | Two #14 Stranded Wire | Pull Cord | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 1 | M | 1001 | | M1001 | E-Stop | XSB | 1001 | | XSB-1001 | DI | Contact | Running | Stopped | Two #14 Stranded Wire | Pull Cord | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 1 | M | 1001 | | M1001 | Speed Switch Low | SSL | 1001 | | SSL-1001 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Speed Switch | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 2 | M | 1002 | | M1002 | Run Status | YS | 1002 | | YS-1002 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 2 | M | 1002 | | M1002 | Fail Status | XS | 1002 | | XS-1002 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 2 | M | 1002 | | M1002 | Auto Status | HS | 1002 | | HS-1002 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 2 | M | 1002 | | M1002 | Run Command | HC | 1002 | | HC-1002 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 2 | M | 1002 | | M1002 | E-Stop | XSA | 1002 | | XSA-1002 | DI | Contact | Running | Stopped | Two #14 Stranded Wire | Pull Cord | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 2 | M | 1002 | | M1002 | E-Stop | XSB | 1002 | | XSB-1002 | DI | Contact | Running | Stopped | Two #14 Stranded Wire | Pull Cord | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Bin 25CY Leveling Screw 2 | M | 1002 | | M1002 | Speed Switch Low | SSL | 1002 | | SSL-1002 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Speed Switch | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pump 1 | M | 1121 | | M1121 | Temperature | TSH | 1121 | | TSH-1121 | DI | mV | - | Alarm | Two #14 Stranded Wire | Transmitter | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pump 1 | M | 1121 | | M1121 | Run Status | YS | 1121 | | YS-1121 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pump 1 | M | 1121 | | M1121 | Fail Status | XS | 1121 | | XS-1121 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pump 1 | M | 1121 | | M1121 | Auto Status | HS | 1121 | | HS-1121 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pump 1 | M | 1121 | | M1121 | Run Command | HC | 1121 | | HC-1121 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | Not in Veolia Scope |
| WCH | Wet Cake Pump 1 | M | 1121 | | M1121 | Speed Reference | SC | 1121 | | SC-1121 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pump 1 | M | 1121 | | M1121 | Speed Feedback | SI | 1121 | | SI-1121 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pump 2 | M | 1122 | | M1122 | Temperature | TSH | 1122 | | TSH-1122 | DI | mV | - | °F | Two #14 Stranded Wire | Transmitter | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pump 2 | M | 1122 | | M1122 | Run Status | YS | 1122 | | YS-1122 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pump 2 | M | 1122 | | M1122 | Fail Status | XS | 1122 | | XS-1122 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pump 2 | M | 1122 | | M1122 | Auto Status | HS | 1122 | | HS-1122 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pump 2 | M | 1122 | | M1122 | Run Command | HC | 1122 | | HC-1122 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | Not in Veolia Scope |
| WCH | Wet Cake Pump 2 | M | 1122 | | M1122 | Speed Reference | SC | 1122 | | SC-1122 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pump 2 | M | 1122 | | M1122 | Speed Feedback | SI | 1122 | | SI-1122 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | Not in Veolia Scope |
| WCH | Wet Cake Pumps 1 Inlet | | | | | Pressure | PIT | 1103 | | PIT-1103 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Transmitter | PLC CP | |
| WCH | Wet Cake Pumps 2 Inlet | | | | | Pressure | PIT | 1104 | | PIT-1104 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Transmitter | PLC CP | |
| WCH | Wet Cake Pumps 1 Discharge | | | | | Pressure | PIT | 1121 | | PIT-1121 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Transmitter | PLC CP | |
| WCH | Wet Cake Pumps 2 Discharge | | | | | Pressure | PIT | 1122 | | PIT-1122 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Transmitter | PLC CP | |
| WCH | Wet Cake to Dosing Header 1 Valve | AV | 1121 | | AV1121 | Open Status | ZSO | 1121 | | ZSO-1121 | DI | Contact | Not Fully Open | Fully Open | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Wet Cake to Dosing Header 1 Valve | AV | 1121 | | AV1121 | Closed Status | ZSC | 1121 | | ZSC-1121 | DI | Contact | Not Fully Closed | Fully Closed | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Wet Cake to Dosing Header 1 Valve | AV | 1121 | | AV1121 | Close Command | HC | 1121 | | HC-1121 | DO | Contact | - | Opened | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| WCH | Wet Cake to Dosing Header 2 Valve | AV | 1122 | | AV1122 | Open Status | ZSO | 1122 | | ZSO-1122 | DI | Contact | Not Fully Open | Fully Open | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Wet Cake to Dosing Header 2 Valve | AV | 1122 | | AV1122 | Closed Status | ZSC | 1122 | | ZSC-1122 | DI | Contact | Not Fully Closed | Fully Closed | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Wet Cake to Dosing Header 2 Valve | AV | 1122 | | AV1122 | Close Command | HC | 1122 | | HC-1122 | DO | Contact | - | Opened | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| WCH | Wet Cake Dryer Bypass Valve | AV | 1123 | | AV1123 | Open Status | ZSO | 1123 | | ZSO-1123 | DI | Contact | Not Fully Open | Fully Open | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Wet Cake Dryer Bypass Valve | AV | 1123 | | AV1123 | Closed Status | ZSC | 1123 | | ZSC-1123 | DI | Contact | Not Fully Closed | Fully Closed | Two #14 Stranded Wire | Valve Actuator | PLC CP | |

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**5700110005**

**PLC CP**

| | | Equipment Tag | | | | | Instrument Tag | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Equipment | Prefix | Number | Suffix | Tag | Signal | Prefix | Number | Suffix | Tag | I/O Type | Signal | Range/Off Status | Units/On Status | Suggested Field Wiring | Source | Destination | Notes |
| WCH | Dosing Header 1 Plant Effluent Flush Valve 1 | AV | 2114 | | AV2114 | Open Command | HC | 2114 | | HC-2114 | DO | Contact | - | Opened | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| WCH | Dosing Header 1 Plant Effluent Flush Valve 2 | AV | 2115 | | AV2115 | Open Command | HC | 2115 | | HC-2115 | DO | Contact | - | Opened | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| WCH | Dosing Header 1 Pressure Relief Valve 1 | AV | 2112 | | AV2112 | Open Status | ZSO | 2112 | | ZSO-2112 | DI | Contact | Not Fully Open | Fully Open | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Dosing Header 1 Pressure Relief Valve 1 | AV | 2112 | | AV2112 | Closed Status | ZSC | 2112 | | ZSC-2112 | DI | Contact | Not Fully Closed | Fully Closed | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Dosing Header 1 Pressure Relief Valve 1 | AV | 2112 | | AV2112 | Open Command | HC | 2112 | | HC-2112 | DO | Contact | - | Opened | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| WCH | Dosing Header 1 Pressure Relief Valve 2 | AV | 2113 | | AV2113 | Open Status | ZSO | 2113 | | ZSO-2113 | DI | Contact | Not Fully Open | Fully Open | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Dosing Header 1 Pressure Relief Valve 2 | AV | 2113 | | AV2113 | Closed Status | ZSC | 2113 | | ZSC-2113 | DI | Contact | Not Fully Closed | Fully Closed | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Dosing Header 1 Pressure Relief Valve 2 | AV | 2113 | | AV2113 | Open Command | HC | 2113 | | HC-2113 | DO | Contact | - | Opened | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| WCH | Dosing Header 1 Pressure | | | | | Pressure | PIT | 2110 | | PIT-2110 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Transmitter | PLC CP | |
| WCH | Dosing Header 2 Plant Effluent Flush Valve 1 | AV | 2124 | | AV2124 | Open Command | HC | 2124 | | HC-2124 | DO | Contact | - | Opened | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| WCH | Dosing Header 2 Plant Effluent Flush Valve 2 | AV | 2125 | | AV2125 | Open Command | HC | 2125 | | HC-2125 | DO | Contact | - | Opened | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| WCH | Dosing Header 2 Pressure Relief Valve 1 | AV | 2122 | | AV2122 | Open Status | ZSO | 2122 | | ZSO-2122 | DI | Contact | Not Fully Open | Fully Open | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Dosing Header 2 Pressure Relief Valve 1 | AV | 2122 | | AV2122 | Closed Status | ZSC | 2122 | | ZSC-2122 | DI | Contact | Not Fully Closed | Fully Closed | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Dosing Header 2 Pressure Relief Valve 1 | AV | 2122 | | AV2122 | Open Command | HC | 2122 | | HC-2122 | DO | Contact | - | Opened | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| WCH | Dosing Header 2 Pressure Relief Valve 2 | AV | 2123 | | AV2123 | Open Status | ZSO | 2123 | | ZSO-2123 | DI | Contact | Not Fully Open | Fully Open | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Dosing Header 2 Pressure Relief Valve 2 | AV | 2123 | | AV2123 | Closed Status | ZSC | 2123 | | ZSC-2123 | DI | Contact | Not Fully Closed | Fully Closed | Two #14 Stranded Wire | Valve Actuator | PLC CP | |
| WCH | Dosing Header 2 Pressure Relief Valve 2 | AV | 2123 | | AV2123 | Open Command | HC | 2123 | | HC-2123 | DO | Contact | - | Opened | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| WCH | Dosing Header 2 Pressure | | | | | Pressure | PIT | 2120 | | PIT-2120 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Transmitter | PLC CP | |
| WCH | Dosing Pump 1 | M | 2131 | | M2131 | Temperature | TSH | 2131 | | TSH-2131 | DI | mV | - | °F | Two #14 Stranded Wire | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 1 | M | 2131 | | M2131 | Run Status | YS | 2131 | | YS-2131 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 1 | M | 2131 | | M2131 | Fail Status | XS | 2131 | | XS-2131 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 1 | M | 2131 | | M2131 | Auto Status | HS | 2131 | | HS-2131 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 1 | M | 2131 | | M2131 | Run Command | HC | 2131 | | HC-2131 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | |
| WCH | Dosing Pump 1 | M | 2131 | | M2131 | Speed Reference | SC | 2131 | | SC-2131 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 1 | M | 2131 | | M2131 | Speed Feedback | SI | 2131 | | SI-2131 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 1 | M | 2131 | | M2131 | Discharge Pressure | PIT | 2131 | | PIT-2131 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 2 | M | 2132 | | M2132 | Temperature | TSH | 2132 | | TSH-2132 | DI | mV | - | °F | Two #14 Stranded Wire | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 2 | M | 2132 | | M2132 | Run Status | YS | 2132 | | YS-2132 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 2 | M | 2132 | | M2132 | Fail Status | XS | 2132 | | XS-2132 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 2 | M | 2132 | | M2132 | Auto Status | HS | 2132 | | HS-2132 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 2 | M | 2132 | | M2132 | Run Command | HC | 2132 | | HC-2132 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | |
| WCH | Dosing Pump 2 | M | 2132 | | M2132 | Speed Reference | SC | 2132 | | SC-2132 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 2 | M | 2132 | | M2132 | Speed Feedback | SI | 2132 | | SI-2132 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 2 | M | 2132 | | M2132 | Discharge Pressure | PIT | 2132 | | PIT-2132 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 3 | M | 2133 | | M2133 | Temperature | TSH | 2133 | | TSH-2133 | DI | mV | - | °F | Two #14 Stranded Wire | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 3 | M | 2133 | | M2133 | Run Status | YS | 2133 | | YS-2133 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 3 | M | 2133 | | M2133 | Fail Status | XS | 2133 | | XS-2133 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 3 | M | 2133 | | M2133 | Auto Status | HS | 2133 | | HS-2133 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 3 | M | 2133 | | M2133 | Run Command | HC | 2133 | | HC-2133 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | |
| WCH | Dosing Pump 3 | M | 2133 | | M2133 | Speed Reference | SC | 2133 | | SC-2133 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 3 | M | 2133 | | M2133 | Speed Feedback | SI | 2133 | | SI-2133 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 3 | M | 2133 | | M2133 | Discharge Pressure | PIT | 2133 | | PIT-2133 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 4 | M | 2134 | | M2134 | Temperature | TSH | 2134 | | TSH-2134 | DI | mV | - | °F | Two #14 Stranded Wire | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 4 | M | 2134 | | M2134 | Run Status | YS | 2134 | | YS-2134 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 4 | M | 2134 | | M2134 | Fail Status | XS | 2134 | | XS-2134 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 4 | M | 2134 | | M2134 | Auto Status | HS | 2134 | | HS-2134 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 4 | M | 2134 | | M2134 | Run Command | HC | 2134 | | HC-2134 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | |
| WCH | Dosing Pump 4 | M | 2134 | | M2134 | Speed Reference | SC | 2134 | | SC-2134 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 4 | M | 2134 | | M2134 | Speed Feedback | SI | 2134 | | SI-2134 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 4 | M | 2134 | | M2134 | Discharge Pressure | PIT | 2134 | | PIT-2134 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 5 | M | 2135 | | M2135 | Temperature | TSH | 2135 | | TSH-2135 | DI | mV | - | °F | Two #14 Stranded Wire | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 5 | M | 2135 | | M2135 | Run Status | YS | 2135 | | YS-2135 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 5 | M | 2135 | | M2135 | Fail Status | XS | 2135 | | XS-2135 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 5 | M | 2135 | | M2135 | Auto Status | HS | 2135 | | HS-2135 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 5 | M | 2135 | | M2135 | Run Command | HC | 2135 | | HC-2135 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | |
| WCH | Dosing Pump 5 | M | 2135 | | M2135 | Speed Reference | SC | 2135 | | SC-2135 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 5 | M | 2135 | | M2135 | Speed Feedback | SI | 2135 | | SI-2135 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 5 | M | 2135 | | M2135 | Discharge Pressure | PIT | 2135 | | PIT-2135 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 6 | M | 2136 | | M2136 | Temperature | TSH | 2136 | | TSH-2136 | DI | mV | - | °F | Two #14 Stranded Wire | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 6 | M | 2136 | | M2136 | Run Status | YS | 2136 | | YS-2136 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 6 | M | 2136 | | M2136 | Fail Status | XS | 2136 | | XS-2136 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 6 | M | 2136 | | M2136 | Auto Status | HS | 2136 | | HS-2136 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 6 | M | 2136 | | M2136 | Run Command | HC | 2136 | | HC-2136 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | |
| WCH | Dosing Pump 6 | M | 2136 | | M2136 | Speed Reference | SC | 2136 | | SC-2136 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 6 | M | 2136 | | M2136 | Speed Feedback | SI | 2136 | | SI-2136 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 6 | M | 2136 | | M2136 | Discharge Pressure | PIT | 2136 | | PIT-2136 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 7 | M | 2137 | | M2137 | Temperature | TSH | 2137 | | TSH-2137 | DI | mV | - | °F | Two #14 Stranded Wire | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 7 | M | 2137 | | M2137 | Run Status | YS | 2137 | | YS-2137 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 7 | M | 2137 | | M2137 | Fail Status | XS | 2137 | | XS-2137 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 7 | M | 2137 | | M2137 | Auto Status | HS | 2137 | | HS-2137 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 7 | M | 2137 | | M2137 | Run Command | HC | 2137 | | HC-2137 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | |
| WCH | Dosing Pump 7 | M | 2137 | | M2137 | Speed Reference | SC | 2137 | | SC-2137 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 7 | M | 2137 | | M2137 | Speed Feedback | SI | 2137 | | SI-2137 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 7 | M | 2137 | | M2137 | Discharge Pressure | PIT | 2137 | | PIT-2137 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 8 | M | 2138 | | M2138 | Temperature | TSH | 2138 | | TSH-2138 | DI | mV | - | °F | Two #14 Stranded Wire | Dosing Platform JB | PLC CP | |
| WCH | Dosing Pump 8 | M | 2138 | | M2138 | Run Status | YS | 2138 | | YS-2138 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 8 | M | 2138 | | M2138 | Fail Status | XS | 2138 | | XS-2138 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |

# Canton, GA Preliminary I/O List

**5700110005**

**PLC CP**

| | | Equipment Tag | | | | | Instrument Tag | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | **Equipment** | **Prefix** | **Number** | **Suffix** | **Tag** | **Signal** | **Prefix** | **Number** | **Suffix** | **Tag** | **I/O Type** | **Signal** | **Range/Off Status** | **Units/On Status** | **Suggested Field Wiring** | **Source** | **Destination** | **Notes** |
| WCH | Dosing Pump 8 | M | 2138 | | M2138 | Auto Status | HS | 2138 | | HS-2138 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Dosing Pump 8 | M | 2138 | | M2138 | Run Command | HC | 2138 | | HC-2138 | DO | Contact | Stopped | Running | Two #14 Stranded Wire | PLC CP | MCC | |
| WCH | Dosing Pump 8 | M | 2138 | | M2138 | Speed Reference | SC | 2138 | | SC-2138 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 8 | M | 2138 | | M2138 | Speed Feedback | SI | 2138 | | SI-2138 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Dosing Pump 8 | M | 2138 | | M2138 | Discharge Pressure | PIT | 2138 | | PIT-2138 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Dosing Platform JB | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| WCH | Depositor | M | 2139 | | M2139 | Forward Travel Limit | ZS | 2139 | C | ZS-2139C | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Depositor Control Box | PLC CP | |
| WCH | Depositor | M | 2139 | | M2139 | Reverse Travel Limit | ZS | 2139 | B | ZS-2139B | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Depositor Control Box | PLC CP | |
| WCH | Depositor | M | 2139 | | M2139 | Forward Over Travel Limit | ZS | 2139 | D | ZS-2139D | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Depositor Control Box | PLC CP | |
| WCH | Depositor | M | 2139 | | M2139 | Reverse Over Travel Limit | ZS | 2139 | A | ZS-2139A | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Depositor Control Box | PLC CP | |
| WCH | Depositor | M | 2139 | | M2139 | Run Status | YS | 2139 | | YS-2139 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Depositor | M | 2139 | | M2139 | Fail Status | XS | 2139 | | XS-2139 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Depositor | M | 2139 | | M2139 | Auto Status | HS | 2139 | | HS-2139 | DI | Contact | Hand/Off | Auto | Two #14 Stranded Wire | MCC | PLC CP | |
| WCH | Depositor | M | 2139 | | M2139 | Run Command | HC | 2139 | | HC-2139 | DO | Contact | Not Forward | Forward Start/Stop | Two #14 Stranded Wire | PLC CP | MCC | |
| WCH | Depositor | M | 2139 | | M2139 | Reverse Command | HCR | 2139 | | HCR-2139 | DO | Contact | Not Reverse | Reverse Start/Stop | Two #14 Stranded Wire | PLC CP | MCC | |
| WCH | Depositor | M | 2139 | | M2139 | Speed Reference | SC | 2139 | | SC-2139 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| WCH | Depositor | M | 2139 | | M2139 | Speed Feedback | SI | 2139 | | SI-2139 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| | | | | | | | | | | - | | | | | | | | |
| | Air Pre-Heater/Cooler Inlet | | | | | Temperature | TE/TIT | 5112 | | TE/TIT-5112 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| | Air Pre-Heater/Cooler Outlet | | | | | Temperature | TE/TIT | 5111 | | TE/TIT-5111 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| | Air Pre-Heater/Cooler | | | | | Differential Pressure | DPIT | 5110A | | DPIT-5110A | AI | 4-20 mA | | PSI | Cable/Twisted Shielded Pair 18 Gauge | Differential Pressure Trans | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| Inst Air | Air Compressor | M | 6001 | | M6001 | Run Status | YS | 6001 | | YS-6001 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | Compressor | PLC CP | |
| Inst Air | Air Compressor | M | 6001 | | M6001 | Fail Status | XS | 6001 | | XS-6001 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Compressor | PLC CP | |
| | | | | | | | | | | - | | | | | | | | |
| Dryer | Warm Zone Sprinkler Valve | AV | 6102 | | AV6102 | Open Command | HC | 6102 | | HC-6102 | DO | Contact | Open | Close | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| Dryer | End Zone Sprinkler Valve | AV | 6101 | | AV6101 | Open Command | HC | 6101 | | HC-6101 | DO | Contact | Open | Close | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| | | | | | | | | | | | | | | | | | | |
| Dryer | Sprinkler Water | | | | | Low Pressure | PSL | 6100 | | PSL-6100 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Pressure Switch | PLC CP | |
| | | | | | | | | | | - | | | | | | | | |
| Dryer | Top Belt Drive | M | 3101 | | M3101 | Run Status | YS | 3101 | | YS-3101 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Top Belt Drive | M | 3101 | | M3101 | Fail Status | XS | 3101 | | XS-3101 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Top Belt Drive | M | 3101 | | M3101 | Auto Status | HS | 3101 | | HS-3101 | DI | Contact | Hand/Off | Auto | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Top Belt Drive | M | 3101 | | M3101 | Run Command | HC | 3101 | | HC-3101 | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | MCC | |
| Dryer | Top Belt Drive | M | 3101 | | M3101 | Speed Feedback | SI | 3101 | | SI-3101 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| Dryer | Top Belt Drive | M | 3101 | | M3101 | Speed Reference | SC | 3101 | | SC-3101 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | MCC | |
| Dryer | Top Belt Drive | M | 3101 | | M3101 | Low Speed | SSL | 3101 | | SSL-3101 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Proximity Switch | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| Dryer | Bottom Belt Drive | M | 3102 | | M3102 | Run Status | YS | 3102 | | YS-3102 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Bottom Belt Drive | M | 3102 | | M3102 | Fail Status | XS | 3102 | | XS-3102 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Bottom Belt Drive | M | 3102 | | M3102 | Auto Status | HS | 3102 | | HS-3102 | DI | Contact | Hand/Off | Auto | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Bottom Belt Drive | M | 3102 | | M3102 | Run Command | HC | 3102 | | HC-3102 | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | MCC | |
| Dryer | Bottom Belt Drive | M | 3102 | | M3102 | Speed Feedback | SI | 3102 | | SI-3102 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| Dryer | Bottom Belt Drive | M | 3102 | | M3102 | Speed Reference | SC | 3102 | | SC-3102 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | MCC | |
| Dryer | Bottom Belt Drive | M | 3102 | | M3102 | Low Speed | SSL | 3102 | | SSL-3102 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Proximity Switch | PLC CP | |
| | | | | | | | | | | - | | | | | | | | |
| Dryer | Dryer | | | | | Pressure | PIT | 3100 | | PIT-3100 | AI | 4-20 mA | - | psi | Cable/Twisted Shielded Pair 18 Gauge | Pressure Transmitter | PLC CP | |
| Dryer | End Zone Bottom Belt | | | | | High Temperature 1 | TSH | 3110 | | TSH-3110 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Temperature Switch | PLC CP | |
| Dryer | End Zone Bottom Belt | | | | | High Temperature 2 | TSH | 3120 | | TSH-3120 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Temperature Switch | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| Dryer | Warm Zone Heat Exchanger Inlet | HTX | | | HTX | Temperature | TE/TIT | 3118 | | TE/TIT-3118 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| Dryer | Warm Zone Heat Exchanger Outlet | HTX | | | HTX | Temperature | TE/TIT | 3128 | | TE/TIT-3128 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| Dryer | Warm Zone | | | | | High Temperature 1 | TSH | 3150 | | TSH-3150 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Temperature Switch | PLC CP | |
| Dryer | Warm Zone | | | | | High Temperature 2 | TSH | 3160 | | TSH-3160 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Temperature Switch | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| Dryer | End Zone Top Belt | | | | | High Temperature 1 | TSH | 3130 | | TSH-3130 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Temperature Switch | PLC CP | |
| Dryer | End Zone Top Belt | | | | | High Temperature 2 | TSH | 3140 | | TSH-3140 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Temperature Switch | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| Dryer | Warm Zone Top Belt | | | | | High Level 1 | LSH | 3111 | | LSH-3111 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Level Switch | PLC CP | |
| | | | | | | | | 3121 | | | | | | | | | | |
| Dryer | End Zone Top Belt | | | | | High Level 1 | LSH | 3112 | | LSH-3112 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Level Switch | PLC CP | |
| | | | | | | | | 3122 | | -3122 | | | | | | | | |
| Dryer | Warm Zone Fan 1 | M | 3113 | | M3113 | Run Status | YS | 3113 | | YS-3113 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Warm Zone Fan 1 | M | 3113 | | M3113 | Fail Status | XS | 3113 | | XS-3113 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Warm Zone Fan 1 | M | 3113 | | M3113 | Auto Status | HS | 3113 | | HS-3113 | DI | Contact | Hand/Off | Auto | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Warm Zone Fan 1 | M | 3113 | | M3113 | Run Command | HC | 3113 | | HC-3113 | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | MCC | |
| Dryer | Warm Zone Fan 1 | M | 3113 | | M3113 | Speed Feedback | SI | 3113 | | SI-3113 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| Dryer | Warm Zone Fan 1 | M | 3113 | | M3113 | Speed Reference | SC | 3113 | | SC-3113 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | MCC | |
| | | | | | | | | | | | | | | | | | | |
| Dryer | Warm Zone Fan 2 | M | 3123 | | M3123 | Run Status | YS | 3123 | | YS-3123 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Warm Zone Fan 2 | M | 3123 | | M3123 | Fail Status | XS | 3123 | | XS-3123 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Warm Zone Fan 2 | M | 3123 | | M3123 | Auto Status | HS | 3123 | | HS-3123 | DI | Contact | Hand/Off | Auto | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Warm Zone Fan 2 | M | 3123 | | M3123 | Run Command | HC | 3123 | | HC-3123 | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | MCC | |
| Dryer | Warm Zone Fan 2 | M | 3123 | | M3123 | Speed Feedback | SI | 3123 | | SI-3123 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| Dryer | Warm Zone Fan 2 | M | 3123 | | M3123 | Speed Reference | SC | 3123 | | SC-3123 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | MCC | |
| | | | | | | | | | | | | | | | | | | |
| Dryer | End Zone Heat Exchanger Inlet | HTX | | | HTX | Temperature | TE/TIT | 3119 | | TE/TIT-3119 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| Dryer | End Zone Heat Exchanger Outlet | HTX | | | HTX | Temperature | TE/TIT | 3129 | | TE/TIT-3129 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| Dryer | Bottom Belt | | | | | Temperature 2 (IR) | TE/TIT | 3112 | | TE/TIT-3112 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| Dryer | Bottom Belt | | | | | Temperature 1 (IR) | TE/TIT | 3122 | | TE/TIT-3122 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| | | | | | | | | | | - | | | | | | | | |
| Dryer | End Zone Fan 1 | M | 3114 | | M3114 | Run Status | YS | 3114 | | YS-3114 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | End Zone Fan 1 | M | 3114 | | M3114 | Fail Status | XS | 3114 | | XS-3114 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | End Zone Fan 1 | M | 3114 | | M3114 | Auto Status | HS | 3114 | | HS-3114 | DI | Contact | Hand/Off | Auto | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | End Zone Fan 1 | M | 3114 | | M3114 | Run Command | HC | 3114 | | HC-3114 | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | MCC | |
| Dryer | End Zone Fan 1 | M | 3114 | | M3114 | Speed Feedback | SI | 3114 | | SI-3114 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| Dryer | End Zone Fan 1 | M | 3114 | | M3114 | Speed Reference | SC | 3114 | | SC-3114 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | MCC | |
| | | | | | | | | | | | | | | | | | | |
| Dryer | End Zone Fan 2 | M | 3124 | | M3124 | Run Status | YS | 3124 | | YS-3124 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | End Zone Fan 2 | M | 3124 | | M3124 | Fail Status | XS | 3124 | | XS-3124 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | End Zone Fan 2 | M | 3124 | | M3124 | Auto Status | HS | 3124 | | HS-3124 | DI | Contact | Hand/Off | Auto | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | End Zone Fan 2 | M | 3124 | | M3124 | Run Command | HC | 3124 | | HC-3124 | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | MCC | |
| Dryer | End Zone Fan 2 | M | 3124 | | M3124 | Speed Feedback | SI | 3124 | | SI-3124 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |

# Canton, GA Preliminary I/O List

**5700110005**

**PLC CP**

| | | Equipment Tag | | | | | Instrument Tag | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Equipment | Prefix | Number | Suffix | Tag | Signal | Prefix | Number | Suffix | Tag | I/O Type | Signal | Range/Off Status | Units/On Status | Suggested Field Wiring | Source | Destination | Notes |
| Dryer | End Zone Fan 2 | M | 3124 | | M3124 | Speed Reference | SC | 3124 | | SC-3124 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | MCC | |
| | | | | | | | | | | | | | | | | | | |
| Dryer | Extraction Screw Hopper | | | | | High Temperature 1 | TSH | 3115 | | TSH-3115 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Temperature Switch | PLC CP | |
| Dryer | Extraction Screw Hopper | | | | | High Temperature 2 | TSH | 3125 | | TSH-3125 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Temperature Switch | PLC CP | |
| Dryer | Extraction Screw Hopper | | | | | High Level | LSH | 3115 | | LSH-3115 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Level Switch | PLC CP | |
| | | | | | | | | 3125 | | | | | | | | | | |
| DSH | Extraction Screw (Dry Product) | M | 3106 | | M3106 | High Level | LSH | 3107 | | LSH-3107 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Level Switch | PLC CP | |
| DSH | Extraction Screw (Dry Product) | M | 3106 | | M3106 | Temperature 1 | TE/TIT | 3116 | | TE/TIT-3116 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| DSH | Extraction Screw (Dry Product) | M | 3106 | | M3106 | Temperature 2 | TE/TIT | 3126 | | TE/TIT-3126 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| DSH | Extraction Screw (Dry Product) | M | 3106 | | M3106 | Temperature 3 | TE/TIT | 3136 | | TE/TIT-3136 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| Dryer | Extraction Screw | M | 3106 | | M3106 | Run Status | YS | 3106 | | YS-3106 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Extraction Screw | M | 3106 | | M3106 | Fail Status | XS | 3106 | | XS-3106 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Extraction Screw | M | 3106 | | M3106 | Auto Status | HS | 3106 | | HS-3106 | DI | Contact | Hand/Off | Auto | Two #14 Stranded Wire | MCC | PLC CP | |
| Dryer | Extraction Screw | M | 3106 | | M3106 | Run Command | HC | 3106 | | HC-3106 | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | MCC | |
| Dryer | Extraction Screw | M | 3106 | | M3106 | Speed Feedback | SI | 3106 | | SI-3106 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| Dryer | Extraction Screw | M | 3106 | | M3106 | Speed Reference | SC | 3106 | | SC-3106 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | MCC | |
| Dryer | Extraction Screw | M | 3106 | | M3106 | E-Stop | XSA | 3106 | | XSA-3106 | DI | Contact | Alarm | Normal | Two #14 Stranded Wire | Switch | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| DAT | Condenser Inlet Air | | | | | Temperature | TE/TIT | 5106 | | TE/TIT-5106 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| DAT | Condenser Outlet Air | | | | | Temperature | TE/TIT | 5107 | | TE/TIT-5107 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| DAT | Condenser Inlet Water | | | | | Temperature | TE/TIT | 5100 | | TE/TIT-5100 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| DAT | Condenser Inlet Water | | | | | Flow | FE/FIT | 5101 | | FE/FIT-5101 | AI | 4-20 mA | - | MGD | Cable/Twisted Shielded Pair 18 Gauge | Flow Meter | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| DAT | Condenser Water Valve | CV | 5101 | | CV5101 | Position Reference | ZC | 5101 | | ZC-5101 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | CV8001 | |
| | | | | | | | | | | | | | | | | | | |
| DAT | Demister Water Valve | AV | 5100 | | AV5100 | Open Command | HC | 5100 | | HC-5100 | DO | Contact | 0 | Open | Two #14 Stranded Wire | PLC CP | Valve Actuator | |
| | | | | | | | | | | | | | | | | | | |
| DAT | Condenser Water (Drain) | | | | | Temperature | TE/TIT | 5105 | | TE/TIT-5105 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Temperature Transmitter | PLC CP | |
| DAT | Condenser Water | | | | | High Level | LSH | 5104 | | LSH-5104 | DI | Contact | - | °F | Two #14 Stranded Wire | Level Switch | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| DAT | Condenser Column | | | | | Differential Pressure | DPIT | 5103 | | DPIT-5103 | AI | 4-20 mA | | PSI | Cable/Twisted Shielded Pair 18 Gauge | Differential Pressure Trans | PLC CP | |
| DAT | Demistor | | | | | Differential Pressure | DPIT | 5102 | | DPIT-5102 | AI | 4-20 mA | | PSI | Cable/Twisted Shielded Pair 18 Gauge | Differential Pressure Trans | PLC CP | |
| | | | | | | | | | | | | | | | | | | |
| DAT | Drying Air Treatment Fan | M | 5108 | | M5108 | Run Status | YS | 5108 | | YS-5108 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| DAT | Drying Air Treatment Fan | M | 5108 | | M5108 | Fail Status | XS | 5108 | | XS-5108 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| DAT | Drying Air Treatment Fan | M | 5108 | | M5108 | Auto Status | HS | 5108 | | HS-5108 | DI | Contact | Hand/Off | Auto | Two #14 Stranded Wire | MCC | PLC CP | |
| DAT | Drying Air Treatment Fan | M | 5108 | | M5108 | Run Command | HC | 5108 | | HC-5108 | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | MCC | |
| DAT | Drying Air Treatment Fan | M | 5108 | | M5108 | Speed Feedback | SI | 5108 | | SI-5108 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| DAT | Drying Air Treatment Fan | M | 5108 | | M5108 | Speed Reference | SC | 5108 | | SC-5108 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | MCC | |
| | | | | | | | | | | | | | | | | | | |
| DAT | Vacuum Fan | M | 5109 | | M5109 | Run Status | YS | 5109 | | YS-5109 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| DAT | Vacuum Fan | M | 5109 | | M5109 | Fail Status | XS | 5109 | | XS-5109 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| DAT | Vacuum Fan | M | 5109 | | M5109 | Auto Status | HS | 5109 | | HS-5109 | DI | Contact | Hand/Off | Auto | Two #14 Stranded Wire | MCC | PLC CP | |
| DAT | Vacuum Fan | M | 5109 | | M5109 | Run Command | HC | 5109 | | HC-5109 | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | MCC | |
| DAT | Vacuum Fan | M | 5109 | | M5109 | Speed Feedback | SI | 5109 | | SI-5109 | AI | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | MCC | PLC CP | |
| DAT | Vacuum Fan | M | 5109 | | M5109 | Speed Reference | SC | 5109 | | SC-5109 | AO | 4-20 mA | 0-100 | % | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | MCC | |
| | | | | | | | | | | | | | | | | | | |
| Air Heater | Thermal Oil System Thermal Heater Flow Alarm | | | | | Alarm Status | XSA | | | XSA- | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Thermal Oil LCP | PLC CP | |
| Air Heater | Thermal Oil System Siemens Controller Alarm | | | | | Alarm Status | XSB | | | XSB- | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | Thermal Oil LCP | PLC CP | |
| Air Heater | Thermal Oil System Main Oil Valves On | | | | | Open Status | ZSO | | | ZSO- | DI | Contact | Closed | Open | Two #14 Stranded Wire | Thermal Oil LCP | PLC CP | |
| Air Heater | Thermal Oil System Remote Control Mode On | | | | | Remote Status | YSA | | | YSA- | DI | Contact | Local | Remote | Two #14 Stranded Wire | Thermal Oil LCP | PLC CP | |
| Air Heater | Thermal Oil System Heater Remote Setpoint Selected | | | | | Remote Status | YSB | | | YSB- | DI | Contact | Local | Remote | Two #14 Stranded Wire | Thermal Oil LCP | PLC CP | |
| Air Heater | Thermal Oil System Secondary Loop Heat Mode | | | | | Run Status | YSC | | | YSC- | DI | Contact | Off | Running | Two #14 Stranded Wire | Thermal Oil LCP | PLC CP | |
| Air Heater | Thermal Oil System Secondary Loop Remote Setpoint Enabled | | | | | Remote Status | YSD | | | YSD- | DI | Contact | Local | Remote | Two #14 Stranded Wire | Thermal Oil LCP | PLC CP | |
| Air Heater | Thermal Oil System Remote Start/Stop (Maintained) | | | | | Start/Stop | HCA | | | HCA- | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | Thermal Oil LCP | |
| Air Heater | Thermal Oil System Remote Thermal Pump Start (Momentary) | | | | | Start | HCB | | | HCB- | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | Thermal Oil LCP | |
| Air Heater | Thermal Oil System Remote Burner Start/Stop (Maintained) | | | | | Start/Stop | HCC | | | HCC- | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | Thermal Oil LCP | |
| | | | | | | | | | | | | | | | | | | |
| Air Heater | Thermal Oil System 3-way Valve Setpoint | | | | | Temperature | TC | 4008 | | TC-4008 | AO | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | Thermal Oil LCP | |
| Air Heater | Thermal Oil System Stack Temperature (0-1400°F) | | | | | Temperature | TI | 4030 | | TI-4030 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Thermal Oil LCP | PLC CP | |
| Air Heater | Thermal Oil System Outlet Temperature (0-650°F) | | | | | Temperature | TI | 4015 | | TI-4015 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Thermal Oil LCP | PLC CP | |
| Air Heater | Thermal Oil System Heater Remote Setpoint (32-650°F) | | | | | Temperature | TC | 4001 | | TC-4001 | AO | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | Thermal Oil LCP | |
| Air Heater | Thermal Oil System Secondary Loop Temperature (0-650°F) | | | | | Temperature | TI | 4018 | | TI-4018 | AI | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | Thermal Oil LCP | PLC CP | |
| Air Heater | Thermal Oil System Secondary Loop Setpoint (0-600°F) | | | | | Position | TC | 4018 | | TC-4018 | AO | 4-20 mA | - | °F | Cable/Twisted Shielded Pair 18 Gauge | PLC CP | Control Valve | |
| | | | | | | | | | | | | | | | | | | |
| Air Heater | Thermal Oil System Fill Pump | M | 4040 | | M4040 | Run Status | YS | 4040 | | YS-4040 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| Air Heater | Thermal Oil System Fill Pump | M | 4040 | | M4040 | Fail Status | XS | 4040 | | XS-4040 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| Air Heater | Thermal Oil System Fill Pump | M | 4040 | | M4040 | Auto Status | HS | 4040 | | HS-4040 | DI | Contact | Hand/Off | Auto | Two #14 Stranded Wire | MCC | PLC CP | |
| Air Heater | Thermal Oil System Fill Pump | M | 4040 | | M4040 | Run Command | HC | 4040 | | HC-4040 | DO | Contact | Stop | Start | Two #14 Stranded Wire | PLC CP | MCC | |
| | | | | | | | | | | | | | | | | | | |
| DSH | Rotary Valve | M | 3107 | | M3107 | Run Status | YS | 3107 | | YS-3107 | DI | Contact | Stopped | Running | Two #14 Stranded Wire | MCC | PLC CP | |
| DSH | Rotary Valve | M | 3107 | | M3107 | Fail Status | XS | 3107 | | XS-3107 | DI | Contact | Normal | Alarm | Two #14 Stranded Wire | MCC | PLC CP | |
| DSH | Rotary Valve | M | 3107 | | M3107 | Auto Status | HS | 3107 | | HS-3107 | DI | Contact | Hand/Off | Auto | Two #14 Stranded Wire | MCC | PLC CP | |

| I/O Totals | | Totals | With 20% Spare | PLC Cards | |
|---|---|---|---|---|---|
| Digital Inputs | DI | 160 | 192 | 12 | 16 Pt Digital Input |
| Digital Outputs | DO | 45 | 54 | 4 | 16 Pt Digital Output |
| Analog Inputs | AI | 62 | 75 | 5 | 16 Pt Analog Input |
| Analog Outputs | AO | 28 | 34 | 5 | 8 Pt Analog Output |
| | | **Card Totals** | 355 | 26 | |

PACKAGE NAME: CANTON PID
PROJECT NUMBER: 5700110005
PROJECT NAME: CANTON, GA

# MD TABLE OF CONTENTS

**Markup Legend**
**Red** - Add
**Green** - Delete
**Blue** - Note to Designer


REVISION: C
CREATED BY: MJG

| ITEM | DRAWING NUMBER | DESCRIPTION | REVISION |
|---|---|---|---|
| 1 | PID-1101 | P&ID SYMBOL LEGEND<br>LINE TYPES & IDENTIFICATION | 16 |
| 2 | PID-1102 | P&ID SYMBOL LEGEND<br>EQUIPMENT SYMBOLS | 19 |
| 3 | 850P-0000 | PROCESS FLOW DIAGRAM | B |
| 4 | 850P-1000 | PIPING & INSTRUMENTATION DIAGRAM<br>WET CAKE HANDLING (WCH) | B |
| 5 | 850P-1001 | PIPING & INSTRUMENTATION DIAGRAM<br>WET CAKE HANDLING (WCH) | B |
| 6 | 850P-2100 | PIPING & INSTRUMENTATION DIAGRAM<br>DOSING PUMP MANIFOLD 1 | A |
| 7 | 850P-2101 | PIPING & INSTRUMENTATION DIAGRAM<br>DOSING PUMP MANIFOLD 2 | A |
| 8 | 850P-2102 | PIPING & INSTRUMENTATION DIAGRAM<br>DOSING PUMPS (1-4) | A |
| 9 | 850P-2103 | PIPING & INSTRUMENTATION DIAGRAM<br>DOSING PUMPS (5-8) | A |
| 10 | 850P-2104 | PIPING & INSTRUMENTATION DIAGRAM<br>DEPOSITORS | A |
| 11 | 850P-3100 | PIPING & INSTRUMENTATION DIAGRAM<br>SLUDGE DRYER | B |
| 12 | 850P-4100 | PIPING & INSTRUMENTATION DIAGRAM<br>THERMAL FLUID HEATER SKID | A |
| 13 | 850P-5100 | PIPING & INSTRUMENTATION DIAGRAM<br>DRYING AIR TREATMENT | B |
| 14 | 850P-6000 | PIPING & INSTRUMENTATION DIAGRAM<br>NOZZLE CLEANING AND SPRINKLER WATER | C |
| 15 | T43-550835 | PIPING DIAGRAM FOR HEATER, | B |
| 16 | T43-550835 | PIPING DIAGRAM FOR HEATER, | B |

KRÜGER

PACKAGE NAME: CANTON PID
PROJECT NUMBER: 5700110005
PROJECT NAME: CANTON, GA

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## REVISION TABLE



| REV | CREATED | APPR | DATE | DESCRIPTION |
|---|---|---|---|---|
| A | MJG | HJH | 06.15.20 | PRELIMINARY RELEASE |
| B | MAB | HJH | 06.26.20 | ADDED TURBO HTXs. VARIOUS MARKUPS. |
| C | MJG | SRW | 08.18.20 | REVISED 850P-5101 & 850P-6000 |
| | | | | |

KRÜGER

# INSTRUMENT IDENTIFICATION

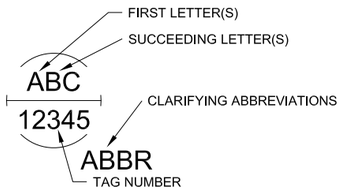
## COMPUTER SYSTEM INTERFACES

- ▲ ANALOG INPUT
- ▼ ANALOG OUTPUT
- △ DISCRETE INPUT
- ▽ DISCRETE OUTPUT

## GENERAL INSTRUMENT OR FUNCTION SYMBOLS

- XXX / XXX — FIELD MOUNTED INSTRUMENT
- XX / XXX / XXX — PLC PANEL MOUNTED INSTRUMENT (OPERATOR INACCESSIBLE)
- XX / XXX / XXX — PLC PANEL MOUNTED INSTRUMENT (OPERATOR ACCESSIBLE)
- XX / XXX / XXX — SECONDARY PANEL MOUNTED INSTRUMENT (OPERATOR INACCESSIBLE)
- XX / XXX / XXX — SECONDARY PANEL MOUNTED INSTRUMENT (OPERATOR ACCESSIBLE)
- XX / XXX / XXX — COMPUTER FUNCTION
- XXX / XXX — PLC FUNCTION
- XXX / XXX — SHARED DISPLAY, SHARED CONTROL

## EXAMPLE SYMBOLS




AIT / 7015 / TURB — TURBIDITY ANALYZER & TRANSMITTER (FIELD INSTRUMENT)

PIR / 2217 — PRESSURE INDICATOR & RECORDER (PLC FUNCTION)

## INSTRUMENT SOCIETY OF AMERICA TABLE

| LETTER | FIRST-LETTER | | SUCCEEDING-LETTERS | | |
|---|---|---|---|---|---|
| | PROCESS OR INITIATING VARIABLE | MODIFIER | READOUT OR PASSIVE FUNCTION | OUTPUT FUNCTION | MODIFIER |
| A | ANALYSIS (+) | | ALARM | | |
| B | BURNER, COMBUSTION | | USER'S CHOICE (*) | USER'S CHOICE (*) | USER'S CHOICE (*) |
| C | USER'S CHOICE (*) | | USER'S CHOICE (*) | CONTROL | USER'S CHOICE (*) |
| D | USER'S CHOICE | DIFFERENTIAL | | | |
| E | VOLTAGE | | PRIMARY ELEMENT (SENSOR) | | |
| F | FLOW RATE | RATIO (FRACTION) | | | |
| G | USER'S CHOICE (*) | | GLASS, GAUGE VIEWING DEVICE | GATE | |
| H | HAND (MANUAL) | | | | HIGH |
| I | CURRENT (ELECTRICAL) | | INDICATE | | |
| J | POWER | SCAN | | | |
| K | TIME, TIME SCHEDULE | TIME RATE OF CHANGE | | CONTROL STATION | |
| L | LEVEL | | LIGHT (PILOT) | | LOW |
| M | USER'S CHOICE (*) | MOMENTARY | | | MIDDLE |
| N | USER'S CHOICE (*) | | USER'S CHOICE (*) | USER'S CHOICE (*) | USER'S CHOICE (*) |
| O | USER'S CHOICE (*) | | USER'S CHOICE (*) | | |
| P | PRESSURE, VACUUM | | POINT (TEST) CONNECTION | | |
| Q | QUANTITY | INTEGRATE, TOTALIZE | | | |
| R | RADIATION | | RECORD OR PRINT | | |
| S | SPEED, FREQUENCY | SAFETY | | SWITCH | |
| T | TEMPERATURE | | | TRANSMIT | |
| U | MULTIVARIABLE | | MULTIFUNCTION | MULTIFUNCTION | MULTIFUNCTION |
| V | VIBRATION, MECHANICAL ANALYSIS | | | VALVE, DAMPER, LOUVER | |
| W | WEIGHT, FORCE | | WELL | | |
| X | UNCLASSIFIED (+) | X AXIS | UNCLASSIFIED (+) | UNCLASSIFIED (+) | UNCLASSIFIED (+) |
| Y | EVENT, STATE OR PRESENCE | Y AXIS | | RELAY, COMPUTE, CONVERT | |
| Z | POSITION, DIMENSION | Z AXIS | | DRIVE, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT | |

(+) WHEN USED, EXPLANATION IS SHOWN ADJACENT TO INSTRUMENT SYMBOL. SEE ABBREVIATIONS AND LETTER SYMBOLS.

(*) WHEN USED, DEFINE THE MEANING HERE FOR THE PROJECT

## ABBREVIATIONS

| | |
|---|---|
| AM | AUTO-MANUAL |
| CP | CONTROL PANEL NO. X |
| DO | DISSOLVED OXYGEN |
| ENC | ENCODER |
| FP | FIELD PANEL |
| FR | FORWARD-REVERSE |
| HOA | HAND-OFF-AUTO |
| HOR | HAND-OFF-REMOTE |
| ISR | INTRINSICALLY SAFE RELAY |
| LCP | LOCAL CONTROL PANEL |
| LOS | LOCKOUT STOP |
| LR | LOCAL-REMOTE |
| MA | MANUAL-AUTO |
| MCC | MOTOR CONTROL CENTER |
| NH3-N | AMMONIA NITROGEN |
| NO3-N | NITRATE NITROGEN |
| NO2-N | NITRITE NITROGEN |
| OC | OPEN-CLOSE (D) |
| OCR | OPEN-CLOSE-REMOTE |
| OCA | OPEN-CLOSE-AUTO |
| OO | ON-OFF |
| OOA | ON-OFF-AUTO |
| OOR | ON-OFF-REMOTE |
| OSC | OPEN-STOP-CLOSE |
| PLC | PROGRAMMABLE LOGIC CONTROLLER |
| PO4-P | ORTHO PHOSPHATE |
| RIO | REMOTE I/O UNIT |
| RM | REMOTE MULTIPLEXING MODULE |
| RTU | REMOTE TELEMETRY UNIT |
| SS | START-STOP |
| SSC | SUPERVISORY SET POINT CONTROL |
| TEMP | TEMPERATURE |
| TURB | TURBIDIMETER |
| PH | PH PROBE |
| ORP | OXYGEN REDUCTION POTENTIAL |
| TSS | TOTAL SUSPENDED SOLIDS |

# LINE LEGEND

- PROCESS (BY OTHERS)
- PROCESS (BY KRUGER)
- PROCESS (OPEN CHANNEL)
- ELECTRICAL SIGNAL
- PNEUMATIC SIGNAL
- DATA LINK
- SKIDS OR GROUPINGS
- PLC
- DUCTING
- INSULATED DUCTING
- REFRACTING DUCTING
- INSULATED LINE (H)
  - A - ACOUSTICAL INSULATION
  - C - COLD CONSERVATION
  - H - HEAT CONSERVATION
  - I - ANTI-FREEZING
  - P - PERSONAL PROTECTION
- TRACED AND INSULATED LINE (E)
  - E - ELECTRICAL TRACING
  - S - STEAM TRACING

PARALLELING LINES

(2) (A) 3(2) (B)

A) TOTAL OF 2 SIGNALS
B) 3 TYPICAL SETS OF 2 SIGNALS EACH. TOTAL OF 6 SIGNALS.

NON-CONNECTING LINES

OR

# INTERFACE SYMBOLS

LT DESC A 650P-2202 — DRAWING INTERFACES

EXTERNAL INTERFACE — EXTERNAL INTERFACES

FROM A1

TO A1

LINE BREAK (INSTRUMENTATION TO I/O)

# EQUIPMENT TAG NUMBERS

(SPECIFIC TO PROJECT)

# FLOW STREAM IDENTIFICATION

FLOW STREAM IDENTIFICATION NOMENCLATURE:

3"-AHP-SS
- SS — NOMINAL LINE SIZE
- AHP — LINE IDENTIFICATION
- - — LINE MATERIAL OF CONSTRUCTION

| | | | |
|---|---|---|---|
| AHP | AIR, HIGH PRESSURE PROCESS | RHW | RECIRCULATED HOT WATER |
| AI | AIR, INSTRUMENT | RS | RAW SEWAGE |
| AL | ALUM | RSD | RECIRCULATED SLUDGE |
| ALP | AIR, LOW PRESSURE PROCESS | RW | RECLAIMED WATER |
| APO | ANIONIC POLYMER | S | SANITARY SEWER (GRAVITY) |
| BDS | BLENDED DIGESTED SLUDGE | SA | SAMPLE |
| BWS | BACKWASH SUPPLY | SC | COLD SLUDGE |
| BWW | BACKWASH WASTEWATER | SE | SECONDARY EFFLUENT |
| BYP | BYPASS | SH | HEATED SLUDGE |
| CHS | CHEMICAL SLUDGE | SL | SUPERNATANT LIQUOR |
| CL | CHLORINE LIQUID | SSM | SECONDARY SCUM |
| CO | CONDENSATE DRAIN | SUP | SUPERNATANT |
| CPO | CATIONIC POLYMER | SW | SURFACE WASH |
| CS | CHLORINE SOLUTION | TC | THICKENING CENTRATE RECYCLE |
| CWR | COOLING WATER RETURN | TPS | THICKENED PRIMARY SLUDGE |
| CWS | COOLING WATER SUPPLY | TUF | THICKENER UNDERFLOW |
| D | DRAIN (SANITARY) | TWAS | THICKENED WASTE ACTIVATED SLUDGE |
| DAS | DIGESTED ACTIVATED SLUDGE | V | VENT |
| DEO | DIGESTED EMERGENCY OVERFLOW | VAC | VACUUM |
| DG | DIGESTER/SEWAGE GAS | WAS | WASTE ACTIVATED SLUDGE |
| DR | DRAIN (EQUIPMENT) | 1W | POTABLE WATER |
| DS | DIGESTED SLUDGE | 2W | NON-POTABLE WATER (CHLORINATED EFFLUENT) |
| DSC | DEWATERED SLUDGE CAKE | 2WR | NON-POTABLE WATER RETURN |
| EBYP | EMERGENCY BYPASS LINE | | |
| EO | EMERGENCY OVERFLOW | | |
| F | FILTRATE | | |
| FC | FERRIC CHLORIDE | | |
| FE | FILTER EFFLUENT | | |
| FI | FILTER INFLUENT | | |
| FTW | FILTER TO WASTE | | |
| G | NATURAL GAS | | |
| HPR | HIGH PRESSURE RETURN (CONDENSATE) | | |
| HPS | HIGH PRESSURE STEAM | | |
| HWR | HEATING WATER RETURN | | |
| HWS | HEATING WATER SUPPLY | | |
| LPG | LIQUIFIED PETROLEUM GAS | | |
| LPO | LIQUID POLYMER | | |
| LPR | LOW PRESSURE RETURN (CONDENSATE) | | |
| LPS | LOW PRESSURE STEAM | | |
| ML | MIXED LIQUOR | | |
| MOL | METHANOL | | |
| MPR | MEDIUM PRESSURE RETURN (CONDENSATE) | | |
| MPS | MEDIUM PRESSURE STEAM | | |
| MS | METHANOL SOLUTION | | |
| NAOH | SODIUM HYDROXIDE | | |
| NE | NITRIFICATION EFFLUENT | | |
| OA | ODOROUS AIR | | |
| OF | OVERFLOW | | |
| OXY | OXYGEN | | |
| P | PROPANE GAS | | |
| PD | PLANT DRAIN | | |
| PE | PRIMARY EFFLUENT | | |
| PI | PRIMARY INFLUENT | | |
| PLE | PLANT EFFLUENT | | |
| PO | POLYMER SOLUTION | | |
| PSD | PRIMARY SLUDGE | | |
| PSM | PRIMARY SCUM | | |
| RA | RETURN AIR | | |
| RAS | RETURN ACTIVATED SLUDGE | | |
| RCY | RECYCLE | | |

# GENERAL NOTES

1. THIS IS A STANDARD LEGEND. THEREFORE, NOT ALL OF THIS INFORMATION MAY BE USED ON THIS PROJECT.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| 16 | UPDATED INSTRUMENT SYMBOLS | MRJB | . | 03.13.19 |
| 15 | REV'D LINE BREAK, ADDED ABBRS | SRW | . | 05.26.15 |
| 14 | REV'D DWG INTERFACE, ADDED EXT INTERFACE | SRW | . | 06.11.12 |



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STANDARD

P&ID SYMBOL LEGEND
LINE TYPES & IDENTIFICATION

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| DSD | CHG | 1 : 2 | PID-1101 | 1 of 1 | 16 |

## VALVE SYMBOLS

- BACKFLOW PREVENTER
- BALL
- BALL CHECK
- BUTTERFLY
- DIAPHRAGM
- GATE
- GLOBE
- KNIFE GATE
- MUD
- NEEDLE
- PINCH
- PLUG
- ROTARY
- SEAT PORT ECCENTRIC PLUG
- SWING CHECK
- TELESCOPING
- VEE- BALL
- DISC CHECK

## OTHER VALVE SYMBOLS

- AIR AND/OR VACUUM RELEASE
- ANGLE GATE
- MULTI-PORT VALVES
- REGULATED SIDE PRESSURE CONTROL
- PRESSURE RELIEF
- SAMPLE

## ACTUATOR SYMBOLS

- ELECTRIC MOTOR
- ELECTROHYRAULIC
- HYDRAULIC
- PNEUMATIC CYLINDER
- PNEUMATIC DIAPHRAGM SPRING-OPPOSED
- PNEUMATIC VANE
- SOLENOID
- VALVE POSITIONER

NOTE:
ON LOSS OF PRIMARY POWER
(PNEUMATIC, ELECTRICAL OR HYDRAULIC)

XX: FO FAIL OPEN
FC FAIL CLOSED
FL FAIL TO LAST POSITION

## GATE SYMBOLS

- BUTTERFLY
- FABRICATED SLIDE
- FLAP
- FLOW DISTRIBUTION
- SHEAR
- SLUICE
- STOP LOG/HAND PULL

## BLOWER SYMBOLS

- BLOWER (POSITIVE DISPLACEMENT)
- BLOWER/FAN (CENTRIFUGAL)
- AXIAL FAN

## PUMP SYMBOLS

- CENTRIFUGAL (DRY PIT)
- CENTRIFUGAL (WET PIT) OR TURBINE
- DIAPHRAGM
- PERISTALTIC
- PISTON
- PROGRESSING
- RECIPROCATING/METERING (POSITIVE DISPLACEMENT)
- ROTARY
- SCREW
- SUBMERSIBLE
- VACUUM

## PRIMARY ELEMENT SYMBOLS

- ELECTROMAGNETIC FLOWMETER
- LEVEL (FLOAT SWITCH OR OR SUBMERSIBLE PROBE)
- PITOT-STATIC
- PROPELLER OR TURBINE METER
- ROTAMETER
- SUBMERSIBLE PRESSURE TRANSMITTER
- THERMAL FLOWMETER
- ULTRASONIC FLOWMETER
- ULTRASONIC LEVEL
- VORTEX METER

## EQUIPMENT & MISCELLANEOUS SYMBOLS

NOTE:
XX = EQUIPMENT TAG NUMBER

- AERATION GRID
- AIR GAP
- ANNULAR DIAPHRAGM SEAL
- ARROW HEAD (FLOW DIRECTION)
- BASKET STRAINER
- BURNER
- CALIBRATION COLUMN
- COMPOSITE SAMPLER
- COMPRESSOR (CENTRIFUGAL)
- COMPRESSOR (ROTARY SCREW)
- COMPRESSOR (PISTON)
- CRUSHER
- DIAPHRAGM SEAL
- DRAIN
- DRIP TRAP
- DYNAMIC MIXER
- EJECTOR
- ELECTRIC MOTOR
- ELECTRIC MOTOR (VARIABLE SPEED )
- ELECTRIC MOTOR & SLUDGE GRINDER
- EXPANSION TANK
- EXPANSION JOINT
- FILTER
- FILTER/ REGULATOR/ GAUGE SET
- FLEXIBLE COUPLING
- FLOW TUBE
- FLUSHING CONNECTION
- HEAT EXCHANGER
- HORN
- HOSE ADAPTOR
- HYDROCYCLONE
- INTRINSICALLY SAFE RELAY
- INTERLOCK (SQUARE)
- INTERLOCK (RECTANGULAR)
- INLINE SILENCER
- MIXER
- MIXER (IN-LINE)
- MIXER (STATIC)
- ORIFICE PLATE
- PARSHALL FLUME
- PIG INSERT POINT
- PIG CATCH POINT
- PIPE REDUCER (CONCENTRIC)
- PIPE REDUCER (ECCENTRIC)
- PIPE FLANGE
- PIPE CAP
- PLUG
- AIR SET (?? = SUPPLY PRESSURE IN PSIG, IA = )
- PULSATION DAMPENER
- RECEPTACLE
- ROTATING DRUM SCREEN (WATER FLUSH)
- ROTATING DRUM SCREEN (MECHANICAL SCRAPER)
- RUPTURE DISK (PRESSURE)
- RUPTURE DISK (VACUUM)
- SCREEN
- SCREW CONVEYOR
- SIGHT GLASS
- SIGHT GLASS LEVEL
- SIPHON LOOP ( INSTRUMENT )
- SKIMMING MECHANISM
- SLOPE 1% MINIMUM
- SPECTACLE FLANGE
- STEAM TRAP
- SURFACE AERATOR
- VENT TO ATMOSPHERE
- VICTAULIC COUPLING
- WEIR
- Y-STRAINER
- DESUPERHEATER
- BUCKET ELEVATOR
- INSULATION
- EMERGENCY STOP
- JET AERATION GRID
- AERATOR
- FLOATING DECANTER
- SPRAY NOZZLE
- OTHER KRUGER SCOPE OF SUPPLY

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| 19 | UPDATED PUMP SYMBOLS | MRJB | SRW | 04.12.19 |
| 18 | ADDED AERATOR & FLOATING DECANTER SYMBOLS | MRJB | SRW | 08.06.18 |



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STANDARD

# P&ID SYMBOL LEGEND EQUIPMENT SYMBOLS

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| CDP | GAT | 1 : 2 | PID-1102 | 1 of 1 | 19 |

POTABLE WATER

All water lines fed with potable water

PROCESS AREA 6000
NOZZLE CLEANING STATION

PROCESS AREA 6000
SPRINKLER WATER

PROCESS AREA 5100
DRYING AIR TREATMENT FAN

PROCESS AREA 5100
VACUUM FAN

PROCESS AREA 5101
AIR PRE-HEATER

PROCESS AREA 5100
CONDENSER

PROCESS AREA 5101
WATER CIRCULATION PUMP

TRUCK (BY OTHERS)

PROCESS AREA 5101
AIR COOLER

PROCESS AREA 3100
ROTARY AIRLOCK

PROCESS AREA 1100
WET CAKE PUMPS (BY OTHERS)

PROCESS AREA 2100
DOSING PUMP MANIFOLDS

PROCESS AREA 2100
DOSING PUMPS

PROCESS AREA 3100
DRYER

DRY PRODUCT CONVEYANCE (BY OTHERS)

BELT FILTER PRESS (BY OTHERS)

PROCESS AREA 1000
WET CAKE BIN (BY OTHERS)

PROCESS AREA 4100
THERMAL FLUID SKID

PLANT DRAIN

WET CAKE CONVEYANCE (BY OTHERS)

PROCESS AREA 9000
ODOR CONTROL (BY OTHERS)

DRYER BYPASS (BY OTHERS)

PFD LINE LEGEND:

SLUDGE

AIR

WATER

THERMAL FLUID

POLYMER

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| B | ADDED TURBO HTX LOOP | MAB | HJH | 06.26.20 |
| A | PRELIMINARY RELEASE | MJG | HJH | 06.15.20 |



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# BIOCON
# PROCESS FLOW DIAGRAM

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | NTS | 850P-0000 | 1 of 1 | B |

From Dewatered Sludge Pump 1

BIN (NOT BY KRUGER): NUMBER OF LIVE BOTTOM SCREWS DEPENDS ON # OF PUMPS. LEVELING SCREWS MAY BE REQUIRED BASED ON LENGTH OF BIM AND BFP CHUTE LOCATION.

TO ODOR CONTROL
A 850P-9000

Add knife gates*

LSH 1101* LSH 1201* LSH 1102* LSH 1202* WIT 1000*

PIT 1104* PIT 1103*

Dryer Feed Pump 1

B 850P-1001

C 850P-1001

Dryer Feed Pump 2

WE 1000A* WE 1000B* WE 1000C*

XSA 1101* XSA 1102* XSA 1001* XSA 1002*

WE 1000D* WE 1000E* WE 1000F*

M1101 M1102 M1001 M1002

M1101* M1102* M1201* M1202* M1001* M1002*

LIVE BTM SCREW 1 LIVE BTM SCREW 2 LIVE BTM SCREW 3 E BTM EW 4 LEVELING SCREW 1 LEVELING SCREW 2

2" SSL 1101* SSL 1102* SSL 1001* SSL 1002*

Sludge Hopper*

*Asterisked items are provided by the h opper manufacturer ( includes hopper instrumentation ot her than Level switches)

NOTES:
1. AIR LINES, REGULATOR/FILTER COMBO, AND ISOLATION VALVES FOR KRUGER SUPPLIED PNEUMATICALLY ACTUATED VALVES ARE TO BE PROVIDED BY THE INSTALLATION CONTRACTOR.
2. ITEMS WITHOUT TAG NUMBERS ARE SUPPLIED AND INSTALLED BY INSTALLATION CONTRACTOR.
3. PROCESS PIPING SCOPE OF SUPPLY IS DESIGNATED BY LINETYPE.
4. REFER TO P&ID LEGENDS FOR LINETYPE AND SYMBOL DESCRIPTIONS.
5. LINE SIZES ARE ESTIMATIONS AND MAY CHANGE DURING DESIGN PHASE.
6. SIGNALS ARE DUPLICATED VIA CONTACTS & TERMINALS AND DIRECT WIRED TO EACH PLC PANEL.

* PREFERRED TAG NUMBER BY CONTROLS. TO BE SUPPLIED BY OTHERS.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| | | | | |
| | | | | |
| B | REMOVED NOTE 7 | MAB | HJH | 06.26.20 |
| A | PRELIMINARY RELEASE | MJG | HJH | 06.15.20 |



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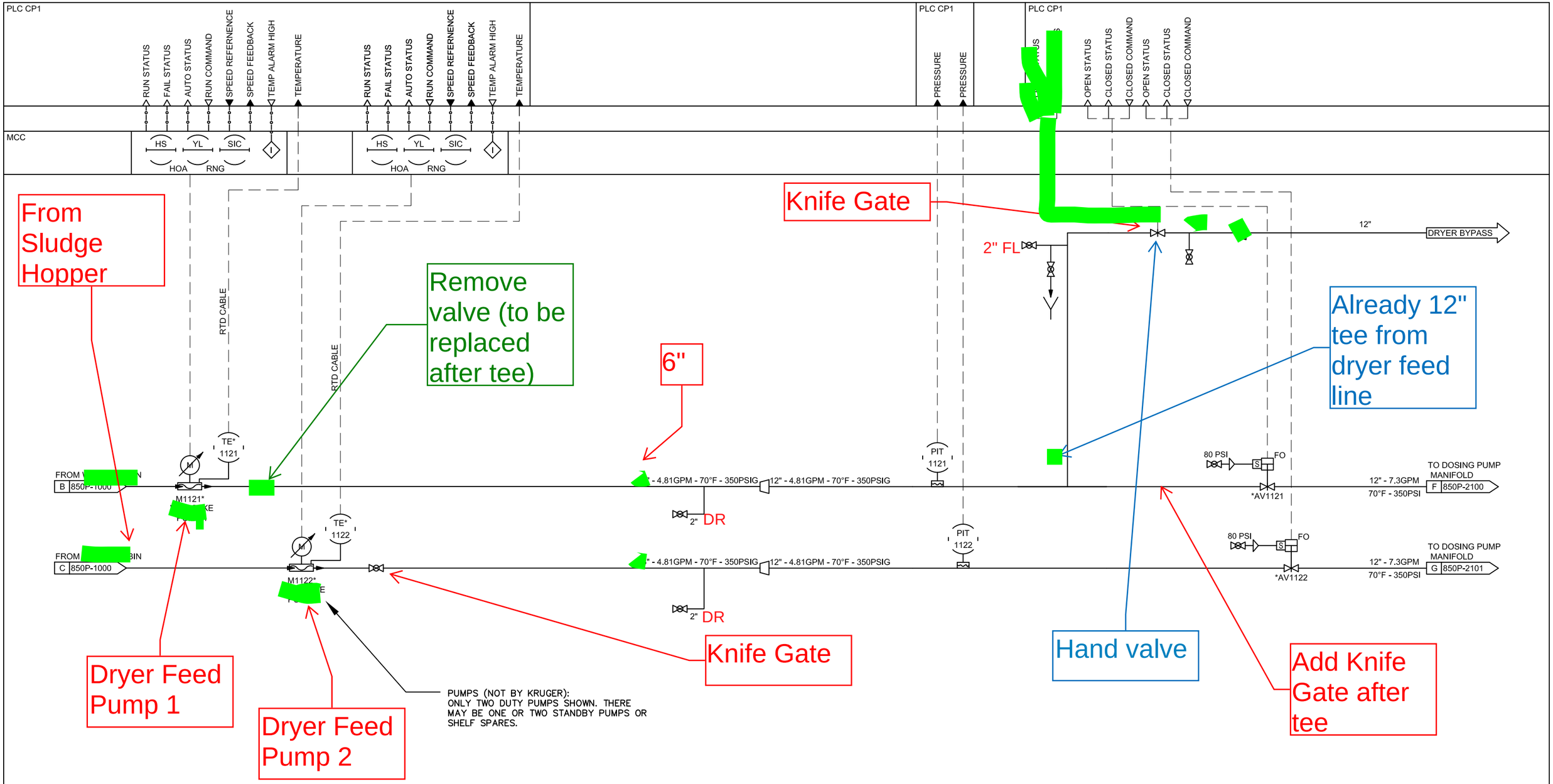
BIOCON
PIPING & INSTRUMENTATION DIAGRAM
WET CAKE HANDLING (WCH)

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | 1 : 2 | 850P-1000 | 1 of 1 | B |




NOTES:

1. AIR LINES, REGULATOR/FILTER COMBO, AND ISOLATION VALVES FOR KRUGER SUPPLIED PNEUMATICALLY ACTUATED VALVES ARE TO BE PROVIDED BY THE INSTALLATION CONTRACTOR.
2. ITEMS WITHOUT TAG NUMBERS ARE SUPPLIED AND INSTALLED BY INSTALLATION CONTRACTOR.
3. PROCESS PIPING SCOPE OF SUPPLY IS DESIGNATED BY LINETYPE.
4. REFER TO P&ID LEGENDS FOR LINETYPE AND SYMBOL DESCRIPTIONS.
5. LINE SIZES ARE ESTIMATIONS AND MAY CHANGE DURING DESIGN PHASE.
6. RTD CABLE TO TEMPERATURE LIMIT ALARM LOCATED IN PLC PANEL.
7. POLYMER SUPPLY AND DELIVERY METHOD BY OTHERS. POLYMER TUBING LINES AND ISOLATION VALVES NOT SHOWN FOR CLARITY.

* PREFERRED TAG NUMBER BY CONTROLS. TO BE SUPPLIED BY OTHERS.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| B | REMOVED CLOSED STATUS FROM I/O | MAB | HJH | 06.26.20 |
| A | PRELIMINARY RELEASE | MJG | HJH | 06.15.20 |



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# BIOCON
# PIPING & INSTRUMENTATION DIAGRAM
# WET CAKE HANDLING (WCH)

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | 1 : 2 | 850P-1001 | 1 of 1 | B |

PLC CP1

OPEN COMMAND
OPEN COMMAND
OPEN STATUS
CLOSED STATUS
CLOSE COMMAND
PRESSURE
OPEN STATUS
CLOSED STATUS
CLOSE COMMAND

MCC

1" -10GPM
55°F - 50PSI
80PSI
S
FC
AV2115

Change to potable water

80PSI
S
FO
AV2113
1"
4"
8"

1"
MV2101
3" - 1.2GPM - 70°F - 70PSI
TO DOSING PUMPS
J 850P-2102

PI
2113

1"
MV2102
3" - 1.2GPM - 70°F - 70PSI
TO DOSING PUMPS
K 850P-2102

FROM MAIN PUMPS
F 850P-1001
12" - 4.81GPM - 70°F - 350PSI
8"
PIT
2110

1"
MV2103
3" - 1.2GPM - 70°F - 70PSI
TO DOSING PUMPS
L 850P-2102

PI
2112

1"
MV2104
3" - 1.2GPM - 70°F - 70PSI
TO DOSING PUMPS
M 850P-2102

8"

80PSI
S
FO
AV2112
4"
1"

Change to potable water

1" - 10GPM
55°F - 50PSI
80PSI
S
FC
AV2114

NOTES:
1. AIR LINES, REGULATOR/FILTER COMBO, AND ISOLATION VALVES FOR KRUGER SUPPLIED PNEUMATICALLY ACTUATED VALVES ARE TO BE PROVIDED BY THE INSTALLATION CONTRACTOR.
2. ITEMS WITHOUT TAG NUMBERS ARE SUPPLIED AND INSTALLED BY INSTALLATION CONTRACTOR.
3. PROCESS PIPING SCOPE OF SUPPLY IS DESIGNATED BY LINETYPE.
4. REFER TO P&ID LEGENDS FOR LINETYPE AND SYMBOL DESCRIPTIONS.
5. LINE SIZES ARE ESTIMATIONS AND MAY CHANGE DURING DESIGN PHASE.
6. POLYMER SUPPLY AND DELIVERY METHOD BY OTHERS. POLYMER LINES AND ISOLATION VALVES NOT SHOWN FOR CLARITY.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| A | PRELIMINARY RELEASE | MJG | HJH | 06.15.20 |



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BIOCON
PIPING & INSTRUMENTATION DIAGRAM
DOSING PUMP MANIFOLD 1

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | 1 : 2 | 850P-2100 | 1 of 1 | A |

PLC CP1

OPEN COMMAND
OPEN COMMAND
OPEN STATUS
CLOSED STATUS
CLOSE COMMAND
PRESSURE
OPEN STATUS
CLOSED STATUS
CLOSE COMMAND

MCC

NON-POTABLE WATER
1" - 10GPM
55°F - 50PSI
80PSI
S
FC
AV2125

Change to potable water

80PSI
S
FO
AV2123
1"
4"
8"

1"
MV2107
3" - 1.2GPM - 70°F - 70PSI
TO DOSING PUMPS
N 850P-2103

PI
2123

1"
MV2106
3" - 1.2GPM - 70°F - 70PSI
TO DOSING PUMPS
O 850P-2103

FROM MAIN PUMPS
G 850P-1001
12" - 4.81GPM - 70°F - 350PSI
8"
PIT
2120

1"
MV2107
3" - 1.2GPM - 70°F - 70PSI
TO DOSING PUMPS
P 850P-2103

PI
2122

1"
MV2108
3" - 1.2GPM - 70°F - 70PSI
TO DOSING PUMPS
Q 850P-2103

8"

80PSI
S
FO
4"
AV2122
1"

Change to potable water

NON-POTABLE WATER
1" - 10GPM
55°F - 50PSI
80PSI
S
FC
AV2124

NOTES:
1. AIR LINES, REGULATOR/FILTER COMBO, AND ISOLATION VALVES FOR KRUGER SUPPLIED PNEUMATICALLY ACTUATED VALVES ARE TO BE PROVIDED BY THE INSTALLATION CONTRACTOR.
2. ITEMS WITHOUT TAG NUMBERS ARE SUPPLIED AND INSTALLED BY INSTALLATION CONTRACTOR.
3. PROCESS PIPING SCOPE OF SUPPLY IS DESIGNATED BY LINETYPE.
4. REFER TO P&ID LEGENDS FOR LINETYPE AND SYMBOL DESCRIPTIONS.
5. LINE SIZES ARE ESTIMATIONS AND MAY CHANGE DURING DESIGN PHASE.
6. POLYMER SUPPLY AND DELIVERY METHOD BY OTHERS. POLYMER LINES AND ISOLATION VALVES NOT SHOWN FOR CLARITY.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| A | PRELIMINARY RELEASE | MJG | HJH | 06.15.20 |

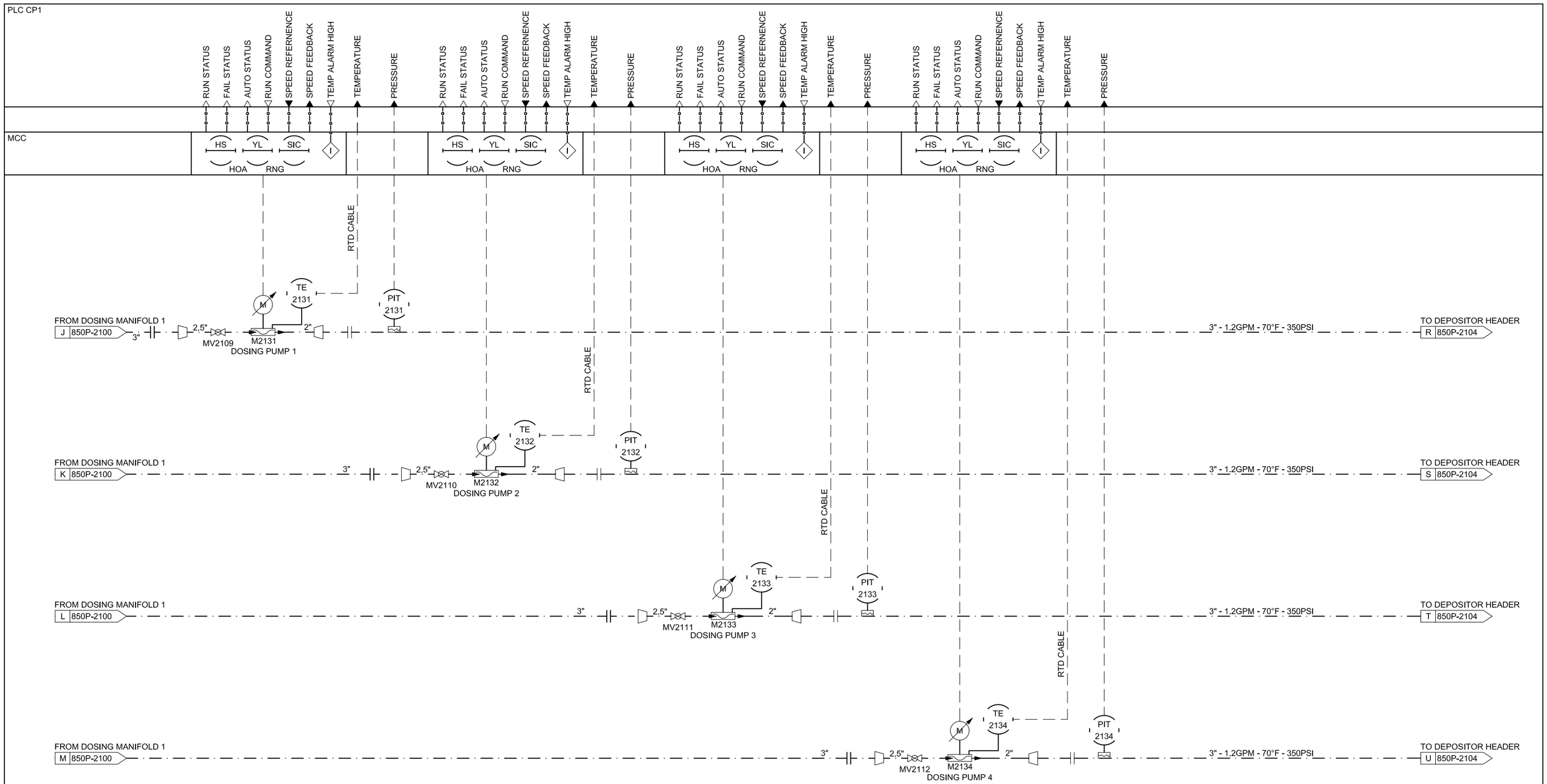


VEOLIA
I. KRUGER, INC.
4001 WESTON PARKWAY
CARY, NC 27513
(919) 677-8310

5700110005
CANTON, GA

BIOCON
PIPING & INSTRUMENTATION DIAGRAM
DOSING PUMP MANIFOLD 2

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | 1 : 2 | 850P-2101 | 1 of 1 | A |




NOTES:

1. AIR LINES, REGULATOR/FILTER COMBO, AND ISOLATION VALVES FOR KRUGER SUPPLIED PNEUMATICALLY ACTUATED VALVES ARE TO BE PROVIDED BY THE INSTALLATION CONTRACTOR.
2. ITEMS WITHOUT TAG NUMBERS ARE SUPPLIED AND INSTALLED BY INSTALLATION CONTRACTOR.
3. PROCESS PIPING SCOPE OF SUPPLY IS DESIGNATED BY LINETYPE.
4. REFER TO P&ID LEGENDS FOR LINETYPE AND SYMBOL DESCRIPTIONS.
5. LINE SIZES ARE ESTIMATIONS AND MAY CHANGE DURING DESIGN PHASE.
6. RTD CABLE TO TEMPERATURE LIMIT ALARM LOCATED IN PLC PANEL.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| A | PRELIMINARY RELEASE | MJG | HJH | 06.15.20 |



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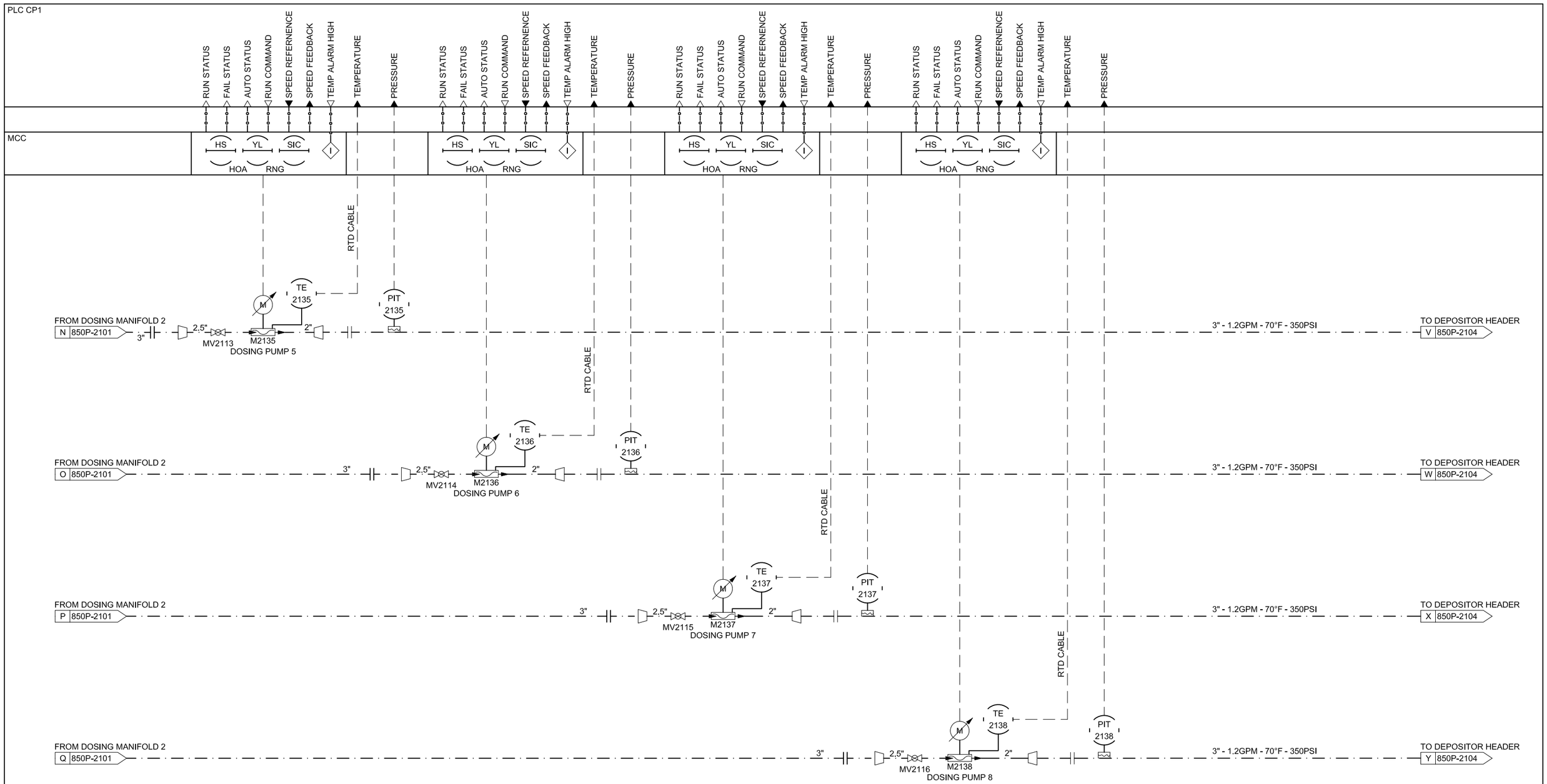
# BIOCON
## PIPING & INSTRUMENTATION DIAGRAM
## DOSING PUMP (1-4)

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | 1 : 2 | 850P-2102 | 1 of 1 | A |




NOTES:

1. AIR LINES, REGULATOR/FILTER COMBO, AND ISOLATION VALVES FOR KRUGER SUPPLIED PNEUMATICALLY ACTUATED VALVES ARE TO BE PROVIDED BY THE INSTALLATION CONTRACTOR.
2. ITEMS WITHOUT TAG NUMBERS ARE SUPPLIED AND INSTALLED BY INSTALLATION CONTRACTOR.
3. PROCESS PIPING SCOPE OF SUPPLY IS DESIGNATED BY LINETYPE.
4. REFER TO P&ID LEGENDS FOR LINETYPE AND SYMBOL DESCRIPTIONS.
5. LINE SIZES ARE ESTIMATIONS AND MAY CHANGE DURING DESIGN PHASE.
6. RTD CABLE TO TEMPERATURE LIMIT ALARM LOCATED IN PLC PANEL.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| A | PRELIMINARY RELEASE | MJG | HJH | 06.15.20 |



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# BIOCON
## PIPING & INSTRUMENTATION DIAGRAM
## DOSING PUMPS (5-8)

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | 1 : 2 | 850P-2103 | 1 of 1 | A |

PLC CP1

MCC

RUN STATUS
FAIL STATUS
AUTO STATUS
SPEED REFERNENCE
SPEED FEEDBACK
RUN COMMAND
DEPOSITOR FORWARD OVER-TRAVEL
DEPOSITOR REVERSE OVER-TRAVEL

HS HOA
YL RNG
SIC
HS RST
I

FROM DOSING PUMP 1 — R | 850P-2102 — 3" - 1.2GPM - 70°F - 250PSI
FROM DOSING PUMP 2 — S | 850P-2102 — 3" - 1.2GPM - 70°F - 250PSI
FROM DOSING PUMP 3 — T | 850P-2102 — 3" - 1.2GPM - 70°F - 250PSI
FROM DOSING PUMP 4 — U | 850P-2102 — 3" - 1.2GPM - 70°F - 250PSI
FROM DOSING PUMP 5 — V | 850P-2103 — 3" - 1.2GPM - 70°F - 250PSI
FROM DOSING PUMP 6 — W | 850P-2103 — 3" - 1.2GPM - 70°F - 250PSI
FROM DOSING PUMP 7 — X | 850P-2103 — 3" - 1.2GPM - 70°F - 250PSI
FROM DOSING PUMP 8 — Y | 850P-2103 — 3" - 1.2GPM - 70°F - 250PSI

CATCH TRAY
MV2117 MV2118 MV2119 MV2120 MV2121 MV2122
MV2123 MV2124 MV2125 MV2126 MV2127 MV2128
MV2129 MV2130 MV2131 MV2132 MV2133 MV2134
MV2135 MV2136 MV2137 MV2138 MV2139 MV2140
1" MV2141 1" MV2142 1" MV2143 1" MV2144 1" MV2145 1" MV2146 1" MV2147 1" MV2148

ROTATING DEPOSITER SHAFTS, GEAR BOX & CONNECTING LINKAGE

M M2139
DEPOSITOR
ZS 2139A FWD O/T
ZS 2139B FWD LIMIT
ZS 2139C REV LIMIT
ZS 2139D REV O/T

TO DRYER BELT — Z | 850P-3100

NOTES:
1. AIR LINES, REGULATOR/FILTER COMBO, AND ISOLATION VALVES FOR KRUGER SUPPLIED PNEUMATICALLY ACTUATED VALVES ARE TO BE PROVIDED BY THE INSTALLATION CONTRACTOR.
2. ITEMS WITHOUT TAG NUMBERS ARE SUPPLIED AND INSTALLED BY INSTALLATION CONTRACTOR.
3. PROCESS PIPING SCOPE OF SUPPLY IS DESIGNATED BY LINETYPE.
4. REFER TO P&ID LEGENDS FOR LINETYPE AND SYMBOL DESCRIPTIONS.
5. LINE SIZES ARE ESTIMATIONS AND MAY CHANGE DURING DESIGN PHASE.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| A | PRELIMINARY RELEASE | MJG | HJH | 06.15.20 |



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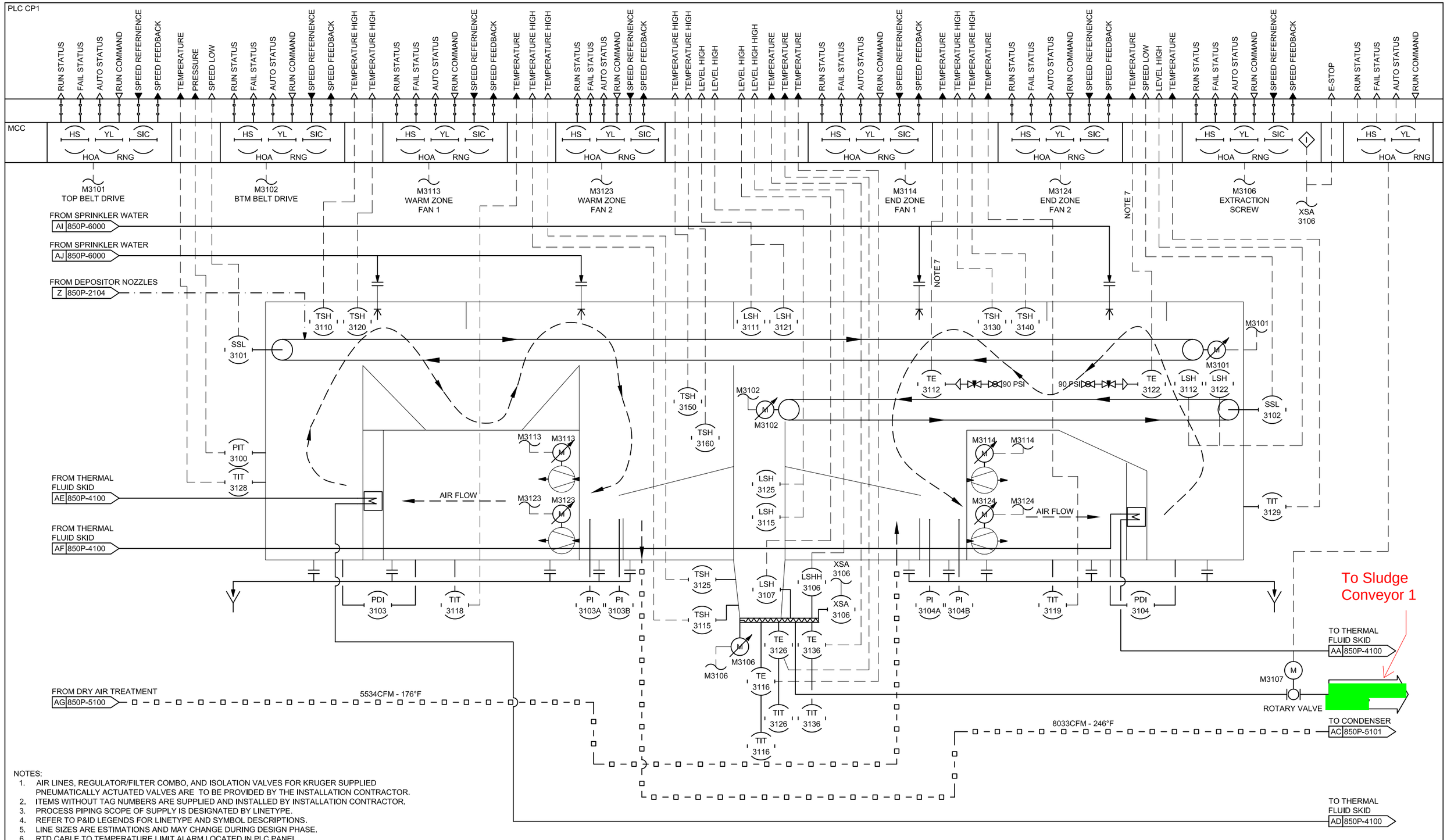
# BIOCON
# PIPING & INSTRUMENTATION DIAGRAM
# DEPOSITORS

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | 1 : 2 | 850P-2104 | 1 of 1 | A |




NOTES:

1. AIR LINES, REGULATOR/FILTER COMBO, AND ISOLATION VALVES FOR KRUGER SUPPLIED PNEUMATICALLY ACTUATED VALVES ARE TO BE PROVIDED BY THE INSTALLATION CONTRACTOR.
2. ITEMS WITHOUT TAG NUMBERS ARE SUPPLIED AND INSTALLED BY INSTALLATION CONTRACTOR.
3. PROCESS PIPING SCOPE OF SUPPLY IS DESIGNATED BY LINETYPE.
4. REFER TO P&ID LEGENDS FOR LINETYPE AND SYMBOL DESCRIPTIONS.
5. LINE SIZES ARE ESTIMATIONS AND MAY CHANGE DURING DESIGN PHASE.
6. RTD CABLE TO TEMPERATURE LIMIT ALARM LOCATED IN PLC PANEL.
7. THERMOCOUPLE WIRE ONLY.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| B | UPDATED LINES AG AND AC | MJG | MAB | 06.26.20 |
| A | PRELIMINARY RELEASE | MJG | HJH | 06.15.20 |



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# BIOCON
# PIPING & INSTRUMENTATION DIAGRAM
# SLUDGE DRYER

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | 1 : 2 | 850P-3100 | 1 of 1 | B |

PLC CP1

MCC

FLUID FLOW ALARM
RUN STATUS
SYSTEM FAULT
SYSTEM ENABLE
ENABLE BURNER
START/STOP
SECONDARY LOOP TEMPERATURE
STACK TEMPERATURE
HEATER TEMPERATURE
MAIN LOOP SET POINT TEMPERATURE
TEMPERATURE VALVE SET POINT
SEC LOOP SETPOINT TEMPERATURE

FROM DRYER WARM ZONE HTX
AA 850P-3100

FROM DRYER END ZONE HTX
AD 850P-3100

REFER TO FULTON P&ID

TO DRYER WARM ZONE HTX
AE 850P-3100

TO DRYER END ZONE HTX
AF 850P-3100

THERMAL FLUID HEATER SKID

NOTES:
1. PROCESS PIPING SCOPE OF SUPPLY IS DESIGNATED BY LINETYPE.
2. REFER TO P&ID LEGENDS FOR LINETYPE AND SYMBOL DESCRIPTIONS.
3. REFER TO MANUFACTURER'S P&ID FOR FULL PIPING AND INSTRUMENTS LAYOUT.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| A | PRELIMINARY RELEASE | MJG | HJH | 06.15.20 |



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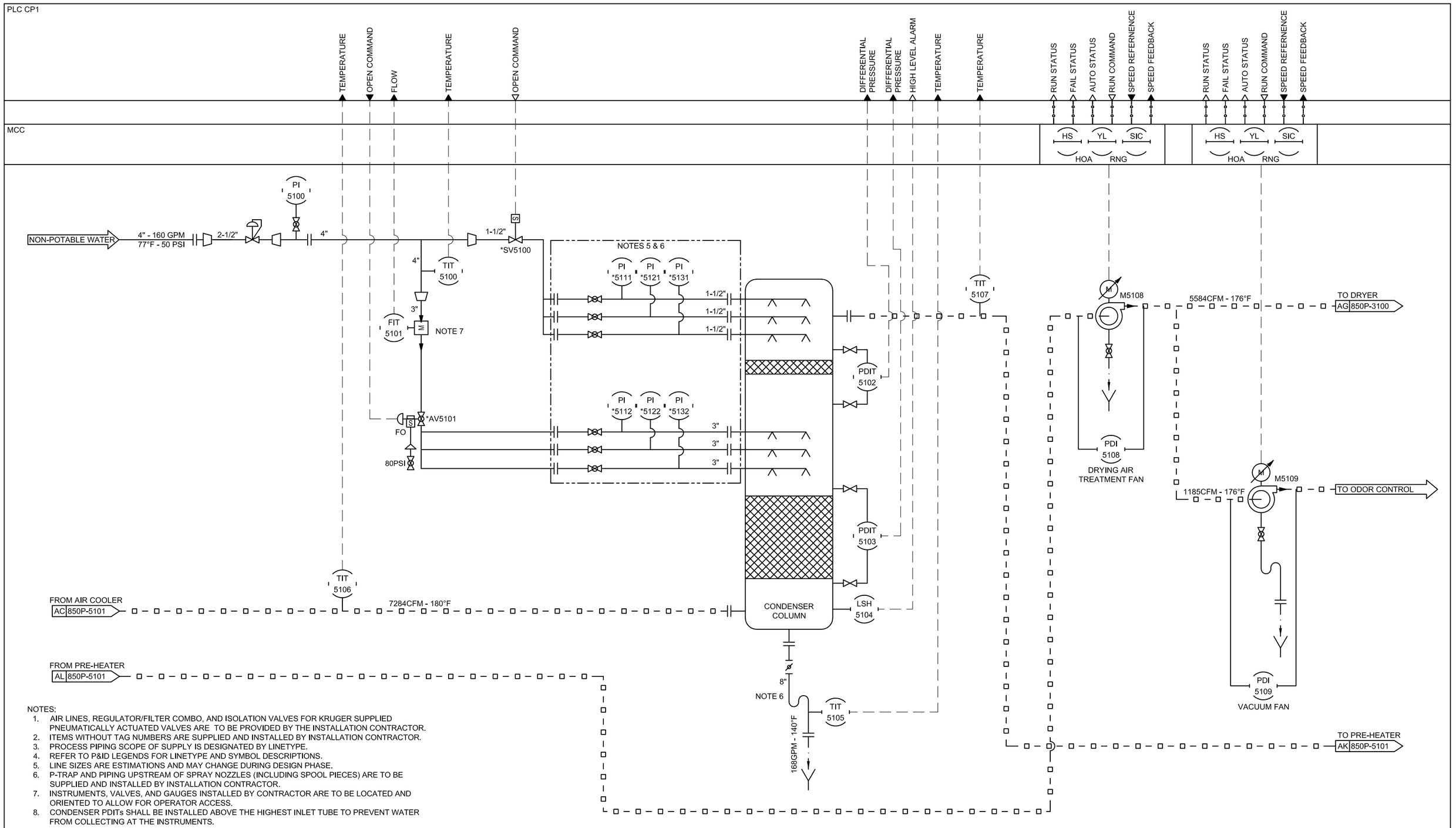
# BIOCON
# PIPING & INSTRUMENTATION DIAGRAM
# THERMAL FLUID HEATER SKID

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | 1 : 2 | 850P-4100 | 1 of 1 | A |




NOTES:

1. AIR LINES, REGULATOR/FILTER COMBO, AND ISOLATION VALVES FOR KRUGER SUPPLIED PNEUMATICALLY ACTUATED VALVES ARE TO BE PROVIDED BY THE INSTALLATION CONTRACTOR.
2. ITEMS WITHOUT TAG NUMBERS ARE SUPPLIED AND INSTALLED BY INSTALLATION CONTRACTOR.
3. PROCESS PIPING SCOPE OF SUPPLY IS DESIGNATED BY LINETYPE.
4. REFER TO P&ID LEGENDS FOR LINETYPE AND SYMBOL DESCRIPTIONS.
5. LINE SIZES ARE ESTIMATIONS AND MAY CHANGE DURING DESIGN PHASE.
6. P-TRAP AND PIPING UPSTREAM OF SPRAY NOZZLES (INCLUDING SPOOL PIECES) ARE TO BE SUPPLIED AND INSTALLED BY INSTALLATION CONTRACTOR.
7. INSTRUMENTS, VALVES, AND GAUGES INSTALLED BY CONTRACTOR ARE TO BE LOCATED AND ORIENTED TO ALLOW FOR OPERATOR ACCESS.
8. CONDENSER PDITs SHALL BE INSTALLED ABOVE THE HIGHEST INLET TUBE TO PREVENT WATER FROM COLLECTING AT THE INSTRUMENTS.

* PREFERRED TAG NUMBER BY CONTROLS. TO BE SUPPLIED BY OTHERS.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| | | | | |
| | | | | |
| B | ADDED TURBO HTX LOOP, UPDATED NOTES | MAB | HJH | 06.26.20 |
| A | PRELIMINARY RELEASE | MJG | HJH | 06.15.20 |



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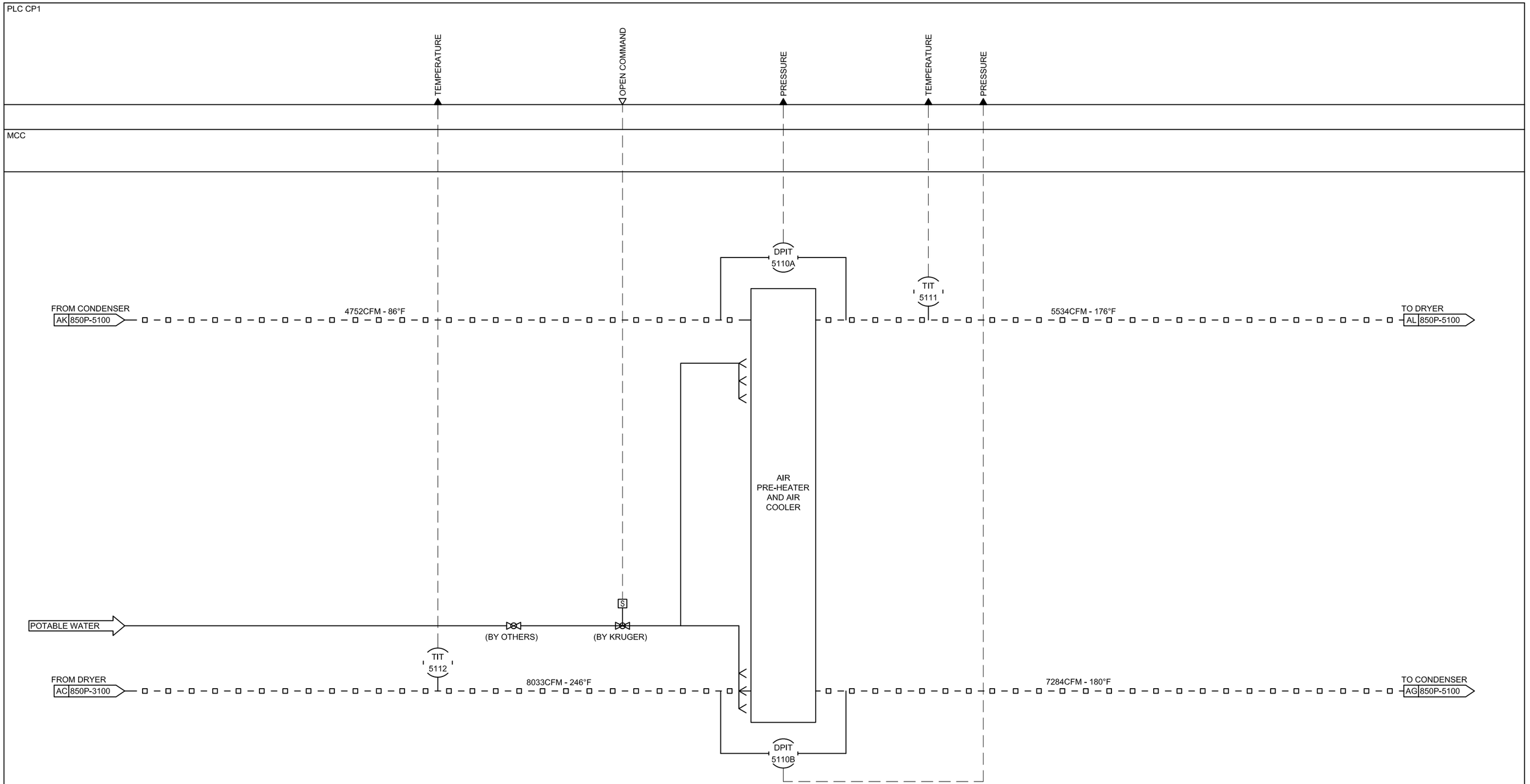
# BIOCON
# PIPING & INSTRUMENTATION DIAGRAM
# DRYING AIR TREATMENT

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | 1 : 2 | 850P-5100 | 1 of 1 | B |




NOTES:

1. AIR LINES, REGULATOR/FILTER COMBO, AND ISOLATION VALVES FOR KRUGER SUPPLIED PNEUMATICALLY ACTUATED VALVES ARE TO BE PROVIDED BY THE INSTALLATION CONTRACTOR.
2. ITEMS WITHOUT TAG NUMBERS ARE SUPPLIED AND INSTALLED BY INSTALLATION CONTRACTOR.
3. PROCESS PIPING SCOPE OF SUPPLY IS DESIGNATED BY LINETYPE.
4. REFER TO P&ID LEGENDS FOR LINETYPE AND SYMBOL DESCRIPTIONS.
5. LINE SIZES ARE ESTIMATIONS AND MAY CHANGE DURING DESIGN PHASE.
6. RTD CABLE TO TEMPERATURE LIMIT ALARM LOCATED IN PLC PANEL.
7. THERMOCOUPLE WIRE ONLY.
8. DPITs SHALL BE INSTALLED ABOVE THE HIGHEST INLET TUBE TO PREVENT CONDENSATION FROM COLLECTING AT THE INSTRUMENTS.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| | | | | |
| B | REVISED AIR HEATER/COOLER. ADDED SOL VALVE | SRW | HJH | 07.29.20 |
| A | PRELIMINARY RELEASE | MJG | HJH | 06.26.20 |



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# BIOCON
## PIPING & INSTRUMENTATION DIAGRAM
## DRYING AIR LOOP

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | 1 : 2 | 850P-5101 | 1 of 1 | A |

PLC CP1

MCC

OPEN COMMAND

PRESSURE LOW

OPEN COMMAND

PI 6100

PSL 6100

1/2"

POTABLE WATER

4" - 288GPM
55°F - 50PSI

2 1/2" - 288GPM
55°F - 80PSI

2 1/2"

2"

S *AV6101

2" NOTE 6

TO DRYER END ZONE / EXTRACTION SCREW
AI 850P-3100

S *AV6102

1 1/4" NOTE 6

TO DRYER WARM ZONE
AJ 850P-3100

PI 6001

MV6004

1/2" MV6001

MV6003

1" 1/2" MV6002

NON-POTABLE WATER

1" - 5GPM
55°F - 50PSI

1" MV6005

NOZZLE CLEANING STATION

4"

NOTES:

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3. PROCESS PIPING SCOPE OF SUPPLY IS DESIGNATED BY LINETYPE.
4. REFER TO P&ID LEGENDS FOR LINETYPE AND SYMBOL DESCRIPTIONS.
5. LINE SIZES ARE ESTIMATIONS AND MAY CHANGE DURING DESIGN PHASE.
6. STAINLESS STEEL PIPING REQUIRED FOR ALL PIPING DOWNSTREAM FROM SOLENOID VALVES.

* PREFERRED TAG NUMBER BY CONTROLS. TO BE SUPPLIED BY OTHERS.

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| B | UPDATED NOTE | MAB | HJH | 08.19.20 |
| A | PRELIMINARY RELEASE | MJG | HJH | 06.15.20 |



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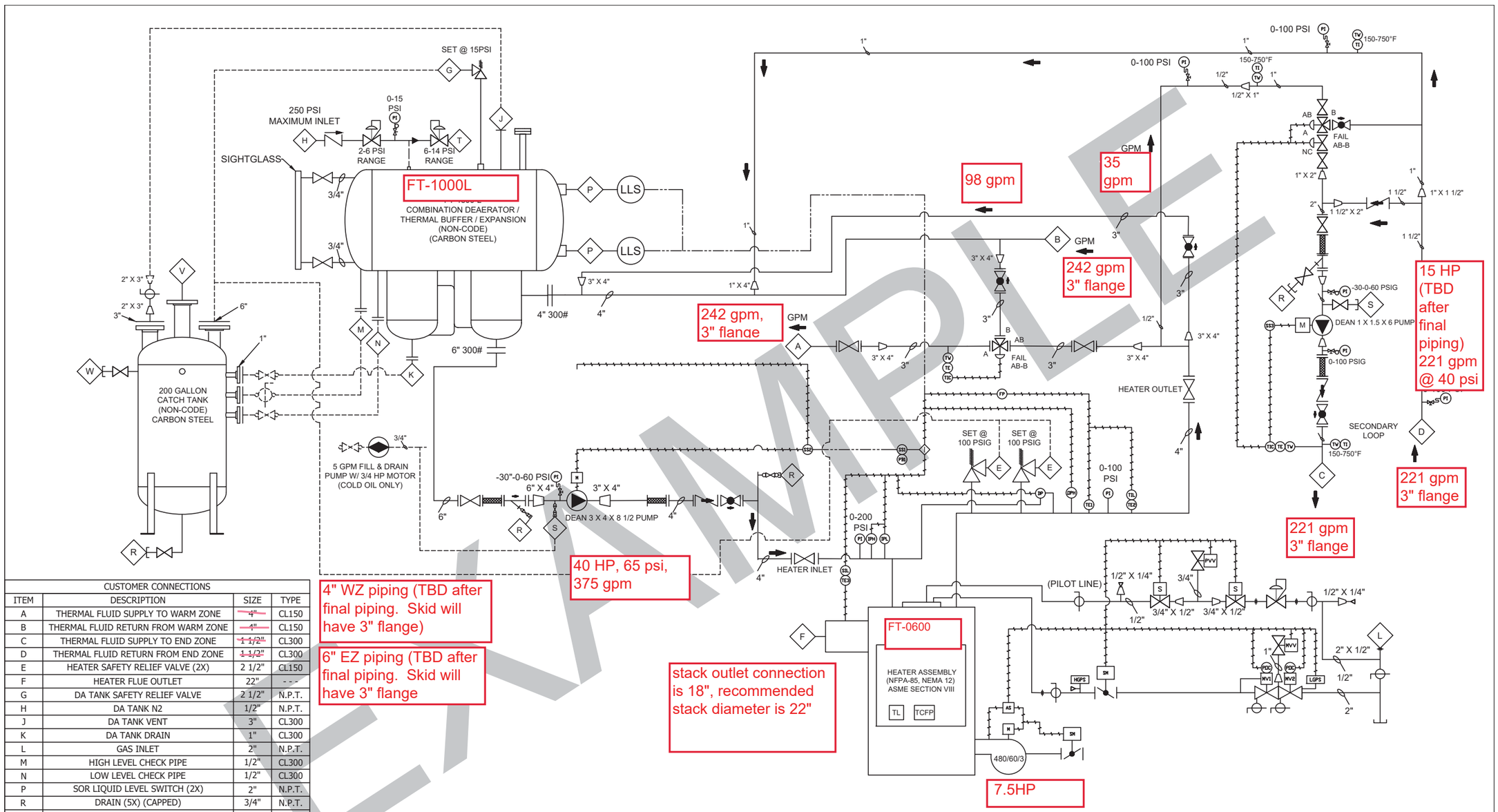
# BIOCON
# PIPING & INSTRUMENTATION DIAGRAM
# NOZZLE CLEANING AND SPRINKLER WATER

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| MJG | HJH | 1 : 2 | 850P-6000 | 1 of 1 | B |




| CUSTOMER CONNECTIONS | | | |
|---|---|---|---|
| ITEM | DESCRIPTION | SIZE | TYPE |
| A | THERMAL FLUID SUPPLY TO WARM ZONE | ~~4"~~ | CL150 |
| B | THERMAL FLUID RETURN FROM WARM ZONE | ~~4"~~ | CL150 |
| C | THERMAL FLUID SUPPLY TO END ZONE | ~~1 1/2"~~ | CL300 |
| D | THERMAL FLUID RETURN FROM END ZONE | ~~1 1/2"~~ | CL300 |
| E | HEATER SAFETY RELIEF VALVE (2X) | 2 1/2" | CL150 |
| F | HEATER FLUE OUTLET | 22" | - - - |
| G | DA TANK SAFETY RELIEF VALVE | 2 1/2" | N.P.T. |
| H | DA TANK N2 | 1/2" | N.P.T. |
| J | DA TANK VENT | 3" | CL300 |
| K | DA TANK DRAIN | 1" | CL300 |
| L | GAS INLET | 2" | N.P.T. |
| M | HIGH LEVEL CHECK PIPE | 1/2" | CL300 |
| N | LOW LEVEL CHECK PIPE | 1/2" | CL300 |
| P | SOR LIQUID LEVEL SWITCH (2X) | 2" | N.P.T. |
| R | DRAIN (5X) (CAPPED) | 3/4" | N.P.T. |
| S | DRAIN AND FILL (3X) (CAPPED) | 3/4" | N.P.T. |
| T | N2 KIT | 1/2" | N.P.T. |
| V | CATCHMENT TANK VENT | 6" | CL150 |
| W | CATCHMENT TANK OVERFLOW (CAPPED) | 3/4" | N.P.T. |

NOTES:
1. (- - -) REPRESENTS PIPING BY OTHERS
2. (—•—) REPRESENTS WIRING BY FULTON
3. (-----) REPRESENTS WIRING BY OTHERS

| REV | REVISION DESCRIPTION | B.O.M. | ELEC. ENG | MECH. ENG | CHECKED | APPROVED |
|---|---|---|---|---|---|---|
| B | UPDATED CONTROL VALVES ON END ZONE PER CUSTOMER REQUEST D. HARRINGTON 12/3/19 | N/A | LNL 12/4/19 | N/A | N/A | RJF 12/4/19 |

REVISION HISTORY

UNLESS OTHERWISE NOTED: DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ±.1/16 (2) PLACE DEC. ±.01 (3) PLACE DEC. ±.005 ANGLES ±.2 DEG. SURFACE FINISH 250 MICRO-INCHES



THIRD ANGLE PROJECTION

| | | | |
|---|---|---|---|
| DRAWN BY: D. HARRINGTON 9/21/2019 | MECH. ENG: N/A | JOB NUMBER: 550835 | DESCRIPTION: CANTON,GA - MARK UP |
| CHECKED BY: N/A | ELEC. ENG: LNL 9/30/2019 | PROJECT NAME: VEOLIA WATER TECH | |
| B.O.M. REVIEW: N/A | APPROVED BY: GW 9/30/2019 | PROJECT MANAGER: G. WILSON | SHEET 1 OF 2 |

The Fulton Companies
972 Centerville Road
Pulaski, New York USA 13142

Fulton

DRAWING NUMBER: T43-550835

REV: B

# LEGEND

| ITEM | DESCRIPTION |
|---|---|
| AAS | AMBIENT AIR SENSOR |
| AFS | AIR FILTER SWITCH |
| AG | AGITATOR |
| AH | ALARM HORN |
| ALWCO | AUXILIARY LOW WATER CUT OFF |
| AS | AIR SWITCH |
| ASME | AMERICAN SOCIETY OF MECHANICAL ENGINEERS |
| CAP | CAPACITANCE SENSOR |
| CS | CONDUCTIVITY SENSOR |
| CQ | CHEMICAL INJECTION QUILL |
| DP | DIFFERENTIAL PRESSURE SWITCH |
| FC | FAIL CLOSED |
| FFA | FLAME FAILURE ALARM |
| FM | FLOW METER |
| FO | FAIL OPEN |
| FOP | FLAME OBSERVATION PORT |
| FP | FLAME PROGRAMMER |
| HGPS | HIGH GAS PRESSURE SWITCH |
| HLAQ | HIGH LIMIT AQUASTAT |
| HLPC | HIGH LIMIT PRESSURE CONTROL |
| IR | INFRARED SCANNER |
| IT | IGNITION TRANSFORMER |

| ITEM | DESCRIPTION |
|---|---|
| LCON | LEVEL CONTROL ON |
| LCOFF | LEVEL CONTROL OFF |
| LG | LEVEL GLASS |
| LGPS | LOW GAS PRESSURE SWITCH |
| LLS | LIQUID LEVEL SWITCH |
| LWCO | LOW WATER CUTOFF |
| M | MOTOR |
| MA | MAGNESIUM ANODE |
| MAWP | MAXIMUM ALLOWABLE WORKING PRESSURE |
| MPC | MODULATING PRESSURE CONTROL |
| MV | MAIN SAFETY SHUTOFF VALVE |
| NC | NORMALLY CLOSED |
| NO | NORMALLY OPEN |
| NPT | NATIONAL PIPE THREAD |
| O2 | O2 TRIM SENSOR |
| OAQ | OPERATING AQUASTAT |
| OPC | OPERATING PRESSURE CONTROL |
| PC | PRESSURE CONTROLLER |
| PE | PRESSURE ELEMENT / PRESSURE SENSOR |
| PI | PRESSURE INDICATOR |
| PIC | PRESSURE INDICATING CONTROLLER |
| PLWCO | PRIMARY LOW WATER CUTOFF |

| ITEM | DESCRIPTION |
|---|---|
| POC | PROOF OF CLOSURE |
| PS | PRESSURE SWITCH |
| PSH | PRESSURE SWITCH HIGH |
| PSL | PRESSURE SWITCH LOW |
| PT | PRESSURE TRANSDUCER |
| PV | PILOT SHUTOFF VALVE |
| PVV | PILOT VENT VALVE |
| SBDC | SURFACE BLOWDOWN CONTROLLER |
| SDT | STEPDOWN TRANSFORMER |
| SM | SERVO MOTOR |
| TC | TEMPERATURE CONTROLLER |
| TCFP | TEMP. CONTROL / FLAME PROGRAMMER |
| TE | TEMPERATURE ELEMENT |
| TL | TEMPERATURE LIMIT |
| TV | THERMOSTATIC VENT |
| VB | VACUUM BREAKER |
| VL | VENT LIMITER |
| UV | UV SCANNER |
| WM | WATER METER |

| ITEM | DESCRIPTION |
|---|---|
| | ANGLE STOP / CHECK VALVE |
| | ANGLE VALVE |
| | BALL VALVE |
| | BLOCK AND BLEED VALVE |
| | BLOWDOWN VALVE |
| | BUTTERFLY VALVE |
| | CAP |
| P M | COMBINATION REGULATOR / SHUTOFF VALVE |
| CS | CONDUCTIVITY SENSOR |
| | CONTROL VALVE |
| | DIAPHRAGM VALVE |
| | DOUBLE BODY VALVE |
| | FLANGE |
| | FLEX LINE |
| | FLOAT SWITCH |
| | GATE VALVE |
| | GLOBE VALVE |
| | LIQUID LEVEL |
| L | LIQUID LEVEL DRAINER |
| | MECHANICAL FLOAT VALVE |
| M | MOTORIZED VALVE |
| | NEEDLE VALVE |

| ITEM | DESCRIPTION |
|---|---|
| | KNIFE TYPE VALVE |
| | ORIFICE |
| | ORIFICE VENT VALVE |
| | PLUG |
| | PRESSURE GAUGE |
| P | PRESSURE REDUCING VALVE (EXTERNAL TAP) |
| P | PRESSURE REDUCING VALVE (SELF-CONTAINED) |
| | PRESSURE RELIEF VALVE |
| | PUMP |
| | PUMP (BI-ROTATIONAL) |
| | REDUCER |
| SM | SERVO MOTOR |
| S | SOLENOID VALVE |
| S | STEAM TRAP |
| | STRAINER (BASKET TYPE) |
| | STOP / CHECK VALVE |
| | SUCTION DIFFUSER |
| | SYPHON LOOP |
| T | TEMPERATURE REGULATING VALVE |
| | THERMOMETER |
| | TRIPLE DUTY VALVE |
| | UNION |
| | Y-STRAINER |



| REV | REVISION DESCRIPTION | B.O.M. | ELEC. ENG | MECH. ENG | CHECKED | APPROVED |
|---|---|---|---|---|---|---|
| B | UPDATED CONTROL VALVES ON END ZONE PER CUSTOMER REQUEST D. HARRINGTON 12/3/19 | N/A | LNL 12/4/19 | N/A | N/A | RJF 12/4/19 |

REVISION HISTORY

UNLESS OTHERWISE NOTED:
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± 1/16
(2) PLACE DEC. ± .01
(3) PLACE DEC. ± .005
ANGLES ± 2 DEG.
SURFACE FINISH
250 MICRO-INCHES



THIRD ANGLE PROJECTION

| | | |
|---|---|---|
| DRAWN BY: D. HARRINGTON 9/21/2019 | MECH. ENG: N/A | JOB NUMBER: 550835 |
| CHECKED BY: N/A | ELEC. ENG: LNL 9/30/2019 | PROJECT NAME: VEOLIA WATER TECH |
| B.O.M. REVIEW: N/A | APPROVED BY: GW 9/30/2019 | PROJECT MANAGER: G. WILSON |

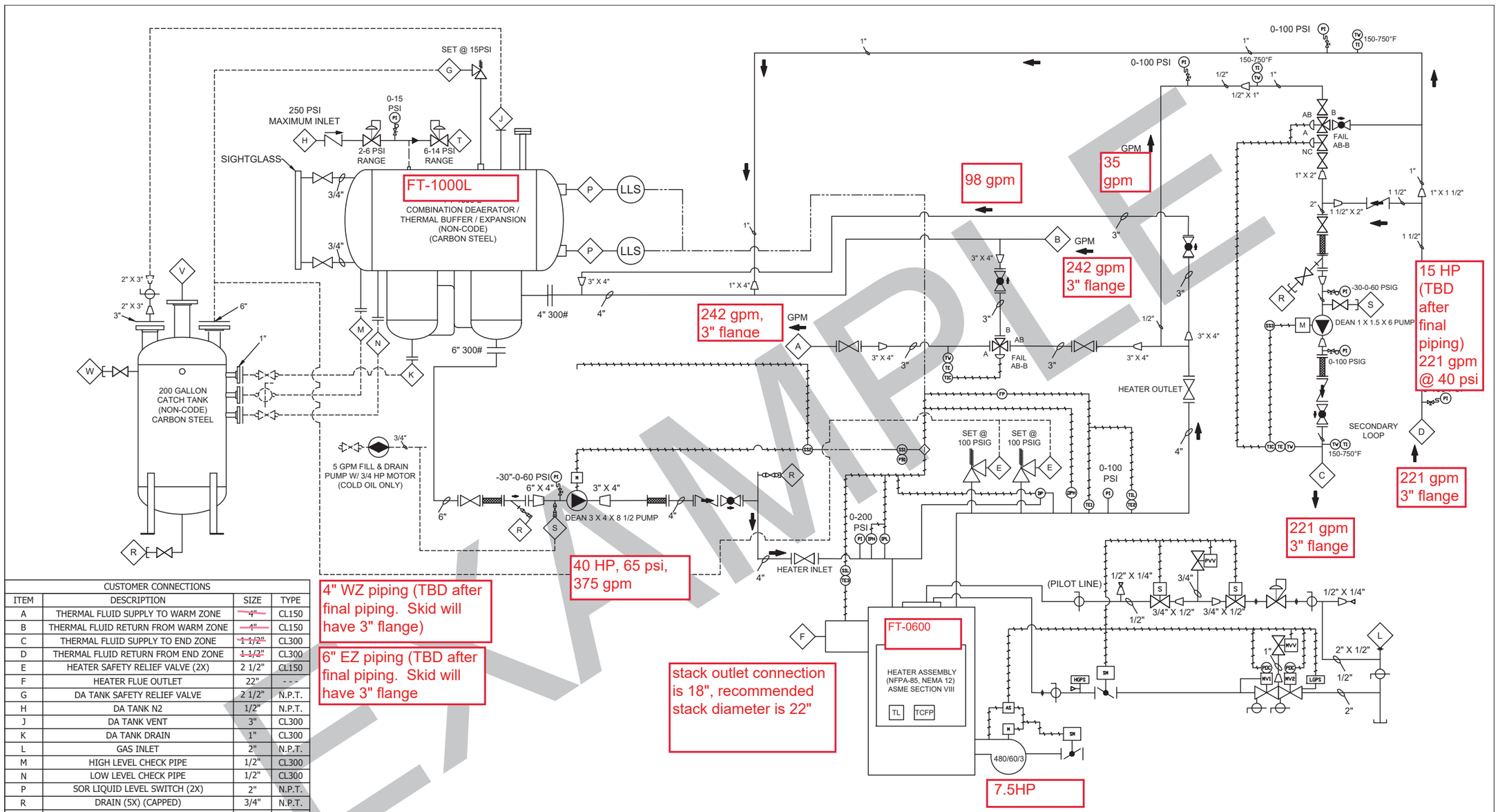
DESCRIPTION: CANTON,GA - MARK UP

SHEET 2 OF 2

The Fulton Companies
972 Centerville Road
Pulaski, New York USA 13142

DRAWING NUMBER: T43-550835

REV: B




| CUSTOMER CONNECTIONS | | | |
|---|---|---|---|
| ITEM | DESCRIPTION | SIZE | TYPE |
| A | THERMAL FLUID SUPPLY TO WARM ZONE | ~~4"~~ | CL150 |
| B | THERMAL FLUID RETURN FROM WARM ZONE | ~~4"~~ | CL150 |
| C | THERMAL FLUID SUPPLY TO END ZONE | ~~1 1/2"~~ | CL300 |
| D | THERMAL FLUID RETURN FROM END ZONE | ~~1 1/2"~~ | CL300 |
| E | HEATER SAFETY RELIEF VALVE (2X) | 2 1/2" | CL150 |
| F | HEATER FLUE OUTLET | 22" | - - - |
| G | DA TANK SAFETY RELIEF VALVE | 2 1/2" | N.P.T. |
| H | DA TANK N2 | 1/2" | N.P.T. |
| J | DA TANK VENT | 3" | CL300 |
| K | DA TANK DRAIN | 1" | CL300 |
| L | GAS INLET | 2" | N.P.T. |
| M | HIGH LEVEL CHECK PIPE | 1/2" | CL300 |
| N | LOW LEVEL CHECK PIPE | 1/2" | CL300 |
| P | SOR LIQUID LEVEL SWITCH (2X) | 2" | N.P.T. |
| R | DRAIN (5X) (CAPPED) | 3/4" | N.P.T. |
| S | DRAIN AND FILL (3X) (CAPPED) | 3/4" | N.P.T. |
| T | N2 KIT | 1/2" | N.P.T. |
| V | CATCHMENT TANK VENT | 6" | CL150 |
| W | CATCHMENT TANK OVERFLOW (CAPPED) | 3/4" | N.P.T. |

NOTES:
1. (- - -) REPRESENTS PIPING BY OTHERS
2. (—•—) REPRESENTS WIRING BY FULTON
3. (-----) REPRESENTS WIRING BY OTHERS

| REV | REVISION DESCRIPTION | B.O.M. | ELEC. ENG | MECH. ENG | CHECKED | APPROVED |
|---|---|---|---|---|---|---|
| B | UPDATED CONTROL VALVES ON END ZONE PER CUSTOMER REQUEST D. HARRINGTON 12/3/19 | N/A | LNL 12/4/19 | N/A | N/A | RJF 12/4/19 |

REVISION HISTORY

UNLESS OTHERWISE NOTED: DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ±.1/16 (2) PLACE DEC. ±.01 (3) PLACE DEC. ±.005 ANGLES ±.2 DEG. SURFACE FINISH 250 MICRO-INCHES



THIRD ANGLE PROJECTION

| | | | |
|---|---|---|---|
| DRAWN BY: D. HARRINGTON 9/21/2019 | MECH. ENG: N/A | JOB NUMBER: 550835 | DESCRIPTION: CANTON,GA - MARK UP |
| CHECKED BY: N/A | ELEC. ENG: LNL 9/30/2019 | PROJECT NAME: VEOLIA WATER TECH | |
| B.O.M. REVIEW: N/A | APPROVED BY: GW 9/30/2019 | PROJECT MANAGER: G. WILSON | SHEET 1 OF 2 |

The Fulton Companies
972 Centerville Road
Pulaski, New York USA 13142

Fulton

DRAWING NUMBER: T43-550835

REV: B

# SECTION 16920

# INSTRUMENTATION

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section includes requirements for supplying and testing calibrated field-mounted analyzers, in line flow devices, pressure indicating devices and associated equipment to be provided by the system supplier under Section 16900. A list of instrumentation specified for this project can be found in the 16900 I&C Attachment, “Table 16920-T1 Instrumentation List”.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

### 1.03 SUBMITTALS

A. Submit shop drawings and catalog data in accordance with Section 01300 and Section 16900.

B. Submit certified dimensional drawings and catalog cuts for each size and type of instrument specified herein. Catalog cuts are to be highlighted to define specific material of construction, features specified herein, and mounting details for the specified application. Show tag number of each applicable instrument.

C. Submit instruction bulletins for each type of instrument specified herein. Show tag number for each applicable instrument. The instruction bulletin shall include installation instructions, wiring diagrams, power requirements, maintenance instructions, and any other details of a specialized nature to the instruments furnished.

D. Submit all verified manufacturer cable lengths required for installation of instrumentation.

E. Submit Manufacturer’s Certification in accordance with Division 1 of the following instruments:

1. Mass Flow Meter and Transmitter
2. Magnetic Flow Meter
3. Pulsar Radar Level Transmitter
4. Ultrasonic Level Transmitter
5. Hydrostatic Level Transducer
6. Dissolvent Oxygen Analyzer
7. pH Analyzer
8. Turbidity

9. Gas Monitor

F. Submit Manufacturer's Certificates for instruments in accordance with Division 1 specifications.

G. Submit Operation and Maintenance Manuals in accordance with Division 1 Specifications, include the following:

1. Instrument ID (as shown on contract), Description, Location, Instrument range, Calibration range, manufacturer, model (including all options provided), and serial number.

2. When applicable, provide report of instrument configuration which shall include all parameters set at each instrument. The report shall include as a minimum the following information: I Parameter ID, Parameter Name, Default Value, Value, Min and Max value, Unit.

3. Final O&M manual shall include the report of the final configuration of the instruments.

## 1.04 SPECIAL TOOLS AND SPARE PARTS

A. The Contractor shall furnish to the Owner all necessary spare parts of components required to maintain the instrumentation system prior to final acceptance of work. The Contractor shall provide a spare parts listing of all necessary spare parts and quantities for review by the Owner.

B. The Contractor shall deliver to the Owner all the required spare parts upon conditional acceptance of the work. The spare parts shall not be used as replacement parts during the guarantee or startup period.

C. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

D. Provide 1 spare of each type of transmitters, sensors, analyzers, probes, switches, displays, and other instrumentation specified under Part 2 Products. A spare sampler is not required.

## 1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Delivery, handle and store the equipment in accordance with Division 1 specifications and the manufacturer's instructions.

B. The Contractor shall use all means necessary to protect the components of this Section before, during and after installation and to protect the installed work and materials of all other trades.

C. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary to the approval of the Engineer and at no cost to the Owner.

D. For all products, sensors, and probes which have a shelf or operating life of less than 5 years, the contractor shall provide 1 additional sensor at final acceptance of the project to the City. This is in addition to spare part identified in Section 1.04.

1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical: 16010

B. General Control System Requirements: 16900

PART 2: PRODUCTS

2.01 GENERAL

A. Electrical components operate on 115 volts ac, 60 hertz unless otherwise specified.

B. Provide two-wire and four-wire transmitter power supplies in local panels as required.

C. Provide fuses or switches for equipment, as recommended by the instrument manufacturer.

D. Provide 4-20 mA dc analog output signals for process transmitters unless otherwise specified.

E. Provide all necessary accessories for installation, including mounting brackets, floor stand, hardware, and similar items.

F. Provide adequate cable from flow tube, level sensor, and analyzer sensor to transmitter for locations as shown on the drawings. Contractor to verify all cable length prior to installation.

G. Attach permanently the scheduled Tag Number to each field instrument.

H. Provide stainless steel nameplates for all field-mounted instruments.

I. Instrument Material of construction shall be suitable for the type of solution to be measured.

J. Provide instrumentation suitable for classified areas as indicated on Contract Documents.

K. Provide surge suppressor on all outdoor instruments as follows:

1. Two-wire instrument – provide signals surge protection.

2. Four-wire instrument – provide combine hybrid AC power protection and signal line protection.

3. Refer to Paragraph 2.23 below for Surge suppressor specifications.

L. Provide 120VAC, 15A toggle switch as a power disconnect on each instruments 120V AC powered, install toggle switch on the line side of the AC surge suppressor. Provide toggle switch in a NEMA 4X cover when located outdoors. Provide NEMA 9 toggle switch in hazardous location.

M. All instrumentation which is available with Hart communications shall include Hart communications over the analog wiring with the product provided, whether Hart is a standard product or an option.

2.02 MANUFACTURERS

A. Mass Flow Meter and Transmitter - FCI Model ST98 or equal

B. Magnetic Flow Meter - Endress & Hauser Model Promag 53 W, Rosemount Series 8750, or equal,

C. Pulsar Radar level Transmitter - Omart Vega, Model Vega Puls 65/66; Endress & Hauser, Micropilot M

D. Ultrasonic Level Sensor and Transmitter - Endress and Hauser, Model Prosonic FMU 90 or equal.

E. Hydrostatic Level Transducer - Endress and Hauser, Model FMX21 or equal.

F. Dissolvent Oxygen Analyzer - Hach Model Provide LDO probe and SC-200 transmitter; Endress and Hauser Oxymax COS61 probe with Liquisys and COM253 transmitter or equal.

G. pH Analyzer – Hach XXX and SC-200 transmitter, or equal.

H. ORP Analyzer – Hach Model XXXX and SC-200 transmitter

I. Turbidity – Hach Analyzer Model Solitax SC Sensor and ST-2000 transmitter

J. Gas Monitor - MSA X5000 series sensor and Gasgard Receiver Manufacturer by MSA, or equal,

2.03 DESIGN CONDITIONS

A. Refer to Section 16900.

2.04 INSTRUMENTATION PROVIDED UNDER THIS SECTION INCLUDES

A. Mass flowmeter and transmitter

B. Magnetic Flow Meter

C. Pulsar Radar Level Transmitter

D. Ultrasonic level sensor and transmitter

E. Hydrostatic Level Transducer

F. Gauge Pressure Indicating Transmitter

G. Dissolvent Oxygen Analyzer

H. pH Analyzer

I. ORP Analyzer

J. Turbidity Analyzer

K. Gas Monitor

L. Pressure Switch

M. Level Switch – Float type

N. Temperature Switch

O. Flow Switch – Paddle Type

P. Limit switch

Q. Display Meter

R. Refrigerated sampler – 5800 series by Isco or equal

S. Temperature Switch.

Refer to Table 16920-01 for Instrumentation list.

2.05 MASS FLOWMETER AND TRANSMITTER

A. Provide a thermal mass flow meter designed to monitoring the airflow rate and provide a continuous output signal proportional to the flow rate.

B. The sensor shall include a pair of platinum resistance temperature detectors (RTDs). One element shall be heated and the other shall serve as the reference element.

C. System shall determine mass flow rate past the sensing point by comparing the temperatures of the heated and reference elements.

D. The flow meter shall meet the following specifications:

1. Process application parameters:
    a. Media: 100% Air
    b. Range: Refer to Instrument List
    c. Pipe Size: Refer to contract drawings
    d. Pipe Orientation: Vertical, uon
    e. Pressure: nominal: 0-10 psi
    f. Temperature: 90 F average
2. Performance requirements:
    a. Accuracy:
        1) Flow: +/-1% of reading, 0.5% full scale.
        2) Temperature: +/-2 F
    b. Repeatability:
        1) Flow: +0.5% reading
        2) Temperature: +/-1 F

E. Provide flow conditioners units at each flow meter.

1. Pipe diameter: Refer to drawings
2. Attachment method: Flange

F. Provide flow element that meets the following requirements:

1. Type: Insertion flow element
2. Material of construction: All welded 316 SST
3. Process connection: ¾” male NPT, adjustable Teflon Ferrule
4. Pressure rating: 150 psig
5. Provide temperature compensation
6. Probe cable: Provide cable length as required per equipment location shown on drawings.

G. Provide a remote transmitter which includes integral automatic diagnostics to alarm out of range verification.

H. Flow transmitter shall me the following requirements:

1. Enclosure: NEMA 4X
2. Display: Integral LCD. Scaled in engineering units
3. Power supply 120 VAC, 1 phase, 60 Hz
4. Output signal: 4 – 20 mA

I. Provide stainless steel hardware as required to mount each sensor and transmitter as shown on contract documents. Transmitter shall be handrail mounted, uon.

J. Manufacturer:

1. Fluid Components International FCI Model ST98. The design of the electrical, mechanical, and instrumentation system is based on the named manufacturer(s) of this instrument. If the contractor submits and provides an "equal" to the specification, they shall be responsible for all modifications to the electrical, mechanical, and instrumentation systems required for use of this equipment at no additional cost to the Commission.
2. Or equal.

## 2.06 ELECTOMAGNETIC FLOW METER

A. Provide low frequency and short form characterized coil design.

B. Provide a steel metering tube with flanged body to fit between ANSI Class 150 pipe flanges, unless otherwise specified.

C. The laying length of the flow meter shall be ISO standard.

D. Provide flow meters with polyurethane or SBR hard rubber liners and Type 316 stainless steel electrodes.

E. Provide Liners and electrodes suitable for municipal potable water.

F. Provide all required mounting hardware, stainless steel grounding rings, and grounding straps for the installation of each magnetic flow meter. Ground the flow meter as recommended by the manufacturer.

G. Provide coils inside the pipe wall, encapsulated in epoxy resin, and encased behind the meter lining material.

H. The ratio of the flow velocity to reference voltage signals generated shall be compatible with the readout instrument without the necessity of circuit modifications.

I. Provide the meter with an accuracy of ½ percent of rate for flow rate between 10 percent and 100 percent of the range setting.

J. Provide a meter housing which is splash proof and weather resistant and capable of accidental submergence in up to 30 feet of water for up to 48 hours without damage to the electronics.

K. Each meter shall be hydraulically calibrated at a calibration facility located in the United States against a master meter, which is traceable to the National Institute of Science and Technology. Submit the calibration curves for each flow meter for three points within the specified flow range.

L. Complete zero stability shall be an inherent characteristic of the meter system. This eliminates the requirement for valving downstream of the meter for creating a full pipe zero flow condition for calibration purposes. Meter systems requiring field zero adjustment are not acceptable.

M. Provide each flow meter with a remote mounted NEMA 4X microprocessor based signal converter with a flow indicator scaled in engineering units. The signal converter converts the meter's DC pulsed signal to linear 4-20 mA DC signal which is proportional to the flow rate. The flow converter operates on 120 volt AC, 60 Hz power source and has RFI protection.

N. Provide interconnecting cable of sufficient length to connect each signal converter to its respective flow meter.

O. Each signal converter shall include both a magnetic driver to power the magnet coils and signal converter electronics. Signal converters shall be identical and interchangeable for all meter sizes.

P. The signal converter electronics shall be of the solid state, feedback type, and utilize integrated circuitry, microprocessor controlled. All operational parameters shall be user configurable locally via an integral keypad. All changes to the database shall be by entry of numerical values or selectable from a menu. When in the configuration mode, normal meter output shall be maintained.

Q. Provide the converter with a back lighted, dot matrix-type, liquid crystal display for easy reading of flow and configuration data. Provide the display with two rows of 16 alphanumeric characters as a minimum. For operation, the top row indicates instantaneous flow rate in direct engineering units and the second row displays accumulated total flow. Error messages will announce incorrect entry values, which the converter will reject. Converter failure shall be announced in the display as an error message. An error message will display when the converter fails.

R. The range setting of the signal converter shall be continuously adjustable between 5 percent and 100 percent of meter capacity. The range and other parameter adjustments shall be direct reading via the integral digital display. The converter shall have input impedance of 10-12 ohms or greater and not be affected by

quadrature noise. The meter shall require no zero adjustment or special tools for startup.

S. Provide fully isolated Input and output signals. The unit shall be capable of accommodating either unidirectional or bi-directional flow. The converter shall incorporate an integral zero return circuit to provide a constant zero output signal in response to an external dry contact closure.

T. The signal converter software includes a noise reduction algorithm to minimize the effects of noise generating processes. The signal converter shall have a self-test feature for checking operational modes and alarms. Continuous diagnostics shall also be performed including, but not limited to, the monitoring of electrode reference voltage to sense meter coil failure. Sensing of meter failure activates a user configurable minimum or maximum output signal and a failure alarm contact.

U. Manufacturer:

1. Endress & Hauser Model Promag 53 W.

2. Rosemount Series 8750.

3. Or equal.

2.07 PULSAR RADAR LEVEL TRANSMITTER

A. The pulse radar type level transmitter shall produce a current signal proportional to the level of liquids or solids being measured. The transmitter shall be provided with a radar transmitting type measuring probe.

B. The rigid 316 stainless-steel Teflon-insulated measuring probe length shall be as specified below. The probe shall be provided with a flange for mounting connection. Refer to drawings for flange size and tank height.

C. The transmitter shall be of the solid-state type 2 -wire system. Span and zero adjustments shall be provided. The transmitter shall operate from 120 volt a-c source. The output signal shall be 4- to 20-mA. The transmitter shall be housed in a NEMA 4X enclosure.

D. Level transmitters shall be mounted as shown on the Contract Drawings. Provide Stainless steel mounting brackets for mounting transmitter.

E. Provide the proper probe coating suitable for the liquid chemical (Methanol and alum) being monitored.

F. Each level transmitter shall be provided with a 4-20 mA loop powered remotely mounted digital indicator. Digital indicator shall be calibrated to display the level, in inches, of the chemical being monitored. The calibration range of the digital indicator shall match the calibrated range of the level transmitter. Digital indicator shall be housed in a NEMA 4X enclosure.

G. Manufacturer:

1. Omart Vega, Model Vega Puls 65/66;

2. Endress & Hauser, Micropilot M

3. Or Equal

## 2.08 ULTRASONIC LEVEL SENSOR AND TRANSMITTER

A. Provide non-contact measurement consisting of a transducer and transmitter/ control unit.

B. Provide an echo-time measuring type transmitter that utilizes an ultrasonic beam to detect the liquid level.

C. Provide a transducer with the following characteristics:

1. Submersion proof transducer constructed of PVC or CPVS.

2. Suitable for mounting via flanged tank connection or via support pipe bracket as indicated on drawings.

3. Automatic temperature compensation for changes in the speed of sound over an ambient temperature range of –20 to 120 degrees F.

4. Provide adequate transducer cable for the installation shown on the drawings.

D. Provide transmitter with the following characteristics:

1. Microprocessor based with adjustable span and zero.

2. Match transducer range and frequency to the application as scheduled.

3. House in NEMA 4X enclosure.

4. Digital display in engineering units for level.

5. Thermostat and enclosure heater for outdoor mounted transmitters.

6. 4 – 20 mA DC Signal output into 0 to 750 ohms.

7. Accuracy of 61.0 percent of span.

8. Power requirement of 115 volts ac, 60 hertz.

E. Refer to schedule for calibration range.

F. Mount the level transmitter as shown on contract drawings. Provide corrosion resistant mounting brackets for mounting transmitter.

## 2.09 HYDROSTATIC LEVEL TRANSDUCER

A. A single pressure transducer shall be submerged in the well or tank to sense the water level as indicated on drawings. The pressure transducer shall have a 4-20mA output and ceramic measuring diaphragm for water applications, which is proportional to the level. The output shall be calibrated based on the length of the cable needed and the depth of the tank or well to be monitored. The transducer signal shall be wired to the programmable controller as indicated on drawings. Provide adequate cable for installation. Contractor shall verify all cable lengths prior to installation.

B. The transducer shall meet the following requirements:

1. Accuracy: 0.2% of full scale

2. Voltage: 0 to 30 VDC
3. Integrated over-voltage and surge protection
4. Process Temperature 14 to 158 F
5. Extension cable: As required
6. Process connection: As shown on drawings
7. Weight

C. Provide an NSF-61 potable water approved Level transducer.

D. Provide mounting brackets, junction box and accessories as required for installation.

E. The transducer shall be installed in a Schedule 80 PVC stilling well, satisfactory for water submersion, percolated with 1/4" holes spaced around the tube throughout the entire length of the tube. The bottom of the tube shall be open with the exception of a stainless steel pin suitable to prevent the transducer from falling through. The transducer assembly shall be readily accessible and shall be located in a manner that allows the transducer and cable to be easily removed without entering the well. The transducer and tube assembly shall be mounted and, in a manner, as indicated on drawings.

F. Provide Endress & Hauser Model Water Pilot FMX21, or equal.

## 2.10 GAUGE PRESSURE INDICATING TRANSMITTER

A. The gauge pressure-indicating transmitter shall provide an electronic signal proportional to the calibrated pressure range. The pressure sending element shall be silicone oil filled with a process media operating temperature range of -40° F to 220° F. The transmitter shall be mounted with a carbon steel high-pressure flange and adapter with 1/2-inch NPT connection. The gauge pressure indicating transmitter shall have the following features:

1. Independent external zero and span adjustments.
2. Overrange protection, 0 psig to 2000 psig.
3. Vent/drain valve.
4. Integral output signal indicator calibrated 0% to 100% linear scale.
5. Universal mounting bracket suitable for either wall or pipe mounting.
6. Two electrical conduit connections, 1/2-inch NPT female.
7. NEMA 4X enclosure.
8. Diaphragm Material 316 S.S.
9. Output Signal 4-20 mA D-C
10. Output Signal to PLC
11. Range: Refer to Instrument List.

12. Loop Power 24 VDC
13. Service: Refer to Instrument List
14. Temperature 40/80°F
15. Specific Gravity: 1.0

B. Accuracy of the pressure transmitter shall be +0.25% of calibrated span.

C. The transmitter shall be calibrated without the use of a microprocessor or external device with the following features:

1. 4-20 mA Points.
2. Linear or Square Root Output
3. Damping
4. Engineering Units

D. The pressure transmitter shall be that manufactured by one of the following:

1. Endress & Hauser, Model PMC 51, or latest version thereof.

## 2.11 DISSOLVED OXYGEN ANALYZER

A. Provide oxygen analyzer for continuous measurement of the concentration of dissolvent oxygen in the open wastewater BNR, PA and Digester tanks, .

B. Provide corrosion-resistant material, full-immersible DO sensor based on optical principle for DO concentration measurement.

C. Provide DO analyzer that meets the following requirements:

1. Measuring range: 0.00 to 20.00 ppm / 0.00 to 20.00 mg/L / 0 to 200% saturation.
2. Resolution: 0.01ppm / 0.01 mg/L / 0.01% saturation.
3. Repeatability: +/- 0.1 ppm (mg/L)
4. Probe operational temperature: 0 to 50 C (32 to 122 F)
5. Temperature accuracy: +/- 0.2 C
6. Measurement accuracy: +/-0.05ppm below 5ppm and +/-0.1ppmabove 5ppm
7. Response time to 40s
8. Body material: Stainless
9. Sensor material: Polybutylene Methacrylate
10. Repeatability: +/- 0.5% of spam
11. Probe Immersion type
12. Response time: < 60 sec. to 90% of value upon step change.

13. Probe cable: Provide cable length as required per equipment location shown on drawings.

14. Mounting: Handrail mounted via Manufacturer's probe mount assembly, unless otherwise noted.

D. Provide microprocessor based electronic design with built-in self-diagnostics. Provide remote transmitter.

E. Transmitter shall meet the following requirements:

1. Microprocessor based electronic design with built-in self-diagnostics.

2. Remote transmitter

3. Ambient condition:

a. Temperature: -20 to 55 C

b. Relative humidity: 0 to 95% non-condensing

4. Relay output: as a minimum (1) isolated output for each sensor, SPDT user configurable contacts rated 100-230 VAC, 2 Amp isolated outputs for off-line, fail state.

5. Conduit connection: liquid tight flexible metal conduit.

6. Analog Outputs: 4 – 20 mA isolated into 500 ohm (minimum) impedance, proportional to dissolved oxygen range selected.

7. Display: TFT, scaled in engineering units.

8. Power requirement: 120 VAC, 1 phase, 60 Hz

9. Enclosure: NEMA 4X/IP66

F. Provide handrail mounting assembly for each sensor including spare, unless otherwise noted.

G. Provide LDO SC probe with and SC-200 Transmitter manufactured by Hach, or Equal.

## 2.12 PH ANALYZER

A. Provide pH analyzer. The instrument shall consist of a microprocessor based analyzer with a pH electrode.

B. The analyzer shall meet the following requirements:

1. Automatic temperature compensation and automatic or manual pH compensation.

2. Power supply: 120 VAC, 1 phase, 60 Hz

3. Four fully programmable alarm relays. Form C SPDT.

4. Enclosure: NEMA 4X

5. Provide mounting bracket for installation as shown on drawings.

6. Probes:
    a. pH probe with the following characteristics:
        1) Immersion mounting pH probe.
        2) Measuring Range: -0 – 14 pH
        3) Accuracy: less than 0.1 pH
        4) Temperature range: 0 to 105C
        5) Prove Digital Combination pH/ORP

C. Sensor cable length: As required for installation shown on drawings.

D. Sensor built-in electronics: Completely encapsulated for protection from moisture and humidity.

E. Provide Immersion Convertible Digital Combination pH probe with and SC-200 Transmitter manufactured by Hach, or Equal.

F. Provide pole mount kit, brackets and accessories for immersion installation in open tank, refer to drawings for installation requirements.

G.

2.13 ORP ANALYZER

A. Provide ORP analyzer. The instrument shall consist of a microprocessor based analyzer with an ORP probe.

B. The analyzer shall meet the following requirements:

1. Power supply: 120 VAC, 1 phase, 60 Hz

2. Four fully programmable alarm relays. Form C SPDT.

3. Enclosure: NEMA 4X

4. Provide mounting bracket for installation as shown on drawings.

5. Probes:
    a. ORP probe with the following characteristics:
        1) Immersion mounting ORP probe.
        2) Measuring Range: -2000 – +2000 millivolts
        3) Accuracy: +/- 20mV
        4) Temperature range: 0 to 105C
        5) Prove Digital Combination pH/ORP

C. Sensor cable length: As required for installation shown on drawings.

D. Sensor built-in electronics: Completely encapsulated for protection from moisture and humidity.

E. Provide Immersion Convertible Digital Combination ORP probe with and SC-200 Transmitter manufactured by Hach, or Equal.

F. Provide pole mount kit, brackets and accessories for immersion installation in open tank, refer to drawings for installation requirements.

G.

## 2.14 TURBIDITY ANALYZER

A. Provide color-independent Turbidity analyzer. The instrument shall consist of a microprocessor-based analyzer with a turbidity probe.

B. Provide a sensor that meets the following requirements:

1. Immersion in open tank
2. Measuring range turbidity: 0.0001 to 4000 NTU
3. Accuracy: Turbidity up to 1000 NTU; without calibration <5% of the measured value +/- 0.01 NTU; with calibration <1% of the measured value +/- 0.01 NTU
4. Repeatability: Turbidity < 1%
5. Response on time: 1s < T90 < 300 s (adjustable)
6. Flow Max 3 m/s
7. Operating temperature rage: 0 to 40C (32 to 104F)
8. Pressure Limit: SST: 6 bar or 600 m (87 psi)

C. Provide Immersion Solitax SC Turbidity sensor with and SC-200 Transmitter manufactured by Hach, or Equal.

D. Provide pole mount kit, brackets and accessories for immersion installation in open tank, refer to drawings for installation requirements.

## 2.15 GAS MONITOR

A. Gas monitor shall be microprocessor-based gas detector for continuous monitoring of combustible gases and vapors with Automatic compensation for humidity and temperature changes. Sensor/transmitter shall be housed in 316 stainless steel enclosure.

B. Provide separated sensors to monitor the desired type of gas (e.g. combustible gas “Methanol”, oxygen, H2S, Carbon Monoxide); and an appropriated control module for each sensor that is capable of accepting, converting, and transmitting signals from the sensors. The complete gas monitor system including sensors, Sample pump, filter, adapter, controllers, receiver, and accessory equipment shall be supplied by a single manufacturer.

C. Sensor

1. Gas sensor shall sample and monitor the atmosphere. Sensors shall be mounted with stainless steel wall mounting brackets and hardware as shown on the Drawings and/or as recommended by the manufacturer

2. Sensor/Controller and associated enclosures shall be rated for used in Class 1 Division 1 Group C and D environments as specified by the National Electrical Code.

3. Combustible gas sensor shall be resistant to poisoning by hydrogen sulfide and silicone.

4. Sensors shall be mounted with non-corrosive hardware as shown on drawings and/or as recommended by the manufacturer.

5. The complete gas monitoring system shall be operable at ambient temperatures from 32 to 120 F and over a humidity range of 0% to 95% relative humidity.

6. The response time for a 67 percent change of any gas concentration shall be within the following limits: 5 sec for combustible gas and 20 sec. for oxygen.

    a. Combustible Gas.

        1) Provide an infrared (IR) gas sensor. The sensor shall be capable of calibration without gas. The sensor/transmitter shall be capable of performing a full calibration by zero adjustment only.

        2) Sensor/transmitter shall allow for gas check without alternate calibration/gas check fittings or cap.

        3) Sensor/transmitter shall detect for an above 100% LEL condition (over-range). This condition shall be indicated on the front panel LCD. The Gas Combustible Sensor/transmitter shall detect Methanol gas. The combustible gas alarm shall be set to 10% LEL warning and 20% Alarm level.

    b. Oxygen (O)

        1) Provide an electromechanical sensor/transmitter with a measured range of 0-to 25% of oxygen. The Oxygen alarm shall be set as follows:

            - Alarm 1: O measurement < 19%
            - Alarm 2: O measurement > 23%.

    c. Hydrogen Sulfide (H2S)

        1) Provide an H2S sensor. The sensor alarm shall be set as follows:

            - Alarm 1: H2S measurement >15ppm
            - Alarm 2: H2S measurement >20ppm

    d. Carbon Monoxide (CO)

        1) Provide an CO sensor. The sensor alarm shall be set as follows:

            - Alarm 1: CO measurement >TBD
            - Alarm 2: CO measurement >TBD

D. Transmitter

1. The gas sensor shall be paired with a microprocessor-based monitor Analyzer/Transmitter with built-in self-diagnostics. Monitor shall be of modular

construction with plug-in circuit boards for easy service and repair and shall be wall mounted with corrosion resisting enclosure. The monitor shall have dual 3-digit LED displays to indicate the concentration of the gas being monitored, the transmitter shall meet the following requirements:

a. Operating/storage temperature: -40C t0 60C.

b. Input power 11 to 30VDC, 3 wires.

c. Signal output: dual 4-20mA current source.

d. Relay ratings: 5A @ 30VDC, 5A @ 220VAC, 3X SPDT _ Fault, warm, alarm.

e. Fault monitored: low supply voltage, RAM checksum error, EEPROM error, internal circuit error, invalid sensor configuration, sensor fault.

2. An adjustable alarm set point shall be provided for each gas being monitored. When the alarm setting is exceeded for a specific gas, the specific alarm light and relay associated with that gas shall be activated. The light and relay shall remain in the alarm state until the condition has cleared, and the alarm is manually reset. A switch external to the enclosure shall provide reset action. An audible alarm shall be activated when any gas alarm level is exceeded. The audible alarm shall be capable of being silenced by a switch external to the monitor enclosure. Such action shall not disable the audible alarm if an alarm condition recurs.

3. The controller shall provide a monitor fault alarm for the gas being monitored. If the combustible gas reading goes below zero by more than 10 percent of full scale, the alarm associated with that gas shall be activated.

4. Calibration shall be performed through the instrument panel via a manufacturer-supplied magnet. It shall not be necessary to open the monitor enclosure to perform calibration or adjustment of the unit.

5. The system reading when measured on zero gas or a known concentration shall change less than 5 percent full scale per month for each gas. With the exception of monthly checks and recalibration, no periodic maintenance shall be necessary.

6. Each sensor shall be paired with a transmitter.

   a. 2 or 3 wires configuration.

E. Gas Monitor Receiver/Controller

1. Provide a wall mounted receiver for combustible and oxygen sensor expandable up to 8 independent channels using plug-in boards.

2. The receiver shall meet the following specifications:

   a. Power supply: 85 – 256 VAC, 50/60 Hz.

   b. Sensor power supply: 18 – 32 VDC

   c. Number of channel: 2 expandable to 8

   d. Led per channel: Alarm 1, Alarm 2, Status and Power.

   e. Input signals: 4 – 20 mA

f. Alarm relay per channel: 2 SPDT

g. Common relays: 2 Alarm, 2 Horn, 1 Fault SPDT

h. Buzzer: 85 dB

i. Accuracy/repeatability: <+/-1% full scale, +/- 1 digit.

j. Operating Temperature; -10 C to 50 C

k. Ambient humidity: 95% non –condensing

l. Enclosure: NEMA 4X

m. Housing material: ABS plastic high resistant

n. Backup battery pack kit

o. The receiver display shall display concentration of each of the gases being measured, along with an indication of whether the gas is within calibration, under range or over range.

p. Each controller shall have an individual 2 alarms and status indicating lights for each gas being monitored along with a green power light. Two SPDT relay rated at 5 amps120 VAC resistive shall be provided for each gas being monitored along with a common relay to power a strobe and audible alarm. Provide strobe and audible alarm as shown on the contract drawings.

q. An adjustable alarm set point shall be provided for each gas being monitored. When the alarm setting is exceeded for a specific gas, the specific alarm light and relay associated with that gas shall be activated. The light and relay shall remain in the alarm state until the condition has cleared, and the alarm is manually reset. Such action shall not disable the audible alarm if an alarm condition recurs.

3. The controller shall provide a monitor fault alarm for each gas being monitored.

4. Contractor to furnish strobe and audible alarm for gas monitor system.

F. Provide start-up kit, and material to test and demonstrate the operation of each combustible gas monitor.

G. Provide one hand-held wireless remote control that utilized infrared light to communicate with the transmitter and facilitate \s sensor zeroing and calibration.

H. The system reading when measured on zero gas or a known concentration shall change less than 5 percent full scale per month for each gas. With the exception of a monthly check and recalibrations, no periodic maintenance shall be necessary.

I. Manufacturer: Model Ultima X5000 series sensor and Gasgard Receiver Manufacturer by MSA, or equal.

## 2.16 REFRIGERATED SAMPLER

A. Equipment

1. Sampler shall be a refrigerated, designed for composite or sequential sampling in an outdoor service.

B. Sample Pump:

1. Peristaltic type having a capacity to maintain the EPAs-recommended line velocity of at least 2 feet per second velocity up to 25 feet of head.

C. Sampler:

1. Sampler shall be designed for composite or sequential sampling in an outdoor service, and for exposure to harsh environments.

2. Characteristics:

a. Operational Temperatures: -20° to 120°F.

b. Maximum Suction Lift: 28 feet.

c. Sample Volumes: 10 to 9,990 ml (adjustable in 1 ml increments).

d. Sampling frequency:

1) Interval between samples shall be 1 minute to 99 hours 59 minutes, in 1-minute increments.

2) Interval between samples shall be 1 flow pulse to 9,999 flow pulses.

e. Sampling modes:

1) Constant time – constant volume

2) Constant time – variable volume

3) Variable time – constant volume

f. Non-wetted, non-conductive sensor detects when liquid sample reaches the pump to automatically compensate for changes in head heights.

3. Refrigerator:

a. Body shall be linear low-density polyethylene.

4. Enclosure:

a. Cabinet shall be double-wall LLDPE.

b. Enclosure shall be NEMA 4X rated.

5. Electrical Equipment:

a. Operate on 115VAC, 60 Hz, or 230VAC, 50 Hz power supply.

b. Provide junction boxes on back side of sampler for field connection.

c. Mount in enclosure in accordance with NEMA 4X for outdoor locations.

D. Bottles and Bottle Filling Equipment:

1. Provide each sampler with components necessary to accommodate:

a. Composite sampling into a single large container.

b. Discrete or composite sampling into 24 smaller containers.

2. Large container for composite sampling shall be a 20-liter polyethylene bottle.

3. Smaller containers for discrete sampling shall be 1-liter polypropylene bottles.

E. Intake Tubing and Strainer: Provide 3/8-inch ID vinyl intake suction tubing with stainless steel and polypropylene strainer.

F. Instrumentation and Control

1. Sample Controller

a. Program Memory: Non-volatile ROM

b. Flow meter signal inputs: 5 to 15 volt DC pulse or 25 ms isolated contact closure for Isco flow meters. 4-20 mA input for non-Isco flow meters.

c. Digital alarms: 4 programmable outputs; 5V, 100 mA

d. Number of composite samples: Programmable from 1 to 999 samples.

2. Software

a. Sample retries: If no sample is detected, up to 3 attempts; user detectable.

b. Rinse cycles: Automatic rinsing of suction line up to 3 rinses for each sample collection.

c. Controller diagnostics: Tests for RAM, ROM, pump, display, and electrical components.

G. Manufacturer:

1. Refrigerated sampler – 5800 series by Isco

2. Or equal

## 2.17 PRESSURE SWITCH

A. The pressure-sensing element shall be a diaphragm as specified herein. The sensing element shall activate a snap acting switch. The switch connection shall be clearly and permanently marked. The assembly shall be provided with an indicating scale to show the trip setting of each switch. The switch shall be enclosed in a NEMA 4X enclosure, unless otherwise noted.

B. Provide switch in NEMA 7/9 enclosure in hazardous locations.

C. Manufacturer: Ashcroft Series B; United Electric Controls Co, Mercoid Corp, Or equal.

## 2.18 LEVEL SWITCH – FLOAT TYPE

A. Float (ball) shall be 5-1/2” diameter leakproof, shockproof, corrosion resistant and constructed of type 316 stainless steel. Float shall have continuously welded seams.

B. Switch assembly shall be a mercury-free, tilt type sensor, which shall be non-floating displacement type with less than 1-inch differential. Switch assembly shall be permanently encapsulated in plastic cartridge (glass shall not be acceptable). Switch contacts shall be rated a minimum of 20 amperes at 115 VAC. Switch shall

be a single pole, single throw type. Furnish normally closed contacts. The float body shall be grounded by the green insulated conductor of the cable supporting the float switch.

C. Cable shall be provided with the sensor and shall be PVC insulated, oil resistant suitable for use in raw wastewater applications. Cable shall be sealed at sensor utilizing a flexible boot and compression type lock seal. Cables shall be a 3-wire cable provided with a minimum size conductor of No. 14 AWG with green grounding conductor. Float switch cable length shall be furnished with continuous length to mount float switches in the wet well and up to the explosion-proof junction box on the pump station exterior, plus an additional 5 feet of cable. Excess cable shall be coiled, and tie wrapped to mounting supports.

D. The float system shall be designed to protect against cable stress associated with constant flexing and shall incorporate a neoprene sleeve from the float through a flared stainless steel clamp tube. This design shall provide for a projected flexing life of 35 years of 15-minute cycling. The float system shall have a manufacturer's three (3) year guarantee against defects in material and workmanship.

E. Provide a high level and low level floats as shown on drawings.

F. Float switches shall be Model 9G-EF, mercury-free, Direct Acting Float Switches with cables and weights, as manufactured by Siemens Water Technologies, or equal.

2.19 TEMPERATURE SWITCH

A. Provide a wall mount temperature switch with a probe on a cable for remote temperature readings.

B. Temperature switch shall meet the following:

1. Set the actuation point shall be adjustment dial.
2. Switch shall be double pole, single throw (DPST)
3. Has a pilot light to indicate when the switch is on.
4. Temperature range: 4- - 90 F
5. Voltage 120VAC
6. Enclosed in Metal/Plastic Enclosure.
7. Current 15A
8. Manufacturer: Dayton, Johnson Controls, or Equal.

2.20 FLOW SWITCH – PADDLE TYPE

A. Provide a paddle-type flow switch to detect the flow of liquid within a pipe.

B. The flowing liquid shall displace the paddle located in the lower housing when the pressure exceeds the force of the spring, which holds the paddle in the normal position.

C. Locate the switch in a separate leak-proof housing. Magnetically actuate the switch by a magnet located on the paddle.

D. Provide the switch with the following characteristics:

1. SPDT snap action micro-switch rated at 5 amps, 120 V AC, 60 Hz.

2. Switch and upper housing shall be removable without taking the line out of service.

3. Switch electronics shall be housed in a NEMA 4X enclosure.

E. The switch shall be UL recognized and CSA certified.

F. Flow switch shall be W.E. Anderson Model V6 or equal.

2.21 LIMIT SWITCH

A. Provide a limit type position switch on valves and gates as shown on drawings to monitor their position. Mount switch on valve to indicate open and close position.

B. Coordinate with valve and gate manufacturer the limit switch to be provided.

C. Switch shall have an operating voltage up to 250 volts AC, for 2-wire operation.

D. Switch shall be provided with normally open and close dry output contacts.

2.22 DISPLAY METERS

A. The display meters shall be 120 VAC powered device with a DC input 4-20 mA. The display meter shall be a digital indicator and shall display 3.5 digits with an accuracy of ±0.1% of full scale.

B. Provide a display meter for level, air flow meter, differential pressure transmitter and gas detector indication, as shown on the drawings. The calibrated range of the indicator should match the calibrated range of the transmitter.

C. Install the display meters in the Control Panel, as shown on the drawings.

D. Provide Red Lion Model #IMP, or equal.

2.23 SURGE PROTECTION

A. All analog instrumentation (4-20 mA loops) shall include surge protective devices at signal loop and at the AC power. Surge suppressor device shall be located at or next to the instrument in an equipment rack.

B. Provide (5) five spares of each type of surge protection device installed.

C. Provides surge suppressor as follows:

1. Combine AC power and signal line protection. Device shall meet the following:

a. “Power On” LED indication light

b. 15 Amp replaceable fuse.

c. AC Power

1) Technology: Three-stage series hybrid

2) Voltage clamp: 325 Vac
3) Input voltage: 120 VAC, 60Hz
4) Output current: 15 Amp max
5) Response time: < 5 nanoseconds
6) Maximum Surge current (8x20micros): 39KA
7) Occurrences at 500 Amp: >50

d. Signal Line
1) Technology: Three-stage series hybrid
2) Peak Surge Current (8x20micros): 10KA
3) Response Time: <5 nanoseconds
4) Voltage Clamp: 8 – 200 Volts
5) Series Resistance: 5 ohms (typical)
6) Certification: UL 1449, Type 2

e. Enclosure
1) Nema 4X
2) Corrosion Resistant
3) Polycarbonate Base, Stainless Steel or Fiberglass
4) Resists temperatures up to 250 deg F

f. Manufacturer: Emerson, Edco SLAC Series

2. Two Pair Signal Line surge suppressor. Device shall meet the following:
a. Operation voltage: 24 VDC
b. Clamping Voltage: 30 VDC
c. Operating Current: 1A
d. Peak Surge Current: 250A )8x20micros)
e. Frequency range: 0 to 20 MHz
f. SPD Technology: Silicon avalanche diode (SAD)
g. Connection Type: Terminal block w/ compression lugs, terminal accept up to 10 AWG
h. Operating temperature: -40C to 85C
i. Certifications UL497B
j. EDCO Base
k. Provide surge device in a NEMA enclosure suitable area to be installed.
l. Manufacturer: Emerson, Edco SLCP Series

3. AC power protection. Device shall meet the following:
a. Status indication power: On & MOVs functional LED indication light

b. Technology: Metal Oxide Varistors (MOVs) w/L-C Filter
c. Voltage clamp: 325 Vac
d. Operating voltage: 120 VAC, 60Hz
e. Clamping voltage: 325 Vac
f. Output current: 15 Amp max
g. Replaceable fuse
h. Peak surge current: 13KA/ Mode, 26KA/Phase
i. Operating frequency: 47-63Hz
j. EMI attenuation: 40dB
k. Mode of Protection: Line-to-Neutral, Line-to-Ground, Neutral-to-Ground.
l. Connection type: Terminal block w/ compression screws
m. Operating temperature: -40C to 85C
n. Polycarbonate NEMA 4x Enclosure
o. 1/2” or 3/4” Punchouts for nipple conduit connectors
p. UL 1449 recognized
q. Manufacturer: Emerson, Edco HSP-121A Series

2.24 STAINLESS STEEL AND COPPER TUBING

A. Provide and install all ½” copper tubing (unless otherwise shown on the drawings), stainless steel valves, connectors, and accessories for connection of the instrumentation to the process. Provide piping taps, fittings, and interfaces to the process piping, wall, or containment to have an unobstructed flow of the process media to the instrument. Slope all air tubing and piping away from the instrument to the process to allow drainage of condensate. Slope all liquid tubing toward the instrument to minimize air pockets in the tubing when the process is emptied.

PART 3: EXECUTION

3.01 INSTALLATION

A. The Contractor shall install all metering and instrumentation in strict accordance with the manufacturer's recommendations as approved by the Engineer.

B. All instrumentation shall include a surge protection device mounted adjacent to the transmitter or instrument. Provide disconnecting means (switch) for all 120 powered instruments.

C. Provide rain hood/sun shield for all exterior instrumentation. Refer to detail on drawings.

D. Refer to section 16900.

3.02 MANUFACTURER’S SERVICES

A. Comply Service of Manufacturer’s representative per Division 1 specifications.

B. The manufacturer shall furnish the services of a qualified, factory-trained service representative who shall inspect the complete equipment installation to insure that it is installed in accordance with the manufacturer's recommendations, make all adjustments necessary to place the system in trouble-free operation and instruct the operating personnel in the proper care and operation of the equipment furnished. A minimum of one (1) day start-up assistance shall be provided.

END OF SECTION

# SECTION 16942

# CONTROL SYSTEM EQUIPMENT

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section includes requirements for the programmable logic controller (PLC) equipment and network services to be provided by the PLC manufacturer and the System Integrator (SI) under Section 16900.

B. For existing PLCs: Provide new I/O modules, wiring arms, terminal blocks, terminations, labeling on existing PLCs enclosure as required to meet the contract. Refer to Drawings for existing PLC I/O modules to be provided. Modification of the exiting PLC enclosure shall be performed to add new I/O points and remove existing I/O signals on existing PLCs. Contractor shall provide the same model of each type of I/O module currently installed.

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Division 1.

### 1.03 SUBMITTALS

A. Submit shop drawings and catalog data in accordance with Section 01300 and Section 16900.

B. Submit Operation and Maintenance Manuals in accordance with Division 1 specifications.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. The Contractor and System Integrator (SI) shall furnish to the representative of the Owner all necessary spare parts of components required to maintain the system. Prior to final acceptance of work, the system supplier shall provide a spare parts listing of all necessary spare parts and quantities for review of the representative of the Owner. The spare parts shall include, but not be limited to, the following minimum requirements.

1. PLC Equipment
    a. Power Supply, 2 of each type
    b. Analog Output Module, 2 of each type
    c. Analog Input Module, 4 of each type
    d. Discrete Output Module, 2 of each type
    e. Discrete Input Module, 4 of each type
    f. CPU Module, 1 of each type
    g. I/O Chassis or Rack Assembly, 1 of each type
    h. Operator Interface Terminal, 1 of each type
    i. Communication Interface Module, 1 of each type

j. Communication Adapter Module, 1 of each type

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Delivery, handle and store the equipment in accordance with Division 1 specifications and the manufacturer's instructions.

1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical: 16010

B. Fiber Optic Cable: 16125

C. General Control Requirements: 16900

D. Cabinets, Panels, Consoles, and Devices: 16946

PART 2: PRODUCTS

2.01 GENERAL

A. DESIGNATION OF COMPONENTS

1. In these specifications and on the plans, all systems and other elements are represented schematically and are designated by numbers, as derived from criteria in ISA standards. The nomenclature and numbers designated herein and, on the plans, shall be employed exclusively throughout shop drawings, data sheets, and the like. Any other symbols, designations, and nomenclature unique to the manufacturer's standard methods shall not replace those prescribed above, as used herein, and on the plans.

B. PROGRAMMABLE LOGIC CONTROLLER (PLC)

1. General

a. The PLC system shall consist of a microprocessor-based standalone device. The PLC shall be a process and logic controller designed for industrial environments in a modular configuration.

b. The PLC shall be a module rack unit complete with central processor, memory, Base with associated power supply, interconnecting cables, discrete and analog input/output modules and communication interface modules.

c. The Programmable Automation Controller system shall be described and tested to operate in a high electrical noise environment.

d. The Programmable Automation Controller shall have the capability of addressing up to 128000 discrete points or 4000 analog points. It shall also have the ability to communicate with up to 250 connections that contain I/O. These calculations are based upon the connection limitation of the controller (i.e., 250 connections x 16 channels per module = 4000 analog points) (i.e., 250 connections x 16 slots x 32 points per module = 128,000 digital points).

e. Each input and output module shall be self-contained and housed within a chassis. These chassis, with their respective modules, shall contain up

to 512 (16 modules x 32 pts/module, using a 17-slot chassis) unique points.

f. The Programmable Controller shall have the ability to communicate with multiple distributed I/O racks or devices configured with multiple I/O modules.

g. The Programmable Controller shall include as an optional feature the capability of addressing remote input and output modules on ControlNet and Ethernet/IP.

h. Real Time Produced/Consumed Connections can made and data seamless exchanged between multiple Controllers

i. The Programmable Automation Controller shall use multiple independent asynchronous scans. These concurrent scans shall be designated for processing of input and output information, program logic, and background processing of other controller functions.

j. The Programmable Automation Controller shall have the ability to support multiple data communications networks DH-485, DeviceNet, Ethernet/IP, Modbus RTU, using communications modules. Communications modules shall be provided as indicated on the system block diagram and other Contract drawings.

k. Controller shall have a USB port communication for Programming, configuration, firmware flash and on-line edits.

l. The Controller shall have at least one dedicated Ethernet/IP port.

m. Modules are defined herein as devices that plug into a rack and are keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot or chassis via an electronic method for identifying a module.

2. PLC Processor

a. The CPU shall be a self-contained unit and provide control program execution and support remote or local programming. This device will also supply I/O scanning and inter-processor and peripheral communication functions.

b. The user program and data shall be contained in battery backed memory. The operating system firmware shall be contained in non-volatile memory. An option shall be possible to store both the user program and system firmware in a non-volatile memory for backup/restore purposes.

c. The operating system firmware can be updated via a separate update tool to allow for easy field updates. The 1756-L72 controllers shall come with the 1784-SD1 Secure Digital (SD) card already installed in every controller.

d. The controller shall contain a minimum of 4 Mbytes of user memory.

e. The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a “green” (OK) indicator when no fault is detected and a “red” (OK) indicator (Blinking or Solid) when a fault is detected.

f. The front panel on the Controller shall include color indicators showing the following status information:

- Program or Run mode of the controller
- The fault status of the controller
- I/O status
- Battery status
- Force LED

g. The front panel of the Controller shall include a mounted key switch. The key shall select the following Controller modes: RUN – No control logic edits possible, program always executing; PROGRAM – Programming allowed, program execution disabled; and REMOTE – Programming terminal can make edits and change processor mode, including test mode, whereby the logic executes and inputs are monitored, but edits are not permanently active unless assembled.

h. All system modules, local and remote chassis shall be designed to provide for free airflow convection cooling. No internal fans or other means of cooling, except heat sinks, shall be required.

i. All system modules including the controller may be removed from the chassis or inserted into the chassis while power is being supplied to the chassis without faulting the controller or damaging the modules. This is known as Removal and Insertion Under Power (RIUP). Alternately a software configurable option shall exist to fault the controller if required.

3. Chassis

a. The PLC Chassis shall be a minimum 7-slot chassis, unless otherwise noted. The chassis shall accept PLC slot type modules to provide backplane connections. The chassis shall accept the processor, all integrated I/O modules and all communications modules with communications provided through the backplane.

b. At least one spare slot shall be provided on each rack.

4. Power Supplies

a. The Programmable Logic Controller shall operate in compliance with an electrical service of 85 to 265 VAC (120 to 220 VAC nominal), single phase, in the frequency range from 47 to 63 Hz.

b. A single main power supply shall have the capability of supplying power to the CPU and local input/output modules. Other power supplies shall provide to power all related PLC devices in remote or local racks. Provide quantity of power supplies as required for operation of the equipment.

c. The power supply shall automatically shut down the Programmable Controller system whenever its output power is detected as exceeding 125% of its rated power.

d. The power supply shall monitor the incoming line voltage for proper levels. When the power supply is wired to utilize AC input, the system shall function properly within the range of 85 to 265 VAC. When the power

supply is wired to utilize DC input, the system shall function properly within the range of 18 to 32 VDC.

e. Design features of the Programmable Controller power supply shall include a diagnostic indicator mounted in a position to be easily viewed by the user. This indicator shall provide the operator with the status of the DC power applied to the backplane. In addition, a means of disabling power to the CPU shall be possible from a power disconnect switch mounted in a position easily accessible by the operator.

f. At the time of power-up, the power supply shall inhibit operation of the processor and I/O modules until the voltages of the backplane are within specifications.

g. In addition to the electronic protection described above the power supply shall offer a failsafe fuse that is not accessible by the customer.

5. Input/Output Modules

a. The Input/Output (I/O) Modules shall be slot type and compatible with the PLC processor. Each module shall be provided with the associated terminal block, wiring arm to connect panel wiring to the module.

b. Discrete Input (DI) Modules: 24 Volt DC or 120VAC, 16-point input module suitable for use with input devices such as push buttons, switches, motor starter contacts, and annunciator panels. The module shall have 1500 V AC opto-electrical isolation, LED status indication, and noise filtering. The module shall be provided for either a sink or source input. Provide Allen Bradley Model 1756-IB16I or 1756-IA16A respectively.

c. Discrete Output (DO) Modules: 24 Volt DC or 120VAC, 16 Point Output Module Provide Allen Bradley Model 1756-OB16 or 1756-OA16.

d. Analog Input (AI) Module: Converts 16 differential analog signals to proportional twelve-bit binary values. The module shall accept 4-20 mA signals from devices such as transmitters and analyzers. The module shall be suitable for 2 or 4 wire systems. The input power for each signal shall be derived from an external 24-volt DC power supply. Provide Allen Bradley Model 1756-IF16.

e. Analog Output (AO) Module: Converts integer or floating-point values to eight analog output signals with 15-bit resolution. The module shall output a 4-20 mA DC signal to such devices as variable frequency drives and modulating valve actuators. Provide Allen Bradley Model 1756-OF8.

6. Program Creation and Storage

a. The program storage medium shall be of a battery backed RAM.

b. The controller shall contain a minimum of 2 Mbytes of user memory.

c. The controller will write all variable data to internal nonvolatile memory storage (Flash) during the power down cycle.

d. Memory shall contain battery back-up capable of retaining all stored program data through a power failure. A low battery condition must be detectable in ladder logic but shall not automatically generate a major fault. A low battery condition will generate a minor fault and will be

detectable in ladder logic and will be indicated on a diagnostic indicator mounted on the front of the controller.

e. The operator should be able to backup volatile memory, including data and program logic onto a personal computer storage device.

f. All user memory in the processor not used for program storage shall be allocable from main memory for the purpose of data storage. The Programmable Controller system shall be capable of storing 3 data types:

1) Predefined

2) User-defined

3) Module-defined

g. Controller programs shall have immediate access to the sub elements of control structures by address and sub element mnemonic, such as timer accumulator value, timer done bit, or PID Process Variable value.

7. Interfacing and Peripherals

a. The programming software shall be on a workstation running the current Windows OS.

b. The system shall have the capability to interface to USB, CD-ROM, DVD and/or a hard disk for loading a user program into, or recording the contents of, the controller's memory. It shall be possible to load or record the entire contents of memory.

c. It shall be possible to use Windows “copy/paste” to easily duplicate all or parts of the controller program within the same project or across multiple projects open on the same workstation.

d. The ability to create libraries of controller programs is required using the standard programming software.

8. PLC Programming

a. The programming format shall be IEC 1131-3 compliant Ladder Diagram (LD) only.

b. The controller shall organize user applications as Tasks, which can be specified as continuous, periodic, or event based.

c. Periodic tasks shall run via an interrupt at a user-defined interval in one microsecond increments from 1 millisecond to 2000 seconds.

d. The periodic and event tasks shall have an associated, user assignable priority from one to fifteen (one being the highest priority), which specifies that task’s relative execution priority in the multitasking hierarchy.

e. The controller shall be able to accommodate a maximum of 32 individual tasks of which one can be continuous.

f. The periodic and event tasks shall have an associated, user assignable priority from one to fifteen (one being the highest priority), which specifies that task’s relative execution priority in the multitasking hierarchy.

g. The event task can be triggered software events (event instruction).

h. Each task shall have a user settable watchdog timeout which is unique to that task.

i. Each program can include routines programmed in LD, FBD, SFC, or ST languages. One of the routines can be specified as the main routine and one can be specified as an optional fault routine. All routines shall be capable of being edited when on-line. The number of routines which can be contained in a program is limited only by memory.

j. Variables within the controller shall be referenced as unique, default or user defined tags.

k. Tags may be created off-line, on-line and at the same time the routine logic is entered.

l. The system shall have the capability to store user tags names in the controller.

m. Tags shall be available to all tasks in the controller (Controller Scoped) or limited in scope to the routines within a single program (Program Scoped) as defined by the user.

n. The ability to program control logic via tags of the Programmable Automation Controller shall exist.

o. It shall be possible to program ladder diagram rungs with the following restrictions:

    1) Series instruction count limited only by user memory.

    2) Branch extensions limited only by user memory.

    3) Branch nesting to six levels.

p. The Programmable Controller shall use a signed double integer format ranging from -2,147,483,648 to +2,147,483,648 for data storage of the counter preset and accumulated values.

q. The Programmable Controller shall store data in the following formats:

    1) Boolean values (o or 1).

    2) Short integer numbers ranging from -128 to + 127

    3) Integer numbers ranging from -32,768 to +32,767

    4) Double integer numbers ranging from -2,147,483,648 to +2,147,483,647

    5) Floating point numbers consisting of eight significant digits. For numbers larger than eight digits, the CPU shall convert the number into exponential form with a range of plus/minus 1.1754944 E -38 to plus/minus 3.402823 E +38

r. The Programmable Controller shall have support for integer and floating point signed math functions consisting of addition, subtraction, multiplication, division, square root, negation, modulus, and absolute value.

s. It shall be possible to complete complex, combined calculations in a single instruction, such as flow totalizing or equations of the format ((A+((B-C)*D))|E).

t. Arrays shall be configurable with one, two or three dimensions.

u. The CPU shall support indexed addressing of array elements.

v. The Programmable Controller shall provide a master system.

w. For any module specifically associated with the Programmable Automation Controller, it shall be possible to configure operation and query the current status of all channels through controller scoped tags without any programming.

x. The system shall contain instructions, which will construct word shift registers (SQI, SQO, and SQL). Additional instructions shall be provided to construct synchronous bit shift registers (BSR and BSL).

y. The Programmable Automation Controller shall provide a master system clock that will allow synchronization of all axes in the chassis local to the controller.

z. In applications requiring repeatable logic it shall be possible to place such logic in a subroutine section. Instructions which call the subroutine and return to the main program shall be included within the system. It shall be possible to program several subroutines and define each subroutine by a unique program file designator. The processor will support nesting of subroutines up to available stack at the moment of the call. It shall be possible to pass selected values (parameters) to a subroutine before its execution.

aa. The system shall have the capability to enter rung comments above ladder diagram rungs. These comments may be entered at the same time the ladder logic is entered.

bb. The capability shall exist for adding, removing, or modifying logic during program execution in routines of LD, FBD, SFC languages. When changes to logic are made or new logic is added it shall be possible to test the edits of such logic before removal of the prior logic occurs. All programming shall be done in Ladder Relay Language.

cc. It shall be possible to manually set (force) either on or off all hardwired discrete input or output points from the programming panel. It shall also be possible to manually set (force) an analog input or output to a user specified value. Removal of these forced I/O points shall be achieved either individually or totally through selected keystrokes.

dd. A means to program a fault recovery routine shall exist. When a major system fault (Controller Fault) occurs in the system, the controller fault recovery routine shall be executed and then the system shall determine if the fault has been eliminated. If the fault is eliminated, program execution resumes. If the fault still exists, the system will shut down.

ee. The controller shall support Master Control Reset (Relay) type functionality to selectively disable sections of logic.

ff. The controller shall include direct support of FOR-NEXT loop constructions.

gg. The controller shall include the ability to create user defined instructions that are re-usable in one or multiple projects/applications. These instructions will allow for the encapsulation of code developed by the user

using the standard instruction set and other add-on instructions. The user defined instructions can be instantiated multiple times, each instance of the instruction having its own backing data and the ability to create custom online help for each user defined instruction.

hh. The controller shall have the ability to create alarm instructions allowing for a single point of configuration for all alarms within the controller. The alarm data can then be read by a management system such as Factory Talk Alarms & Events and presented across the enterprise to HMI and other systems.

9. Programming Software

a. The PLC programming software shall be supplied by the Contractor, and be of the same manufacturer as PLC. The programming software shall run on a laptop or personal computer, and provide the means for directly entering, debugging, and documenting all aspects of the Ladder Logic or special function program, both on-line and off-line. Provide all cabling and accessories for direct connection to the PLC. The software shall be the latest version, with provisions, modules, and software for all communications. Lite versions are not acceptable. The software shall be licensed to Canton City, Georgia Department of Public Works.

b. The PLC programming software shall be provided to the Owner. The system supplier shall use their own software of the same version as provided to the Owner for all required programming and integration.

C. CONTROL SYSTEM NETWORK

1. General: The control system network shall consist of four different communications protocols.

a. PLCs, OITs shall communicate via Ethernet network, Fiber Optic Cable or Cat 6e shielded cable as shown on drawings.

b. Information will be transmitted to and from the Human Machine Interface (HMI) operating the PCS platforms via an Ethernet local area network.

c. Power monitors will communicate to associated PLC via Ethernet Network.

d. Existing Allen Bradley Flexlogix CPU system shall be demolished and replaced with the new system. LCP-H control panel is to remain for connection of existing IO to the new system. Refer to Section 16900 for additional requirements.

e. Ethernet communications interface module shall provide a gateway from the existing ControlNet network to the new Ethernet communications system as required. Provide and install all modules within the PLC cabinets and chassis. Provide Allen Bradley Model 1756-ENBT.

D. EXISTING FLEXLOGIX CONTROLNET COMMUNICATION

1. Provide Controlnet communication between existing FlexLogix IO modules and ControlLogix PLC. The FlexLogix adapter module shall be able to interface 128 points of input/output to a PLC Processor via ControlNet communications. The module shall have an integral BNC type communications port for connection to the ControlNet network. The module

shall be powered by a 24 VDC power source and provide 5 V dc power to the connected input/output modules through an internal power converter. Adapter module shall be an Allen/Bradley Model 1794-ACN.

E. OPERATOR INTERFACE TERMINAL (OIT)

1. Operator interface terminal shall be provided which will be a panel mounted electronic assembly that allows bi-directional communication between the programmable logic controller and the operator interface. It shall be Computer with a quad core intel Atm E345 CPU, 4GB RAM and 128GB SSD.

2. The operator interface terminal shall be a 15-inch Color display, with 1366x768 resolution with projected capacitive multi-touch. The operator interface terminal will employ.

3. Screens will be configured using an off-line PC based software package that runs in the Microsoft Windows environment, Windows 10. Each display screen will consist of graphic representations of legend plates, pushbuttons, pilot lights, numeric data displays, numeric data entry buttons, bar graphs, time displays, dynamic text displays, selector switches, illuminated pushbuttons, counter numeric preset and increment/decrement buttons. Graphics can be created using any software that produces or converts to standard Windows ".bmp" files. Applications will be downloaded to the operator interface and stored in its memory.

4. The operator interface terminal shall be capable of display text messages that can be triggered by the status values of bits or numeric variables in the programmable logic controller. In addition, the unit must be capable of accepting and displaying text messages that are stored in the programmable logic controller as ASCII strings.

5. The operator interface terminal shall be provided with the interface and cabling necessary to communicate with the PLC via Ethernet. Additionally, the contractor shall provide all cabling necessary to program the PLC locally without disconnecting the OIT or Ethernet connection.

6. OIT power requirements shall be 24VDC.

7. Provide Panel mount brackets, cabling for power and communications, and all other accessories as required by the manufacturer and the contract documents.

8. The OIT programming software shall be supplied by the System Integrator and provided to the City. A Windows based configuration and development software package shall be provided on a CD to develop graphics, database tables, and to configure the operator interface terminal. The programming software shall run on a laptop or personal computer, and provide the means for directly entering, debugging, and documenting the operator interface terminal for all graphics, configuration, database, and development. Provide all cabling and accessories for direct connection to the PLC. The software shall be the latest version, with provisions, modules, and software for all communications. The software shall be licensed to Canton City, Georgia, Department of Public Works

2.02 MANUFACTURERS

A. Provide ControlLogix 1756-L72 PLC and associated modules manufacturer by Allen Bradley.

B. Provide Panelview Plus 7, 15 inch, Model 2711P-T15C22A9P**,** manufactured by Allen Bradley.

C. Provide Allen Bradley RSLogix5000 PLC programming software and Factory Talk ME edition for OIT programming.

2.03 DESIGN CONDITIONS

A. The PLC, OIT and associated hardware shall have the following ratings:

| | |
|---|---|
| Temperature | 0 to 50° C ambient |
| Humidity | 5% to 95% relative humidity (non-condensing) |
| Power | 120 VAC, 60 Hz |

PART 3: EXECUTION (Refer to Section 16900)

END OF SECTION

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# SECTION 16946

# CABINETS, PANELS, CONSOLES, AND DEVICES

## PART 1: GENERAL

### 1.01 SECTION INCLUDES

A. This section includes requirements for materials, and installation of the cabinets, control panels and consoles to be provided by the System Integrator (SI) under Section 16900. A list of Control Panels specified for this project can be found at the end of this section, “Table 16946-01 – Control Panel List”

### 1.02 QUALITY ASSURANCE

A. Comply with applicable portions of Section 01400.

### 1.03 SUBMITTALS

A. Submit shop drawings and catalog data in accordance with Section 01300 and Section 16900.

### 1.04 SPECIAL TOOLS AND SPARE PARTS

A. Provide spare parts recommended by the manufacturer. As a minimum provide the following:

1 – spare heater of each type provided

1 – spare fan of each type provided

1 – spare Ethernet switch of each type provided

1 – Fiber optic transceiver of each type provided

2 – spare power supplies of each type provided

10 – spare relays of each type provided

5 – TVSS for AC power of each type provided

10 – IO Surge Suppression Devices of each type provided

5 – Intrinsically Safe Barriers and Relays of each type provided

2 – Wi-Fi Radios of each type provided

2 – Wi-Fi___33 Antennas of each type provided

5 – Antenna Surge Protection devices of each type provided

B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment. Special tools are those that are not readily available through a commercial tool supplier.

1.05 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Delivery, handle and store the equipment in accordance with division 1 specifications and the manufacturer's instructions.

1.06 RELATED WORK SPECIFIED ELSEWHERE

A. General Electrical: 16010

B. General Control System Requirements: 16900

PART 2: PART 2 - PRODUCTS

2.01 GENERAL

A. NEMA 12 CABINETS AND ENCLOSURES

1. The NEMA 12 cabinets and enclosures shall be floor or wall mounted enclosures, unless otherwise shown, suitable for a damp and dusty environment. Access door shall have continuous hinges with neoprene gaskets, with 3-point latch system. Cabinets shall be constructed from formed 12-gauge steel. All exposed edges and welds on the enclosure shall be ground smooth.

2. The exterior of the enclosure shall be painted with a rust-inhibiting primer and two coats of epoxy gray paint.

3. The interior shall be provided with a formed 12-gauge subpanel for attaching surface-mounted components and a hinged subpanel for front panel mounted hardware. All components shall be attached with screws and the subpanel shall be threaded. Rivets on back of panel nuts shall not be allowed. Each interior shall be equipped with an incandescent lamp, 120-volt 15-ampere duplex GFI receptacle and two single-pole, 15-ampere, 120-volt circuit breakers. One circuit breaker shall be for the lights and outlets. The other circuit breaker shall be for the PLC and instrumentation equipment. The interior shall be painted with two coats of white enamel paint. Refer to instrumentation drawing for enclosure size and installation details. The NEMA 12 cabinet shall be a Hoffman NEMA 12, or equal.

B. NEMA 4X CABINETS AND ENCLOSURE

1. NEMA 4X cabinets shall be floor-mounted or wall mounting as shown on the drawings. Fabricated from stainless steel or fiberglass, as specified. Access door shall have continuous hinge and hasps for locking.

2. Interior requirements shall be the same as NEMA 12 enclosure. The NEMA 4X cabinet shall be Hoffman NEMA 4X, or equal.

C. NEMA 7 CABINET AND ENCLOSURES

1. Provide NEMA 7 explosion proof enclosures cabinets for hazardous areas Class 1 Div. 1 and 2. The panels shall be floor-mounted or wall mounting as shown on the drawings.

2. Panel shall meet the following:

a. Corrosion resistant, copper free aluminum.

b. Type 4 watertight gasket.

c. Stainless steel cover bolts for type 4X corrosion protection

d. UL approval

3. Contract to coordinate panel layout and entry the conduit size with panel supplier before shipping.

4. The NEMA 7 cabinet shall be Adalat, or equal.

D. UPS SYSTEMS

1. Provide an on-line UPS to protect the PLC and other equipment in the cabinet from line disturbance, subcycle power losses, and power outages. In normal operation, the a-c power shall be rectified to d-c power. The d-c power from the charger shall maintain the batteries at full charge. When line power fails, the inverter shall change the battery d-c power pack to a-c while it regulates and provides a sine wave power to the load. The load shall automatically transfer to the inverter a-c line in less than 10 milliseconds. The UPS shall be complete with power indication, inverter circuit breaker protection, power fail, and low battery alarm relay contacts. Batteries shall be sealed, leakproof and maintenance free, mounted in a separate battery rack. UPS unit shall come complete with internal battery charger and battery connect cables.

2. The UPS system shall have the following requirements:

a. Input/Output Voltage: 120-volt a-c, single phase 60 Hz.

b. Minimum Output Rating: 1500 VA at each PLC Cabinet; 1000 VA at RIO Cabinet; 3000 VA at Network Cabinet in Administration building, 1500 VA for each client workstation in administration building.

c. Output Harmonic Distortion: 5% maximum at full load.

d. Frequency Stability: +/-0.5%.

e. Overload Capacity: 125% for 10 minutes.

f. Maximum Charge Rate with Load: 20 amperes.

g. Minimum Run Time: 30 minutes at half load.

h. Relay alarm module with minimum two dry contacts for connection to the PLC (PLC and RIO Cabinets): Fail and Low Battery

3. A shelf mounting bracket assembly shall be provided for mounting the UPS inside PLC cabinets. All wiring between the PLC and UPS shall be provided and installed by the System Integrator (SI).

4. A rack mounted power supply shall be provided for the network cabinet in the Administration Building.

5. Submit calculations with each panel indicating the calculated runtime for the connected loads in the panel.

6. The UPS systems shall be manufactured by Eaton Powerware or equal.

E. PANEL CONTROL CIRCUIT DEVICES AND COMPONENTS

1. General: All components, except those on the front panels, shall be mounted behind on fixed or swing-out panels; terminal blocks for field connections shall be mounted on fixed channels located near the bottom of the sections but clear of the conduit entry area. Fixed panels shall be located so as not prevent access within the cabinets to other components, wiring, and terminal blocks on fixed panels or front panels.

2. Control Relays: Control relays shall have either 24-volt d-c or 120-volt a-c coils. Control relays shall be 10-ampere, 300-volt, DC relays shall be blade type and AC relays shall be pin type with dust cover, LED indication, and sockets. All relays shall be of one manufacturer: Struthers-Dunn, Potter-Brumfield, or equal.

3. Circuit Breakers: Circuit breakers shall be din rail mounted, single-pole, 120 volt, 15-ampere rating.

4. Wire marking: Each signal and circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings. These numbers shall be marked on all conductors at every terminal using white numbered wire markers which shall be Thomas & Betts sleeve markers, T&B Shrink-Kon, or equal.

5. Terminal Blocks: Terminal block shall be high-density type molded plastic with barriers and box lug terminals and shall be rated 25 amperes at 300 Volts. White marking strips fastened securely to the molded sections shall be provided with printed wire numbers or circuit identifications. Terminal screws will be accessible with a standard size narrow blade screwdriver. Provide minimum 25% spare terminal blocks mounted in each cabinet. Terminal blocks shall be Phoenix Contact Type UK with mounting rail or equal.

6. D-C Power Supplies: Provide dual d-c power supplies with relay monitored backup at all locations requiring d-c circuits. Each power supply shall be enclosed and include internal short-circuit protection. Current requirements of connected equipment shall not exceed 75% of manufacturer maximum rating. Submit power supply calculations with each panel demonstrating 25% available power above the connected load.

7. Receptacles: Duplex receptacles shall be molded composition, ivory, specification grade. Duplex receptacles for 120-volt, single-phase, 3-wire service to be rated 20 amperes, 125 volts, back or side wired, NEMA Type 5-20R. Provide ground fault interrupter type where indicated and as required by UL.

8. DC Signal Conditioner: Provide a DC Signal Conditioner where required to drive or isolate loads. The signal conditioner shall have input and output ranges compatible with the associated equipment. The DC input/output isolation shall allow up to 600 V differences between grounds. The conditioner shall have an accuracy of +/-0.1% of input span, a zero and span adjustment and a maximum response time of 100msec. The operating temperature range shall be 0 to 60 degrees C. Power for the signal conditioner shall be 120 VAC at 60 Hz. Provide an Action Instruments Action Pak Model 4300, or equal.

9. Push Buttons, Selector Switches, and Indicating Lights: Push buttons, selector switches, and indicating lights shall be heavy duty, 30.5 mm, oil tight type with

synthetic rubber boots and include any special gasketing required to make the installation watertight. Indicating lights shall be LED cluster push-to-test transformer type. Provide Allen-Bradley Bulletin 800H; Square D Class 9001, Type SK; or equal.

10. Transient Voltage Surge Suppressor: The AC power line protector shall be a solid state low pass non-linear filter to protect the cabinet equipment from spikes, transients, and noise on incoming AC power lines. The protector shall be rated 120 volts A-C, 15 amps, 60 Hz. Refer to section 16670 for specifications.

11. I/O Signal Surge Suppressors

    a. Surge suppression shall be provided for each analog signal which exits the room/building where the PLC cabinet is installed. Refer to Specification Section 16670.2.03.

    b. Surge suppressors shall be mounted on a universal mounting rail. They shall be wired in the circuit so as to protect the PLC equipment from electrical transients whose source is external to the enclosure.

    c. Surge suppressors shall be rated at the nominal power supply voltage of the circuit they are protecting.

    d. Digital I/O signal surge suppressors shall meet the following:

    e. Common power for the input points on each input module shall be protected from incoming transients by the furnishing of a surge suppressor the PLC input and the incoming signal. The surge suppressor shall as a minimum include a gas filled discharge tube, a metal oxide varistor and a series coil. The maximum series resistance at 100 Hz shall be 50 Ohms. At one megahertz at least 30 decibels of attenuation shall be provided. The rated operating current shall be one to two Amps.

12. Panel Heating/Ventilation and Cooling Devices

    a. Furnish thermostatically controlled fan-driven electric heater units on enclosures mounted in exterior locations. Heaters shall be capable of maintaining an inside air temperature of 50 degrees F based on an outside air temperature of 30 degrees F. Air sensing thermostats shall be adjustable from 0 degrees F to 100 degrees F. Heaters shall be Hoffman Design air, or equal.

    b. Furnish ventilation fans with an associated vent/louver to draw air throughout the interior of all NEMA 12 PLC or RIO enclosures. Size fans based on enclosure heat loss calculations and ambient temperature in the facility.

    c. For exterior PLC and RIO enclosures or as indicated on the drawings, provide air conditioning units to maintain an interior panel temperature of 86 degrees Fahrenheit or less based on an exterior ambient temperature of 104 degrees Fahrenheit.

    d. Provide Hoffman or equal.

13. Intrinsically Safe Relay/Barrier

a. An intrinsically safe relay/barrier shall be installed in the control panel for connection of all devices located in hazardous locations.

F. PANEL CONTROL CIRCUIT WIRING

1. Instrumentation signal cables shall be of the type used for process control with shielded pairs or triads with polyvinyl jacket and overall shield over the multiple pairs or triads. The instrumentation cable shall be rated 300 volts at 90 C or better. The size of the instrumentation cable shall be AWG No. 16 with seven strands minimum, unless otherwise specified elsewhere. All instrumentation cables shall meet all the requirements of IPCEA S-61-402 and shall be UL listed.

2. 120-volt a-c wiring within the panel shall be AWG No. 14 MTW or THHN. Main power (120-volt a-c) to the panels shall be wired using color coded AWG No. 12. A-C power to all system power supplies, CRTs, printers, and computers, shall be accomplished using molded 3-wire plug cords.

   Wires shall be color coded in accordance with the following table:

| | |
|---|---|
| BLACK | L1 (hot) |
| WHITE | L2 (neutral) |
| RED | a-c control circuits |
| BLUE | d-c circuits (+) |
| BLUE/BLACK | d-c circuits (-) |
| YELLOW | Interlock control circuits wired from an external power source |
| GREEN | Equipment ground |

3. All interfacing between the cabinet and the field shall be accomplished at terminal blocks or surge suppression devices. No internal panel wiring shall be connected to terminals on the “field side” of the terminal blocks. Likewise, no field wiring shall be connected to terminals on the ‘panel side’ of the terminal blocks.

4. Wiring run from components on a swing-out panel or door to other components on a fixed back panel shall be made up in tied bundles. These shall be tied covered with split spiral wrap and shall be secured to panels at both sides of the hinge loop so that conductors are not strained at terminals.

5. Wiring run to control devices on the front panels shall be tied together at short intervals and secured to the inside face of the panel using Panduit adhesive mounts with Eastman No. 910 adhesive or with wireway and covers.

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

7. Conformance to the above wiring installation requirements shall be reflected by details shown on the shop drawings for the Engineer’s review.

8. Signal conditioners and control interface relays shall be provided wherever proper instrument interfacing dictates use of these components. Each auxiliary device shall be assigned a tag number and shall appear on the panel

shop drawings. Not all control relays, signal conditioners, and analog loop splitters are shown on the drawings or specified. The system integrator shall provide as required for a working system.

9. All electrical devices within the panel shall be identified by tag number, machine printed on a phenolic nameplate from the panel interior. Labels shall be laminated plastic with an adhesive backing. The labels shall be consistent in size throughout the panel.

10. All electrical devices within the cabinet, or fed from the cabinet, shall have independent disconnecting means with overcurrent protection.

11. All panels shall be fabricated by the system integrator (SI) who is a recognized Underwriter's Laboratories (UL) Industrial Control Panel Fabricator. Each panel shall include certification and a label which states that it has been fabricated within the standards of UL 508 for non-hazardous installations and UL 698A for hazardous installations. Only labeled panels produced by recognized UL panel manufacturers shall be considered acceptable for use on the project. NEMA ratings for enclosures shall be retained with UL Certification.

G. MANAGED ETHERNET SWITCH PLC and RIO CABINETS

1. Provide a 10/100/1000 FX/TX management Ethernet switch for integration of the local control station networks.
    a. The switch shall meet the following requirements:
        1) TCP/IP protocol
        2) Integrated web server function
        3) IGMP snooping
        4) VLAN
        5) Port security
        6) Status LED
    b. Configuration/Diagnostic
        1) Web-based management, SNMP Serial Factory Manager
        2) Port status indication
    c. Power
        1) 24VDC or 120 VAC, 60 Hz
        2) If 24 VDC switch is provided, provide required power supply.
    d. Provide number of Ethernet (copper) ports and fiber optic (FO) ports as shown on drawings and as indicated. All switches shall have a minimum of two spare Ethernet ports, or more as indicated.
    e. Environmental:
        1) Operating temperature: -40 grade C to +85 grade C
    f. UL listed
    g. Provide as a minimum 2 spare TX ports on each ethernet switch.

h. Provide din rail or rack mount switch based on type of enclosure to be installed.

i. Manufacturer

1) Provide Ethernet Switch manufacturer by Red Lion Model 7000 or equal.

H. CAT5/FIBER OPTIC TRANSCEIVER

1. The Ethernet to Fiber converter shall be a stand-alone unit providing a single conversion between 10/100-Mbps Ethernet, such as 10/100BASE-T and 10/100BASE-FL. It shall consist of one (1) 10/100BASE-T RJ45 port and one (1) ST connector Multimode Fiber port. It shall contain a 95/240 VAC universal power supply. The entire unit shall be approved by UL, CUL, and CE. The Ethernet to Fiber converter shall be manufactured by n-Tron/Redlion, or equal.

I. NETWORK SWITCH ADMINSTRATION BUILDING NETWORK CABINET

1. Provide a 19” rack mounted ethernet switch for connection of the plant control system HMI hardware and the other equipment in the Administration building to the PLC system.

2. Switch shall use SFP ports for connection from the same manufacturer as the switch.

3. Power shall be 120 volt, 1 phase.

4. The switch shall be able to detect a blocked ports and redirect data flow.

5. Provide network management software with the switch and load on both servers in the Administration building. The software shall allow logging into the switch for diagnostics and support.

6. Network switch shall be same manufacturer as PLC switch.

2.02 WIFI WIRELESS NETWORK

A. Wi-Fi coverage area is the entire fenced area of the wastewater treatment plant and the new Administration Building. The System Integrator shall provide the number of Wi-Fi radios as shown on the drawings. All wiring, hardware, and connection means shall be in compliance with the National Electrical Code and/or applicable local codes.

B. Mounting and wiring:

1. All radios shall be mounted on a DIN rail conforming to DIN EN50022. Mounting foot of radio shall be constructed of metal.

2. Radios shall be capable of being installed side by side, with no gap or air space required for heat dissipation, with no loss of accuracy.

3. Radios shall be installed in control panels as shown on the drawings.

4. Mounting guidelines will be followed as indicated in installation instruction provided by manufacturer.

5. Wires shall be attached to the modules by pluggable terminal blocks that accept wire sizes from 24 to 14 AWG.

6. Pluggable terminal blocks will be keyed to help prevent incorrect positioning of the plug in the modules.

7. The terminal blocks will be clearly numbered to provide easy reference.

C. 802.11N DIN-Rail Mount Radio Features:

1. Transmit power shall be maximum 200 mW.

2. The radio shall be UL listed and rated for Class 1, Division 2 areas.

3. Shall be approved for use in the 2.4 GHz and 5 GHz ranges, as required in FCC/CFR 47, Part 15.

4. Shall incorporate 2 Multiple Input Multiple Output (MiMo) antenna technology with two antenna to achieve the maximum throughput of 300 Mbps over 5 GHz at 802.11n.

5. Shall comply with the 802.11a/b/g/n standards.

6. To ensure that communication is secure and interoperable the module must support TKIP, WPA, WPA2, 802.11i security standards and 802.1X/RADIUS.

7. The radio shall be configured through an embedded web server that is accessed through a standard browser on a PC. Device configurations can be saved on a standard SD card.

8. The radio shall have two Ethernet 10/100 Mbps port that supports TCP/IP, UDP and IPv4 protocols.

9. The radio shall support firmware upgrades via the SD card, wireless and Ethernet connections.

10. The radio shall support Access Point, Repeater, and Client modes for application diversity.

11. The radio shall support configuration via wireless or wired Ethernet network. The radio shall incorporate a mode button on the front of the radio to perform basic configuration changes. The radio shall support cluster management to configure specific radio settings for groups of radios through modifying one radio in that group.

12. The radio shall have LED visual indicators for displaying power, WLAN connection and LAN status and relative signal strength when in Client mode.

13. Input power: 24 VDC nominal, range of 10 VDC – 36 VDC.

14. Operating temperature: -25 ºC to 60 ºC.

15. Degree of Protection: IP20

16. Radio shall be manufactured by Phoenix Contact, FL WLAN 5111, or approved equal.

C. Omnidirectional Antenna Features (802.11N radio):

1. Provide quantity as indicated on the drawings and as required by the manufacturer.

2. Dual Band Frequency Range: 2.4 GHz – 2.5 GHz and 5.15 – 5.83 GHz.

3. Gain: 2.5 dBi and 5 dBi at 2.4 GHz and 5 GHz, respectively.

4. Impedance: 50 Ohms.

5. Horizontal beam width: 360º.

6. Vertical beam width: 30º.

7. Connector: Type N male.

8. Mounting Hardware: direct mounting on radio.

9. Operating temperature: -40 ºC to 70 ºC. IP68 rated.

10. Provide antenna cable, connectors, and surge protection for the antenna as recommended by the manufacturer.

11. Antenna shall be Phoenix Contact, ANT-OMNI-2459-02, or approved equal.

PART 3: EXECUTION

(Refer to Section 16900)

END OF SECTION

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# SECTION 16960

# HMI HARDWARE AND SOFTWARE

## PART 1: GENERAL

### 1.01 DESCRIPTION

A. This section includes requirements for the materials specified herein for the Human Machine Interface (HMI) System Software and Hardware.

B. The following equipment and software shall be provided, installed, configured, and tested by the System Integrator:

1. PLC Programming Software and Licenses (Refer to Section 16942)
2. HMI Runtime/Development Server Software (2 license)
3. HMI Runtime Client Software (3 licenses)
4. HMI Webview Software (3 Licenses)
5. Operator Interface Terminal Software (Refer to Section 16942)
6. HMI Server Hardware (2 Redundant Servers)
7. HMI Client Workstations (3 Workstations) with 21” Monitor
8. HMI Workstation 60 inch Monitor (2)
9. HMI Remote Access Tablets (3)
10. 19” Network Rack Enclosure
11. Uninterruptible Power Supply (Refer to Section 16946)
12. All other specified hardware, software, cabling, and equipment.

### 1.02 QUALITY ASSURANCE

A. Qualifications of Manufacturers and Vendors

B. All equipment furnished under this Section shall be furnished by system integrator (SI) as specified in Section 16900.

C. The SI shall furnish all equipment specified herein. All systems shall be the unit responsibility of the SI.

D. Materials and installation shall be in accordance with the latest revision of the following:

1. Underwriters Laboratory (UL)
2. National Electrical Manufacturer’s Association (NEMA)
3. Institute of Electrical and Electronics Engineers (IEEE)

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Fiber Optic Cable: 16125

B. General Control System Requirements: 16900

C. Control System Equipment: 16942

D. Control Description: 16965

1.04 SUBMITTAL

A. Provide submittals in accordance with 16900.

B. Submit data sheets and catalog literature that include the following:

1. Description of the hardware to be provided. Interfaces and cable date for connection of servers to operator workstation to PLCs

2. Submit details of all software specified and include type version, options, network capabilities, license agreement and system requirements.

3. IP addressing of all components on Ethernet communication. A Schematic with all IP addressing shall be included with the O&M manual.

4. Technical reference guide of the computers, printers, and hardware

C. Submit proposed graphic displays, reports, alarm priorities and list of user, groups, and privileges.

D. The Operational and Maintenance Manual shall include the following:

1. Data sheets and catalog literature of the HMI hardware.

2. Original manufacturer programming manuals, technical reference manuals and user manuals.

3. Color printout of all screens and pop-up windows.

4. Description of the HMI software including, but not limited to, detailed procedures for navigation thought the screens, operation of the configured keys “hotkeys”, login procedure, set-point changing, chart trending, report, and system backups.

5. Schematic of IP addressing with equipment identification and location

1.05 DELIVERY, STORAGE AND HANDLING

A. Due to rapidly evolving technology of the equipment specified herein, the requirements specified are to establish a baseline for the type of equipment required. Provide the latest hardware and software of similar specification at the time of purchase equivalent in cost to that which is specified. No equipment shall be ordered more than 3 months prior to when it is needed to be continuously used on the project.

B. Provide a temperature and humidity controlled, dust-free environment for storage and installed locations of all computing equipment.

C. Contractor is responsible for cleaning installed computer equipment, including monitor, keyboard, mouse, computer, Ethernet switches and the furniture there the equipment is installed.

## PART 2: PRODUCTS

### 2.01 FACILITY CONTROL SYSTEM SOFTWARE DESCRIPTION

A. Provide all software packages identified in Item 1.1.B. General information of the software is provided below.

B. HMI programming software package:

1. FactoryTalk View Site Edition Server: 250 Displays (9701-VWSS250LENE) Quantity 2

2. Factory Talk View Studio for FactoryTalk View Enterprise (9701-VWSTENE) Quantity 2

3. Factory Talk View SE Client (9701-VMSCWAENM) Quantity 3

4. Factory Talk ViewPoint 3 Client System (9522-VMP03RENM) Quantity 1

C. Software shall include device drives as required on this application.

D. Automatically call a pre-programmed list of personnel based on pre-selected sequence.

E. Remote monitoring shall be provided though Webserver application. Alarm summary display and equipment status screens shall be configured from remote visualization of the system. Remote system control shall be performed through the Microsoft remote access feature.

F. Provide 3 year extended maintenance and warranty package from Rockwell to provide all updates, patches, and work required for the system. The software and maintenance agreement shall be licensed directly to the City of Canton from Rockwell Automation. The maintenance agreement shall not begin until acceptance of the HMI system by the City.

### 2.02 HUMAN MACHINE INTERFACE (HMI) SOFTWARE SYSTEM

A. General

1. Provide a Windows®-based software program for creating and running data acquisition, monitoring, and control applications.

2. Configuration. The system shall provide a mechanism for accepting configuration input either directly from the keyboard, via a mouse, or indirectly through ASCII files that are created by an external text editor or relational database program.

3. On-line Operation. All configuration changes shall be capable of being made on-line, while the system is operating. Data definitions, operator displays, etc. shall be capable of being modified, added, or deleted without having to interrupt the data acquisition.

4. Documentation. The system shall provide complete user documentation, including examples of how to operate the various modules within the system. Documentation shall be provided on standard electronic format.

5. On-line Help. An on-line "help" facility, based upon Windows standard Hypertext, shall provide useful, context-sensitive information on the operation of the package. This help facility shall be capable of being invoked on-line through a point-and-click operation.

6. System Server. The system shall be capable of running as configured server/workstation. The Server shall include the following functions:

    a. HMI Server. The HMI Server is to store HMI project components (for example, graphic displays) and serves them to system wide operator workstations thereby removing the need to create duplicate copies and maintain them for multiple operator workstations.

    b. Data Server. The data server links networks and devices to system wide visualization and development components such as HMI clients and engineering workstations. It shall provide communication services between applications and devices on the plant floor allowing users to read, write, and configure values in plant floor devices, such as sensor readings and other system controller data.

    c. The server should handle failure detection and failovers automatically for all components (clients) of the system.

    d. Alarm Server. This alarm server alerts operators to critical alarm conditions and maintains a record of alarm status for historical access.

    e. Domain Server. A domain server is to be available that the system utilizes to manage highly distributed systems.

    f. Security Server. An available security server should protect against unauthorized use but still allow authorized users to use the system efficiently. The security is to be a centralized system which restricts access to system resources based on key security components. The security server shall have the capability to have either control-system local users/groups or domain-linked users/groups and the ability to use an existing domain.

        The key components that are to be securely managed by the security server are:

        - Users and groups of users
        - Actions, such as read, write, update, and download which can be performed on a secured resource.
        - Defined objects in the system, such as areas, data servers, graphic displays, control networks and devices, and so on, for which actions are allowed or denied. Each piece of the system can define its own set of securable resources and actions.
        - The computers or groups of computers from which actions can be performed on a secured resource.

g. License Server. Electronic software licenses for components are to be managed by a software license server. Software licenses for engineering workstations and for operator interface consoles shall be independent of the type and mixture of I/O used (analog vs. discrete, input vs. output). The software licenses (both runtime and engineering) shall be portable allowing the operator to transfer licenses from one PC to another without requiring intervention from the vendor.

h. OPC Server. The system must allow for 3rd party connectivity to the system controllers and to the HMI Server via an OPC interface. This open connectivity shall follow the OPC Foundation's standards to get information to or from the system. If the system is configured for redundancy, OPC communications must continue even in the event of an HMI or data server failure, without any extra work required from the 3rd party OPC client.

7. Capacity. The system software shall be provided with device tags to meet the system requirements. The software shall be able to display data from and write values directly to other nodes without the need to duplicate the data in the local system. Configurations that are not attached to I/O and do not contain tags shall also be available. These systems shall be available with two types of rights to a tag:

   a. With rights to read and write to tags in other nodes.

   b. With rights to only read tags from other nodes

   The developer using security codes controls the rights. For the smaller systems with a limited number of tags, only primary blocks are counted towards the I/O limit. There shall be no need to include tags located in other nodes nor tags that are calculated points.

B. Data Handling Capabilities

No programming, compiling, or linking shall be required to configure the system. The database tags shall be configurable on-line. New function and database tag assignments can be added while the system is performing data acquisition and control operations.

The process database containing the current value of the data, or tag list, shall be memory-resident. Floating-point arithmetic shall be used in all calculations. The database shall be stored as a standard Windows file on the local or network hard disk and, upon starting the system, this database is loaded into the computer’s memory. Only computers physically connected to the programmable controllers shall require a database.

1. Data Integrity

   The software shall provide pre-emptive multitasking to ensure that common Windows actions do not interfere with I/O communications, processing of data, alarming, and the integrity of the real-time and historical data. These common Windows actions include moving a window with a mouse, opening a file, accessing the hard disk, or printing a graphic display.

2. Database Tag Configuration

   Various input/output hardware assignments, as well as processing functions, shall be assigned to named tags or “function blocks". Multiple tags can be tied together to perform more complex functions. The scan-processing program shall also be capable of detecting and handling configuration errors at run-time. Any errors encountered shall generate messages to the user.

   The user shall be able to perform tag configuration (adding, modifying, deleting, and viewing) in several ways, as follows:

   a. Directly from the graphics editor, so that tags can be configured as graphics are developed.

   b. Via an interactive spreadsheet-style database builder program that uses a fill-in-the-blank menu methodology.

   c. Via the importation of an ASCII file developed in another standard windows program as input for tag creation.

   d. Importing tags from Allen Bradley PLC database

3. Database Tag Types

   Functions shall be available in the database to support the following tag types: Analog input, Analog Alarm, Analog Output, Boolean Logic, Calculation, Digital Input, Digital Output, Digital Register, Event Action, Program, Real-time Trend, Timer, Deadtime, , On-Off Control, String, System. SQL (Structured Query Language) Package (Package consists of two (2) database tag-types, the SQL Data and SQL Trigger that will use utilize Microsoft’s Open Database Connectivity (ODBC) for connection to the external ODBC-compliant database)

4. Tag Attributes

   Each tag shall have an instrumentation tag name of up to 255 characters. The name shall be alphanumeric. All other application programs will use this tagname as their sole reference to the data element assigned.

   For tags assigned to actual hardware points, they shall also contain fields for hardware device name, hardware address, hardware specific parameters, and signal conditioning requirements.

   Tags shall be processed periodically, with the fastest scan rate being fifty (50) milliseconds. Scan rates shall be able to be set independently for each appropriate tag. Longer scan rates of up to once per twenty-four (24) hours shall also be supported. A mechanism for load-leveling, or phasing, the time-based processing of tags is also required. Alternatively, the user may elect to have tags processed on an exception basis. This choice shall be allowed on a tag-by-tag basis.

   Each tag associated with a hardware address or capable of causing an alarm condition shall have a means of displaying a descriptive message on the alarm printer. The descriptor shall be, at least, 40 characters in length.

The system shall provide built-in signal generators, including saw tooth, ramp up, ramp down, sine curves and random numbers that can be used for process simulation purposes.

C. I/O Device Communications

The system shall support communication with a variety of external input/output (I/O) devices. The devices that can be interfaced to the system must include:

1. Display-only Communications. To facilitate communications with the programmable controller, the system shall provide display-only communications. Communications to read or write tags (analog and digital registers) shall only be established when a graphics display containing these tags is open. When the display is closed, communications shall cease.

2. Error Detection and Recovery. The device communications program will perform error checking on messages. These error checks shall include lost response (time-out) and data error (checksum, LRC, CRC, etc.).

3. Diagnostics. The system shall provide a diagnostic program capable of running on-line or off-line that can monitor message rates from the communication program. The diagnostic shall display the number of new messages, retries, time-outs, and any occurrences of error. For serial drivers, a built-in datascope shall be provided.

4. Communications Drivers. Provide a communications driver and all software licensing for communications with Allen Bradley PLCs via Ethernet/IP as indicated on drawings. The driver shall access all files in the PLC. The drivers shall be an open protocol, no proprietary software or drivers will be accepted.

5. The HMI Software Manufacturer, as an integral component of their system shall provide the communications drivers.

D. Graphics Capabilities

The graphics package shall provide a means of creating and displaying color graphic displays that will be used by the operator to monitor and control the process. Real-time values being read from the field devices shall be capable of being displayed in a variety of user-configurable formats.

Graphic displays shall be individual Microsoft Windows files and shall be able to be stored on the system disk, virtual (RAM) disk or file server, based on user-entered selections. There shall be no limit (other than physical disk size) to the number of displays that can be developed and accessed on-line.

The development and runtime graphics packages shall be multi-document architecture applications with the capability to each support up to ten (10) open displays simultaneously.

1. Graphic Creation. The system shall provide an interactive object-oriented editor that allows creation of graphic displays using a pointing device (for example, a mouse). The software must be designed with the ability to make changes to the graphics while the system is running. Shutting down the system shall not be required to make changes.

a. Color Support. The graphics package shall provide support for an unlimited choice of colors with 256 colors supported at any one time. The user shall have the ability to create, save, and restore custom color palettes.

b. Graphic Animation. Each display must have the ability to dynamically update elements in the picture. Defining the method for dynamic update shall be determined by a point and click operation.

c. Templates. A standard template shall be provided for allowing the user to create graphic layouts to be implemented to standardize the look of all displays. A set of templates shall be included with the standard product.

d. Tag Groups. The system shall provide a method of grouping tag names in a file such that specific tag names are provided to a generalized display. In this instance, display links shall not contain hard-coded tag names, but rather, they will contain identifiers that are substituted for real tag names from the tag group file when the display is requested by the operator. The system shall provide for the importation and exportation of tag group files from/to comma separated variable (CSV) files.

e. Operator Action Tracking. The system shall print a descriptive message with a time stamp and user ID on the alarm printer or to an alarm file for system events.

f. Command/Scripting Language. The system shall provide a command language that allows simple or complex actions or combination of actions to be readily performed. This language shall provide a mechanism for assigning multiple keystrokes and/or commands to a single keystroke, to a display-based pushbutton, or to any object on the display.

E. Alarm Handling

The system shall be capable of detecting alarm conditions based on the states and values of the various sensed variables. The alarm conditions shall be detected even if the variables causing alarms are not currently on the display. Alarm limits can be entered by the user at configuration time or from the operator's display during run-time. Alarm limits are expressed in engineering units.

1. Alarm Priorities and Filters. The system shall support at least 3 alarm priorities for each alarm type: High, Medium, and Low. A filtering mechanism shall be provided so that the system alarm priority can be adjusted.

2. Alarm Counters. There shall be a built-in method that keeps track of, at a minimum, the current number of alarms in each category.

3. Alarm Destinations. The system shall provide a means for placing an alarm message in one or more of the following locations:

- Alarm summary display
- Alarm printer

- Alarm message file on disk
- Alarm history window (first-in, first-out scrolling window on the display)

4. Alarm Notification and Acknowledgment. When a new alarm condition is detected, an alarm message will be generated. If the alarm condition code text for the block is on the current display, then the text will flash until the alarm is acknowledged. Alarm acknowledgment will be performed from the operator's keyboard or from a menu pull-down and shall require no more than one keystroke or mouse click.

5. Alarm Summary Display. The system must offer an alarm summary display as a pre-defined dynamic link within the graphics package. This alarm summary display must show a list of the pending alarms in the system. As new alarms are detected, entries are made to the display list. As the alarm conditions clear, the entries are removed from the list. Alarms can be acknowledged from the alarm summary display either individually (by clicking on an alarm acknowledgment field) or by a full page using a menu pull-down.

   The alarm summary display must provide sorting and filtering capabilities. The user shall be able to filter on node name, alarm area(s), alarm status and alarm priority. The user must be able to sort on time, tag, alarm area, alarm priority and alarm status.

F. Archiving and Reporting

The system must provide a facility for automatically collecting, storing, and recalling data. Recalled data will be made available to a trend display program, a report generation program and to user-written programs.

1. Data File Handling. Data will be stored in Windows-compatible files in compressed format.

2. Archive Configuration. The data to be collected by the archiving program will be identified through an interactive, menu-based configuration. The user will enter the tag name, collection rate, and data compression deadband value.

3. Displaying Archived Data. The operator shall be able to recall archived data from the disk to be displayed in graphic format. The display of archived data shall be user-configurable. It shall be possible to configure objects in graphic displays that, when selected, fetch pre-defined historical trend data from disk and display it to the operator.

The display shall support up to eight (8) variables to be displayed on the same time/value axis simultaneously. For each entry in the display list, the operator will be able to assign a given tag name and marker to a particular line color selected from a palette of 256 colors. The operator may also enter display engineering units ranges to cause scaling of the display.

Historical trend windows must be able to update with newly collected data at one (1), two (2), or five (5) minute intervals, as selected by the user.

Local display of data collected by any node on the network shall be supported.

4. Display Output. The trend graphic display must be printable to a black and white or color printer via the standard Microsoft Windows Print Manager. The data contained in the display must also be capable of being sent to an ASCII file or .PRN file.

G. Security Management

The software shall provide a user-based security system. If enabled, the security system must allow for the creation of users with certain rights and/or privileges. These rights must include the ability to run any combination or all of the applications in the data acquisition system. The ability to allow or disallow user access to change values, such as setpoint and machine-setups, on an individual tag basis shall be supported.

Groups of users, such as Operators or Supervisors, can be created and granted rights. All users assigned to a group obtain the rights of the group, although they are still tracked by the system by their individual ID. Individual members of a group may also be assigned additional rights. The security system will support either centralized or distributed security file management.

When user-based security is enabled, an audit trail will be generated in the system, which will tag every operator action with user identification (ID). Systems that use a level-based security methodology shall not be acceptable.

2.03 HMI HARDWARE

A. Provide two HMI server workstations, three HMI client workstations, two 60” monitor, and three tablets.

B. Provide next day computer manufacturer on-site service for all computer system hardware devices covering parts and labor for 5 years from date of purchase. The on-site service shall be performed by an authorized representative of the manufacture of the installed equipment.

2.04 CLIENT WORKSTATION

A. 1 Quad-Core Xeon Processor, 1.80 GHZ or greater, minimum of 10 MB L3 cache on chip die,

B. 1333 MHz front side bus minimum. Workstation shall have a second socket capable of accepting an equal quad core processor.

C. 8 GB of RAM fully buffered with ECC and 1333 MHz speed minimum. D. Media Drives

D. DVD ± Dual-layer Drive with both Read and Write Capability

E. Expansion slots

1. One x 8 PCI Express slot

2. Three x 4 PCI Express slots minimum

3. Two PCI-X 64-bit/133 MHz slots minimum

F. Internal Disk

1. 1 TB of usable storage minimum, consisting of one SAS, 15,000 RPM hard drive.

G. Video graphics card capable of 1600 X 900 pixels, 70 Hz refresh rate and 32-bit true color minimum. DVI, and HDMI or Display Port outputs. 512MB of dedicated video RAM minimum. Quad monitor support required.

H. Voice modem compatible with the selected HMI software and software alarm dialer.

I. I/O Ports & devices

1. Minimum of four USB 2.0 ports

J. Interface devices

1. Generic USB 104 key (Windows) keyboard, no hot keys onboard

2. Two button USB optical mouse with scroll wheel

3. Monitor

a. Provide two monitors for the one of the Operator Workstations. Provide one monitor and a 60 inch HDTV monitor for the other two workstations.

b. Monitor shall be LCD 21 inch nominal size

c. 1600 x 900 resolution with 70Hx minimum

d. 16 ms response time

e. 250 nits brightness minimum

f. 400 to 1 contrast ration

K. Networking

1. Provide (2) network cards in addition to any on-board network interface

2. Gigabit Ethernet port, copper connection accepting standard CAT-6 cables for Ethernet communications

L. Power supplies must operate from the voltage shown on the drawings

M. Operating System: Latest edition and release of Windows 10 Pro Operating System Software with service packs compatible with the selected HMI software. Provide all DVD media required to reinstall operating system and system drivers from bare metal server configuration. Furnished operating system must be compatible with the HMI, PLC programming, IO drivers, and any other system software furnished on the project.

N. Other Software

1. Microsoft Office Professional 2010 with the following programs at a minimum.

a. Microsoft Excel

b. Microsoft Word

c. Microsoft Access

d. Microsoft PowerPoint

2. Adobe Acrobat Reader (Latest Edition)

3. Virus Scan and protection software Symantec Norton Antivirus Business Pack

4. Microsoft Internet Explorer (Latest Edition)

5. WinZip Professional (Latest Edition)

O. Manufacturer

1. Dell PowerEdge T420 Series, or Equal.

2.05 SERVER

A. 1 Quad-Core Xeon Processor, 2.80 GHZ or greater, minimum of 10 MB L3 cache on chip die,

B. 1333 MHz front side bus minimum. Workstation shall have a second socket capable of accepting an equal quad core processor.

C. 16 GB of RAM fully buffered with ECC and 1333 MHz speed minimum.

D. DVD ± Dual-layer Drive with both Read and Write Capability

E. Expansion slots

1. Four Three x 8 PCI Express slot

2. One x 16 PCI Express slots minimum

F. Internal Disk Array

1. 1 TB of usable storage minimum, consisting of two SAS, 15,000 RPM hard drives configured in a RAID 1 array.

G. Video graphics card capable of 12800 X 10240 pixels, 70 Hz refresh rate and 32-bit true color minimum.

H. I/O Ports & devices

1. Minimum of four USB 2.0 ports

I. Interface devices

1. Rack mounted server will connect to rack mounted keyboard/monitor/mouse specified with 19” rack enclosure.

J. Networking

1. Network cards in addition to any on-board network interface

2. Gigabit Ethernet port, copper connection accepting standard CAT-6 cables for Ethernet communications

3. All Network features shall support the Microsoft server software.

K. Power supplies must operate from the voltage as shown on the drawings.

L. Operating System: Latest edition and release of Windows Server 2019 Software with service packs compatible with the selected HMI software. Provide all DVD media required to reinstall operating system and system drivers from bare metal server configuration. Furnished operating system must be compatible with the HMI, PLC programming, IO drivers, and any other system software furnished on the project. 5 CALs shall be provided at minimum for Windows Server.

M. Other Software

1. Microsoft Office Professional 2010 with the following programs at a minimum.
    a. Microsoft Excel
    b. Microsoft Word
    c. Microsoft Access
    d. Microsoft PowerPoint
2. Adobe Acrobat Reader (Latest Edition)
3. Virus Scan and protection software Symantec Norton Antivirus Business Pack
4. Microsoft Internet Explorer (Latest Edition)
5. WinZip Professional (Latest Edition)

N. Manufacturer

1. Dell PowerEdge R320 Series, or Equal.

2.06 19” RACK NETWORK/SERVER ENCLOSURE

A. Provide a network cabinet for installation in the administration building electrical room. The network cabinet shall be fan cooled and include 30 amp power strip for connection of the servers, network switch, radio, and other ancillary equipment to an uninterruptible power supply.

1. Network cabinet shall provide space for all equipment plus have 25% spare capacity, minimum size shall be 42 U space and 36 inches deep.
2. Cabinet shall allow for all equipment to be provided in 19 inch rack mounting units. Shelfs shall be provided as required for equipment.
3. Provide 4 sides with door access in front and rear.
4. Provide Roof fans and tray
5. Provide all mounting rails, cable management systems, and power strips for equipment.
6. Provide 30 amp, 120 volt power to panel for UPS power. The UPS shall power all equipment in the network cabinet.

7. Provide shelfs or mounting brackets for all equipment in the cabinet that does not come with 19” rack mounting hardware.

8. Minimum equipment to be provided in network cabinet includes the two HMI servers, KVM switch, one monitor, mouse, keyboard: 3000 VA UPS, cooling fans, power strips for 120 volt connection, radio system for facility Wi-Fi. Network switch for control system, fiber optic connections from FOD, and ancillary equipment.

9. Fiber Optic Distribution Box (FOD) shall be mounted adjacent to the network cabinet in the electrical room. Provide and install fiber optic patch cables into the network cabinet via bottom or top entry. Protect cables with Electrical Non-Metallic Tubing or equivalent protection.

10. Provide pull out shelf under monitor for keyboard and mouse operation.

B. Monitor Keyboard Tray/KVM Switch

1. The equipment shall be 19” rack mounted

2. Monitor shall be 17”, 1280 x 1024 resolution.

3. The KVM shall allow sharing of the keyboard, video, and mouse between both servers mounted within the rack.

4. Cabinet shall allow for all equipment to be provided in 19 inch rack mounting units. Shelfs shall be provided as required for equipment.

5. Provide 4 sides with door access in front and rear.

6. Provide Roof fans and tray.

7. Provide all mounting rails, cable management systems, and power strips.

2.07 Color Printer

8. The printer shall be capable of black and color plain paper printing at 600x600 dots per inch, 24 PPM minimum. The printer can support customer’s paper size 13x50 inches. The printer shall use laser technology to produce black or color prints without changing out print cartridges. The printer shall have a built-in USB port, wireless, and network port connection.

9. The printers shall support the HMI operating system.

10. Provide manufacturer recommended suppliers paper, hardware interface and cables for network connection.

11. Two-side printing.

12. Manufacturer: HP model Color LaserJet Pro, or equal

2.08 60” MONITOR

C. Provide two 60 inch monitor/HDTV for mounting on the wall in the administration building. Provide all wall mounting hardware with vertical tilt, power cables, and HDMI cables for connection of monitor to client workstation and receptacle.

D. Monitor shall be LED backlight rated for 24/7 use, 700 cd/m2 brightness, 4000:1 contrast ratio, 1920 x 1080 resolution, HDMI video connection, and 3 year onsite warranty.

E. Provide Sharp, or equal.

2.09 MANAGED ETHERNET SWITCH

F. Refer to Specification 16946.

PART 3: EXECUTION

3.01 GENERAL

A. Refer to Section 16900.

B. Refer to above references for software and hardware to be provided by the System Integrator.

C. System integrator shall provide hardware configuration, software development and complete system integration, installation, startup, testing, and demonstration of all equipment.

D. Install all equipment at the Owner's facility in accordance with applicable federal, state, and local codes. System Integrator shall be responsible for the performance of the complete system.

3.02 SOFTWARE INSTALLATION & CONFIGURATION

A. The HMI Server/client licenses, PLC Development program license and other software provided shall be installed, configured, tested and commissioning by the system integrator. All software shall be licensed to the City of Canton.

END OF SECTION

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# SECTION 16965

# CONTROL DESCRIPTIONS

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. This Section is provided to identify preliminary control strategies to be used to program the system.

B. All Plant Control System (PCS) PLC programming, Operator Interface Terminal (OIT) programming, and Human Machine Interface (HMI) programming shall be performed by the System Integrator as specified in section 16900.

C. The control descriptions are a baseline for the programming of the PLC and HMI systems. The workshops with the City and Engineer and the input from the vendors will define the final control descriptions. The System Integrator shall develop and maintain the control descriptions and all modifications during the project and implement into the final Operations and Maintenance manuals.

### 1.02 RELATED WORK

A. Refer to Section 16900 and the Process and Instrumentation drawings (P&IDs), the Input/Output list, the system block diagram, and vendor specifications.

## PART 2: PRODUCTS (Not Used)

## PART 3: EXECUTION

### 3.01 GENERAL

A. The control descriptions are broken into areas. The following is a list of areas and the P&IDs associated with each area.

Area 1: Influent Metering Flume, Headworks, and Grit Chambers
P&ID: 1-I-1

Area 4: Fine Screenings
P&ID 4-I-1

Area 5: BNR Basins 1 to 3
P&ID 5-I-1 to 5-I-4

Area 6: BNR Basin 4
P&ID 6-I-1 to 6-I-2

Area 7: Membrane (MBR) Facility
P&ID 7-I-1

Area 8: RAS Splitter Box
P&ID 8-I-1

Area 10: UVPA Facility
P&ID 10-I-1 to 10-I-2

Area 11: WAS Storage and Reuse Pump Station
P&ID 11-I-1 to 11-I-2

Area 12: Aerobic Digesters
P&ID 12-I-1 to 12-I-2

Area 14: Compressed Air System
P&ID 14-I-1

Area 15: Solids Handling Facility
P&ID 15-I-1 to 15-I-9

Area 17: BNR Alum Facility
P&ID 17-I-1

Area 18: Odor Control System
P&ID 18-I-1

Area 20: Electrical Systems
P&ID 20-I-1 to 20-I-2

B. PROGRAMMABLE LOGIC CONTROLLERS

1. The plant control system (PCS) consists of Rockwell Automation ControLogix PLCs located throughout the plant in a distributed platform. The system integrator is responsible for all PLC programming of the PLCs provided in the PCS Block Diagram on contract drawing I-2.

2. The vendor PLCs will be programmed by the vendors. The system integrator shall coordinate all the databases with the vendors for transferring data between the vendor PLC and the Plant Control System.

3. Refer to 16900 for IO and database requirements. The SI shall incorporate all vendor PLC and OIT database points into the PCS system for monitoring and alarming on the plant control system

C. HUMAN MACHINE INTERFACE (HMI)

1. The HMI is the Human Machine interface of the Plant Control System (PCS), The HMI consists of three workstations, two located at the Administration Building Operator Area and one located at the Administration Building Conference Room. The HMI Servers are located in the Administration Building Electrical Room.

2. The purpose of the HMI is to provide the operator with the ability to monitor and control the facility through the graphics and alarming at the workstations.

3. The HMI also provide archiving of data for troubleshooting and report development.

D. OPERATOR INTERFACE TERMINAL (OIT)

1. Operator interface terminal (OIT) is an electronic operator interface display panel that offers keypad/touch screen operation at the PLC panels throughout the plant. The OITs shall provide access to all database points and graphics throughout the facility.

2. Several of the vendor control panels include an OIT. The vendors are responsible for the program development of their OIT. The system integrator shall coordinate with the vendor for access to the database and OIT graphic structure, including alarming.

3. Refer to Section 16900 and Drawing I-2 for locations of OITs for the PCS PLC panels.

E. PLANT CONTROL SYSTEM (PCS) INTEGRATION

1. The system integrator is responsible for complete programming, software development, hardware interfacing, and software integration of the complete PCS for all components connected via hardwire, network communications, and wireless communications.

2. The IO list, HMI and OIT database, and control system drawings shall be completed and maintained by the SI throughout the project. The SI is responsible to implement all work required by the contract plus any changes performed during the course of the project. Updates to these documents shall be included in each System Integrator meeting and submitted for information a minimum of every 3 months during construction.

3. The system integrator shall attend construction progress meeting in addition to the coordination meetings defined in Section 16900 to present any information relevant to the PCS and project schedule. As the project is a phased construction, the PCS fabrication, implementation, programming, and testing shall be an integral part of the construction schedule.

4. The system integrator shall review the existing HMI database and PLC logic prior to disconnection or removal of the equipment. The existing system operation shall be presented to the Engineer and City at a workshop to determine if the existing logic shall be reproduced in the new PLC and HMI system or if new logic is required. This is only for existing equipment that is to remain in the new PCS.

3.02 PROGRAM DEVELOPMENT

A. SCREENS

1. The HMI system shall be configured with individual screens for the entire plant, each process, and individual components. The screens shall be developed with a navigation system to access the overview, each process, alarming, trending, and each component in a logical order. Screens are required for all components and data, including those implemented from the vendor panels interfaced into the PCS.

2. An overview screen of the facility shall be developed by the SI. The screen shall allow navigation to all process areas and include key flow, level, and analytical values without have to leave the screen.

3. Each process area shall have a screen or multiple screen. The P&IDs shall be used as a baseline for the screen development for the equipment shown. The vendor equipment provided by vendor submittals shall be used for development of other process areas. The minimum number of full display screens required for the process development shall be 50.

4. An alarm screen for current alarms and historical alarms shall be provided. An alarm banner on all screens to show the 3-5 most current alarms shall be developed.

5. Trending screens shall be developed for each analog value, plus analog values that are grouped as required by the engineer during the workshops. A minimum of 50 trends shall be developed.

6. Equipment run time screens including alarms with setpoints for maintenance shall be developed for each pump, motor, or equipment which runs on a continuous or partial basis. The screen shall allow the operator to reset the setpoint for maintenance or monitoring of each individual component.

7. Pop up screens shall be developed for each component, such as a valve, pump, gate, motor, instrument, etc. The screen shall include the specific parameters for that device, including automatic and manual control from the PCS. The pop up screen shall be activated by a navigation point on the device. The primary parameters for monitoring the device shall be on the process graphic screen.

8. The OIT at each PLC shall have identical screens so that all process' can be monitored and accessed from any location in the plant. The OIT screens shall be similar or identical to the HMI screens to allow an operator to see the same information at any location.

9. Each major component and equipment which is shown on the graphics shall include a page that can be accessed from the screen describing the equipment function, part and model number, manufacturer, and other pertinent information as defined by the City.

10. Other screens such as security, reporting, and PLC/network health shall be developed as required by the engineer during the workshops. These workshops will be in integral part of the programming of the PCS and development of the HMI and OIT systems.

B. PROGRAMMING STANDARDS

1. Operation mode: Equipment will be operated in the following modes:

   a. Remote/Auto: In automatic mode, the PLC will control the operation of the respective equipment based on the PLC programming.

   b. Remote/Manual: In manual mode, the operator will control the operation of the respective equipment through the HMI.

   c. Local: In local mode, the operator will control the operation of the respective equipment through the local control panels or local control stations at the field.

2. Equipment status: The equipment will have the following operational status:

| Status | Description | Color-Code |
|---|---|---|
| In Fail | Equipment is in failure condition and not available for operation | Amber with “Fail” text indication. |
| Running | Equipment is running | Red |
| Ready | Equipment is stopped, ready to run and not in fail condition | Green |
| Out of service | Equipment out of sequence by the operator or alarm condition. The equipment can be set by the operator to “Out of Service” when in maintenance | Blue |

   a. If an equipment status is “in fail” an alarm will be displayed at the HMI and the associated PLC will automatically perform the following:

   b. Lockout the equipment of sequence. The PLC will automatically set the equipment Out of Service until the fail condition is cleared.

   c. Start the next equipment in sequence, if applicable.

3. For Blowers or other equipment with more than two components in operation, a Matrix shall be configured at the PLC for manual lead/lags/standby sequence of operation. The matrix shown below will be set at the HMI/OIT for operator sequence selection.

| Equipment | Lead | Lag1 | Lag2 | Standby |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |

4. Time delays: Time delays for alarm and control are defined at the PLC. The operator adjusts these variable though the HMI.

5. Alarm/Control Set-point: The operator adjusts the alarm and control set-points either from the PCS thru the HMI or OITs, the adjustment is updated automatically at the other location.

6. Equipment Run time will be calculated by the PLC, based on time in operation.

7. Password is set at the HMI and OIT for set-point modifications by the Operator.

8. Graphics/Displays: Graphics of the process will be set at the HMI and OITs for monitoring and control.

9. Alarms: A summary of the alarms will be set at the HMI and OITs.

10. Manual/Auto control via the HMI and OIT shall be through a pop up display for each device which will include a selection of “Manual” or “Auto”. In “Manual” the device shall be able to be started or stopped from the HMI/OIT by the

operator. If the equipment is variable speed the speed selection shall be able to be set and maintained in the manual mode. In “Auto” the device shall be controlled via the control strategies defined in Section 3.03 below. Refer to Item 1 above. All equipment which has control points shall be provided with Manual/Auto Control.

11. The PCS shall track the parameters configuration of each motor or valve (running status, speed setpoint, open/close status, position setpoint, etc.…) that has a Manual/Auto software selector switch. This will allow for a bumpless transfer when going either from “Manual” to “Auto” mode or vice versa. When the Manual/Auto software selector switch of a motor is in the “Manual” position and then switched to the “Auto” position, the motor running status and speed setpoint shall be the initial values for the automatic calculations to start from. When the Manual/Auto software selector switch of a valve is in the “Manual” position and then switched to the “Auto” position, the valve opened/ closed/position status shall be the initial values for the automatic calculations to start from. When the Manual/Auto software selector switch of a motor is in the “Auto” position and then switched to the “Manual” position, the last calculated motor running status and speed setpoint shall be the values to be held when in “Manual” mode. When the Manual/Auto software selector switch of a valve is in the “Auto” position and then switched to the “Manual” position, the last calculated valve opened/closed/position status shall be the values to be held when in “Manual” mode.

12. The OITs shall be programmed with an HMI/OIT Control software selector switch to determine whether the associated PLC is being controlled from either the local OIT or from the plant wide HMI.

13. Unless specifically noted, all equipment shall be programmed to be automatically restarted and configured as it was right before a plant power outage event had occurred and when the standby generator has kicked in and is powering the plant. Also, unless specifically noted, all equipment shall be programmed to be automatically restarted and configured as it was right before the standby generator is shut down and power goes back to normal operations through the normal plant power feeds.

14. All motors shall be programmed so that if a motor because of a fail condition, it shall not be re-started automatically once the problem with the motor has been resolved. The start command on either the PCS HMI or OIT shall not be a maintained contact but a momentary command to the PLC. The run confirms of all motors shall seal in the control output to the motor once the momentary start command drops out. The run confirms shall be on an operator settable delay timer (with a default value of five seconds) in that if the run confirm is not present after five seconds, the contact output to the motor from the PLC shall drop out and an alarm shall be generated and notified at the HMI.

15. When an analog signal goes outside the 4-20 mA range due to a failure at the instrument or PLC card, an alarm shall be generated, and any control shall maintain on the last setpoint unless directed otherwise. Points may be configured differently on an individual basis as defined in workshops.

16. All analog instruments, except flowmeters shall include a High-High, High, Low, Low-Low, Bad-Transmitter-Alarm (BTA), and Rate of Change (ROC) analog alarms. These shall be monitored, programmed, configured, and

displayed, at the OIT and HMI. The final setpoints will be decided, configured, and enabled during startup with coordination with the engineer and operators.

17. Program all alarms to be individually disabled for testing and if a component is out of service or has failed. This parameter shall be accessible from the HMI.

18. All interlocks that cause a shutdown condition (Stop a piece of equipment and prevent it from being restarted or moved) shall be shown on the faceplate pop-up graphic for that piece of equipment. Interlock strategy shall be included in the “Auto” mode of operation. Failures of equipment and fault conditions shall require a reset action of the equipment from the local OIT. Resetting equipment from the HMI will be only through higher security levels.

19. The run confirm or on status of all motors and lamps shall be accumulated to calculate a run time status of the equipment on the SCADA controller and to be displayed on the HMI. Each run time accumulator shall show the today’s and the yesterday’s totals. Every day at midnight, the today’s total shall be moved to the yesterday’s total and the today’s total shall be reset. Each run time accumulator shall also show an accumulative totalizer with a maintenance setpoint for alarming total runtime hours. The total shall include a reset button on the HMI.

20. The run confirmed or on status of all motors and lamps shall be accounted for to calculate the number of times a motor has been started on the HMI. Each counter shall show the today’s and the yesterday’s totals. Every day at midnight, the today’s total shall be moved to the yesterday’s total and the today’s total shall be reset. Each counter shall also show an accumulative counter with a reset button on the HMI.

21. All flow indications shall be totalized. Do not totalize if the analog signal is outside the 4-20 mA range or if the value of the flow input is less than 2% of the full range of the input. Each flow totalizer shall show the today’s and the yesterday’s totals. Every day at midnight, the today’s total shall be moved to the yesterday’s total and the today’s total shall be reset. Each flow totalizer shall also show an accumulative totalizer with a reset button on the HMI.

22. The system integrator shall develop an interlock table for all equipment which defines interlocks directly connected to the equipment and interlocks between PLCs and other equipment and process’. All interlocks shall be able to be enabled and disabled from the HMI via an interlock screen.

23. The system integrator shall define each control point or parameter in the PLC with a security setting.

## 3.03 CONTROL STRATEGIES

### A. AREA 1 INFLUENT METERING FLUME, HEADWORKS, AND GRIT CHAMBER

#### 1. MONITORING POINTS

a. FI-200 Drain PS 1 Flow

b. FI-201 Influent Flow

c. LI-303 Screen #1 Upstream Level

d. LH-303 Screen #1 Upstream Hi Level
e. FI-304 Screen #1 Downstream Level
f. MN-300 Screen #1 Run
g. MF-300 Screen #1 Fail
h. MN-300 Screen #1 Conveyor Run
i. MF-300 Screen #1 Conveyor Fail
j. LI-313 Screen #2 Upstream Level
k. LH-313 Screen #2 Upstream Hi Level
l. FI-314 Screen #2 Downstream Level
m. MN-310 Screen #2 Run
n. MF-310 Screen #2 Fail
o. MN-310 Screen #2 Conveyor Run
p. MF-310 Screen #2 Conveyor Fail
q. LH-320 Grit Removal #1 Run
r. MF-320 Grit Removal #1 Fail
s. LH-320 Grit Removal #2 Run
t. MF-340 Grit Removal #2 Fail
u. MN-340 Grit Conveyor Run
v. MF-340 Grit Conveyor Fail

2. CONTROL POINTS
   a. FC-100 Influent Sampler Flow Meter #1 Flow
   b. MC-300 Screen #1 Start/Stop
   c. MC-310 Screen #2 Start/Stop
   d. MC-320 Grit Removal #1 Start/Stop
   e. MC-340 Grit Removal #2 Start/Stop

3. OPERATION
   a. The existing influent flume includes the existing level and flow monitoring equipment.
   b. The existing Screens (2) and existing Conveyor will be connected to PLC-IH for monitoring and control.
   c. One existing Grit System and Conveyor will be modified with a new control panel. The Conveyor system will be connected to PLC-IH for monitoring only. The new Grit Control Panel will provide monitoring and control of both Grit Removal systems via a network Connection to PLC-IH.
   d. Provide monitoring of the signals indicated in Section 3.02 above.

e. The SI shall review the existing logic in the existing PLC prior to modifying and discuss the existing system with the engineer and City during a workshop.

4. CONTROL

a. Automatic Operation – Screens

1) Level Control Mode

a) Operator will adjust four screen system level set-points:

– Shutoff Level for screen shutoff

– Low Level for screen low speed operation

– High Level for screen high speed operation

– High High level for alarm condition

b) The ultrasonic level sensors will sense the sewage level upstream of the screen.

c) When the sewage level reaches the predetermined Low Level, the screen will begin to operate at low speed.

d) The screen will continue to operate until the sewage level drops below the Shutoff Level set point and then it will stop.

e) If the sewage level increases and reaches the High Level set-point, screen operation will switch to high speed.

f) The screen will operate at high speed until the sewage level drops below the predetermined set point and then it will stop.

g) If the sewage level continues to increase and reaches the High High Level set-point, an alarm will be actuated to notify the operations staff of a problem.

2) Timer Control Mode

a) The operator must set a Run-Time duration, Off-Time duration, and operating speed (High or Low).

b) Operator selects screen for operation by opening associated slide gate. This will start and stop screens automatically.

c) The screen is activated by the ultrasonic level sensor.

d) The screen will alternate between running at the predetermined speed for the Run-Time duration and pausing for the predetermined Off-Time duration, provided the sewage level stays between the Shutoff Level and the High Alarm.

e) If the sewage level increases to the High Level an alarm will be actuated, and screen operation will transfer to the Level Control Mode

b. Emergency Operation

1) If any component jams during operation, the controls will automatically detect the problem, and the following will occur automatically:

a) Screen will stop.
b) Reverse the travel direction for a predetermined period of time.
c) Screen will stop.
d) Travel direction will return to normal.

B. AREA 4 FINE SCREENINGS FACILITY

1. MONITORING POINTS

| | | |
|---|---|---|
| a. | MA-401 | FS1 Influent Sluice Gate 1. Remote |
| b. | ZH-401 | FS1 Influent Sluice Gate 1. Open |
| c. | ZL-401 | FS1 Influent Sluice Gate 1. Close |
| d. | ZF-401 | FS1 Influent Sluice Gate 1. Fail |
| e. | YN-410 | Fine Screenings #1. Control Power |
| f. | MA-410 | Fine Screenings #1. Remote |
| g. | XF-410 | Fine Screenings #1. Fail |
| h. | LH-410 | Fine Screenings #1. High Level |
| i. | LHH-410 | Fine Screenings #1. Hi High Level |
| j. | YN-410 | Fine Screenings #1. E-Stop |
| k. | MA-410 | Fine Screenings #1. Run |
| l. | MA-430 | FS1 Effluent Sluice Gate 1. Remote |
| m. | ZH-430 | FS1 Effluent Sluice Gate 1. Open |
| n. | ZL-430 | FS1 Effluent Sluice Gate 1. Close |
| o. | ZF-430 | FS1 Effluent Sluice Gate 1. Fail |
| p. | MA-402 | FS2 Influent Sluice Gate 2. Remote |
| q. | ZH-402 | FS2 Influent Sluice Gate 2. Open |
| r. | ZL-402 | FS2 Influent Sluice Gate 2. Close |
| s. | ZF-402 | FS2 Influent Sluice Gate 2. Fail |
| t. | YN-420 | Fine Screenings #2. Control Power |
| u. | MA-420 | Fine Screenings #2. Remote |
| v. | XF-420 | Fine Screenings #2. Fail |
| w. | LH-420 | Fine Screenings #2. High Level |
| x. | LHH-420 | Fine Screenings #2. Hi High Level |
| y. | YN-420 | Fine Screenings #2. E-Stop |
| z. | MA-420 | Fine Screenings #2. Run |
| aa. | MA-420 | Fine Screenings #2. Pump Run |
| bb. | SI-420 | Fine Screenings #2. Speed Indication |
| cc. | MA-440 | FS2 Effluent Sluice Gate 1. Remote |

dd. ZH-440 FS2 Effluent Sluice Gate 1. Open
ee. ZL-440 FS2 Effluent Sluice Gate 1. Close
ff. ZF-440 FS2 Effluent Sluice Gate 1. Fail
gg. YN-450 FS Conveyor Power
hh. MA-450 FS Conveyor Remote
ii. MN-450 FS Conveyor Run
jj. YN-450 FS Conveyor E-stop
kk. MF-450 FS Conveyor Fail

2. CONTROL POINTS
   a. ZO-401 FS1 Influent Sluice Gate 1. Open
   b. ZC-401 FS1 Influent Sluice Gate 1. Close
   c. MC-410 Fine Screenings #1. Start/Stop
   d. SC-410 Fine Screenings #1. Speed Control
   e. ZO-430 FS1 Effluent Sluice Gate 1. Open
   f. ZC-430 FS1 Effluent Sluice Gate 1. Close
   g. ZO-402 FS2 Influent Sluice Gate 1. Open
   h. ZC-402 FS2 Influent Sluice Gate 1. Close
   i. MC-1210 Fine Screenings #2. Start/Stop
   j. SC-420 Fine Screenings #2. Speed Control
   k. ZO-440 FS2 Effluent Sluice Gate 1. Open
   l. ZC-440 FS2 Effluent Sluice Gate 1. Close
   m. MC-450 FS Conveyor Start/Stop

3. OPERATION
   a. The fine screen facility is a new facility for the upgrade.
   b. Each fine screen has a motorized influent sluice gate, a fine screen with a main control panel (MCP), a local control panel (LCP), and a motorized effluent sluice gate.
   c. A conveyor system provides the dumping of the screenings into a dumpster.

4. CONTROL
   a. Automatic Operation – Influent and Effluent Valves
      1) Operator shall control the influent and effluent valves in a Remote/ Manual operation only, to either open or close the valve.
   b. Automatic Operation – Fine Screens
      1) Level Control Mode
         a) Low Level for screen low speed operation

b) High Level for screen high speed operation

c) High High level for alarm condition

d) Operator selects screen for operation by opening associated influent and effluent sluice gate. This will start and stop screens automatically.

e) The ultrasonic level sensors will sense the sewage level upstream of the screen.

f) When the sewage level reaches the predetermined Low Level, the screen will begin to operate at low speed.

g) The screen will continue to operate until the sewage level drops below the Shutoff Level set point and then it will stop.

h) If the sewage level increases and reaches the High Level set-point, screen operation will switch to high speed.

i) The screen will operate at high speed until the sewage level drops below the predetermined set point and then it will stop.

j) If the sewage level continues to increase and reaches the High High Level set-point, an alarm will be actuated to notify the operations staff of a problem.

2) Timer Control Mode

a) The operator must set a Run-Time duration, Off-Time duration, and operating speed (High or Low).

b) Operator selects screen for operation by opening associated slide gate. This will start and stop screens automatically.

c) The screen is activated by the ultrasonic level sensor.

d) The screen will alternate between running at the predetermined speed for the Run-Time duration and pausing for the predetermined Off-Time duration, provided the sewage level stays between the Shutoff Level and the High Alarm.

e) If the sewage level increases to the High Level an alarm will be actuated, and screen operation will transfer to the Level Control Mode

c. Conveyor

1) The conveyor will operate when either of the fine screens operate. The conveyor direction will be based on which screen is in operation.

C. AREA 4 AERATION BASINS 1 (BASINS 2 AND 3 ARE TYPICAL)
(AREA 5 AERATION BASIN 4 TYPICAL)

1. MONITORING POINTS

| | | |
|---|---|---|
| a. | ZL-501 | BNR Influent Channel Sluice Gate # 1. Closed |
| b. | ZH-501 | BNR Influent Channel Sluice Gate # 1. Open |
| c. | AI-502A | AT1 OX-1-1 DO #1 DO |
| d. | AI-502B | AT1 OX-1-1 DO #2 DO |

| | | |
|---|---|---|
| e. | SI-503 | AT1 OX-1-1 Air Valve # 1. Position Ind |
| f. | MA-503 | AT1 OX-1-1 Air Valve # 1. Remote |
| g. | XF-503 | AT1 OX-1-1 Air Valve # 1. Valve Failure |
| h. | SI-504 | AT1 OX-1-1 Air Valve # 2. Position Ind |
| i. | MA-504 | AT1 OX-1-1 Air Valve # 2. Remote |
| j. | XF-504 | AT1 OX-1-1 Air Valve # 2. Valve Failure |
| k. | AI-505 | AT1 AX-1-1 ORP #1 ORP |
| l. | AI-508A | AT1 OX-1-2 DO #3 DO |
| m. | AI-508B | AT1 OX-1-2 DO #4 DO |
| n. | SI-509 | AT1 OX-1-2 Air Valve # 3. Position Ind |
| o. | MA-509 | AT1 OX-1-2 Air Valve # 3. Remote |
| p. | XF-509 | AT1 OX-1-2 Air Valve # 3. Valve Failure |
| q. | SI-510 | AT1 OX-1-2 Air Valve # 4. Position Ind |
| r. | MA-510 | AT1 OX-1-2 Air Valve # 4. Remote |
| s. | XF-510 | AT1 OX-1-2 Air Valve # 4. Valve Failure |
| t. | ZL-511 | AT1 Sluice Gate # 1. Closed |
| u. | ZH-511 | AT1 Sluice Gate # 1. Open |
| v. | FI-516 | AT1 AX--11 Recycle Flow Meter #1. Flow |
| w. | SI-536 | AT1 AX-1-1 Recycle Valve #1. Position Ind |
| x. | MA-536 | AT1 AX-1-1 Recycle Valve #1. Remote |
| y. | XF-536 | AT1 AX-1-1 Recycle Valve #1. Valve Failure |
| z. | SI-515 | AT1 AX-1-1 IR Pump # 1. Speed Indication |
| aa. | MA-515 | AT1 AX-1-1 IR Pump # 1. Remote |
| bb. | MN-515 | AT1 AX-1-1 IR Pump # 1. Run Status |
| cc. | TH-515 | AT1 AX-1-1 IR Pump # 1. Hi Temperature |
| dd. | YF-515 | AT1 AX-1-1 IR Pump # 1. Seal Leak |
| ee. | MF-515 | AT1 AX-1-1 IR Pump # 1. VFD Fail |
| ff. | FI-556 | AT1 OX-1-2 Recycle Flow Meter #2. Flow |
| gg. | SI-576 | AT1 OX-1-2 Recycle Valve #2. Position Ind |
| hh. | MA-576 | AT1 OX-1-2 Recycle Valve #2. Remote |
| ii. | XF-576 | AT1 OX-1-2 Recycle Valve #2. Valve Failure |
| jj. | SI-517 | AT1 OX-1-2 IR Pump # 1. Speed Indication |
| kk. | MA-517 | AT1 AX-1-2 IR Pump # 1. Remote |
| ll. | MN-517 | AT1 OX-1-2 IR Pump # 1. Run Status |
| mm. | TH-517 | AT1 OX-1-2 IR Pump # 1. Hi Temperature |

nn. YF-517 AT1 OX-1-2 IR Pump # 1. Seal Leak
oo. MF-517 AT1 OX-1-2 IR Pump # 1. VFD Fail
pp. MA-518 BNR Effluent Sluice Gate 1. Remote
qq. ZH-518 BNR Effluent Sluice Gate 1. Open
rr. ZL-518 BNR Effluent Sluice Gate 1. Close
ss. ZF-518 BNR Effluent Sluice Gate 1. Fail

2. CONTROL POINTS
   a. XC-503 AT1 OX-1-1 Air Valve # 1. Position Control
   b. XC-504 AT1 OX-1-1 Air Valve # 2. Position Control
   c. XC-509 AT1 OX-1-2 Air Valve # 3. Position Control
   d. XC-510 AT1 OX-1-2 Air Valve # 4. Position Control
   e. XC-536 AT1 AX-1-1 Recycle Valve #1. Position Control
   f. MC-515 AT1 AX-1-1 IR Pump # 1. Motor Control
   g. SC-515 AT1 AX-1-1 IR Pump # 1. Speed Control
   h. XC-576 AT1 OX-1-2 Recycle Valve #2. Position Control
   i. MC-517 AT1 OX-1-2 IR Pump # 2. Motor Control
   j. SC-517 AT1 OX-1-2 IR Pump # 2. Speed Control
   k. ZO-518 BNR Effluent Sluice Gate 1. Open
   l. ZC-518 BNR Effluent Sluice Gate 1. Close

3. OPERATION
   a. The aeration basins are defined in Area 4 of the P&IDs. Each basin has 2 pumps, 4 air valves, an influent gate (monitoring only, and an effluent gate.

4. CONTROL
   a. Automatic Operation – Influent and Effluent Valves
      1) Influent Valves are Monitored Only
         a) Effluent Valves are controlled from the HMI to open or close by the operator
      2) Automatic Operation – Air Valves
         a) Each air control valve will be controlled by the H/O/A selector switch located on the valve actuator. When the H/O/A switch is in the "hand" position, the valve may be manually controlled by the open/stop/close push buttons located on the valve actuator. When the H/O/A switch is in the "auto" position, the air control valve will be automatically controlled by PLC as follows:
            – An auto/manual selector switch shall be configured in the HMI software for each air control valve to select either manual or automatic control of the valve. In the "manual"

mode, the plant operator may manually position the valve from the computer via the HMI software. When the auto/manual switch is in the "auto" position, the valve will be automatically controlled by PLC in response to the dissolved oxygen content of the mixed liquor in the basin as follows:

+ For each zone, the PLC will compare the actual DO of the mixed liquor in the basin, as measured by the DO probe, to the DO set-point entered by the operator ($DO_{Setpoint1}$ and $DO_{Setpoint2}$) and will increment or decrement the associated air valves position. A PID Air Valve Controller will be configured in the PLC to control the % of opening and closing of each valve at each Diffuser Grid zones. The plant operator will enter the desired DO set-point to be maintained at each basin zone in the HMI.
+ The PLC will control the air valves at diffuser grids for each DO as defined by the engineer during the workshops.
    - If the DO reading is below the $DO_{Setpoint1}$, PLC will open the air control valves in $X_1$% increments, starting with the air control valve associated with diffuser grid 3-6. A time delay ($T_1$) will occur in the PLC after each incremental opening, prior to opening the valve another $X_1$%. Both the increment value $X_1$ and the time delay $T_1$ will be an adjustable value in the PLC logic and can be field adjusted on the HMI system with appropriate security access.
    - If the air control valve in the first air diffuser is $Y_1$% open, and the DO in the ditch is still below the $DO_{Setpoint1}$, the PLC will open the air control valve for the next air diffuser grid in $X_1$% increments. This incremental opening of the air control valves will continue sequentially until the $DO_{Setpoint1}$ is met. The maximum percent open of the valve (value $Y_1$) will be an adjustable value in the PLC logic and be able to be adjusted on the HMI system with appropriate security access.
    - If the DO in the basin is greater than the $DO_{Setpoint1}$, the PLC will close the air control valves in $X_2$% increments, in the reverse order until the $DO_{Setpoint1}$ is met using a time delay of $T_2$ and will move to the previous valve when the valve is $Y_2$% closed. The minimum percent closed of the valve (value $Y_2$) will be an adjustable value in the PLC logic and be able to be adjusted on the HMI system with appropriate security access.
+ Each Zone will have adjustable values for each of the parameter which will be established in the HMI system. The parameter will be accessible through security

password protection implemented in the HMI. The plant operator will enter the desired DO set-point to be maintained at each basin zone in the HMI.

3) Automatic Operation – IR Pumps

a) The IR pumps recycle internally in the basins and are used to return activated sludge from the zones. There is one pump in each zone as shown on the drawings.

b) Each pump is controlled by a VFD, enabling control of flow. The flow is monitored by a flow meter.

c) The VFD for the RAS pump will include a H/O/A selector switch.

d) In Hand mode, the pump shall run, and speed control shall be performed through the VFD keypad.

e) In Auto, the VFD and pump operation will be controlled through the PLC. Start/stop of the pump shall be initiated by the Operator at the HMI. The pump speed shall be controlled by one of three modes:

– Constant flow: Operator enters desired flow rate and pump speed varies to maintain the set flow rate.

– Percentage of influent: Operator enters desired percent RAS (of influent) and pump speed varies to maintain the flow in concert with influent.

– Manual: Operator enters desired speed

D. AREA 5 AERATION BLOWERS

1. MONITORING POINTS

a. PI-601 BNR Air Supply Pressure

b. PI-602 BNR Air Supply Pressure

c. PI-603 BNR Air Supply Pressure

d. PI-604 BNR Air Supply Pressure

e. ZL-610 Blower #1 Air Valve. Closed

f. ZH-610 Blower #1 Air Valve. Open

g. MA-610 Blower #1. Remote

h. PD-611 Blower #1. Filter Alarm

i. MN-610 Blower #1. Run Status

j. PI-612 Blower #1. Suction Pressure

k. TI-613 Blower #1. Oil Temperature

l. PI-614 Blower #1. Discharge Pressure

m. TI-615 Blower #1. Discharge Temperature

n. XF-610 Blower #1. System Fail

o. XW-610 Blower #1. System Warning

| | | |
|---|---|---|
| p. | SI-610 | Blower #1. Speed Indication |
| q. | ZL-620 | Blower #2 Air Valve. Closed |
| r. | ZH-620 | Blower #2 Air Valve. Open |
| s. | MA-620 | Blower #2. Remote |
| t. | PD-621 | Blower #2. Filter Alarm |
| u. | MN-620 | Blower #2. Run Status |
| v. | PI-622 | Blower #2. Suction Pressure |
| w. | TI-623 | Blower #2. Oil Temperature |
| x. | PI-624 | Blower #2. Discharge Pressure |
| y. | TI-625 | Blower #2. Discharge Temperature |
| z. | XF-620 | Blower #2. System Fail |
| aa. | XW-620 | Blower #2. System Warning |
| bb. | SI-620 | Blower #2. Speed Indication |
| cc. | ZL-630 | Blower #3 Air Valve. Closed |
| dd. | ZH-630 | Blower #3 Air Valve. Open |
| ee. | MA-630 | Blower #3. Remote |
| ff. | PD-631 | Blower #3. Filter Alarm |
| gg. | MN-630 | Blower #3. Run Status |
| hh. | PI-632 | Blower #3. Suction Pressure |
| ii. | TI-633 | Blower #3. Oil Temperature |
| jj. | PI-634 | Blower #3. Discharge Pressure |
| kk. | TI-635 | Blower #3. Discharge Temperature |
| ll. | XF-630 | Blower #3. System Fail |
| mm. | XW-630 | Blower #3. System Warning |
| nn. | SI-630 | Blower #3. Speed Indication |
| oo. | ZL-640 | Blower #4 Air Valve. Closed |
| pp. | ZH-640 | Blower #4 Air Valve. Open |
| qq. | MA-640 | Blower #4. Remote |
| rr. | PD-641 | Blower #4. Filter Alarm |
| ss. | MN-640 | Blower #4. Run Status |
| tt. | PI-642 | Blower #4. Suction Pressure |
| uu. | TI-643 | Blower #4. Oil Temperature |
| vv. | PI-644 | Blower #4. Discharge Pressure |
| ww. | TI-645 | Blower #4. Discharge Temperature |
| xx. | XF-640 | Blower #4. System Fail |

yy. XW-640 Blower #4. System Warning
zz. SI-640 Blower #4. Speed Indication
aaa. ZL-650 Blower #5 Air Valve. Closed
bbb. ZH-650 Blower #5 Air Valve. Open
ccc. MA-650 Blower #5. Remote
ddd. PD-651 Blower #5. Filter Alarm
eee. MN-650 Blower #5. Run Status
fff. PI-652 Blower #5. Suction Pressure
ggg. TI-653 Blower #5. Oil Temperature
hhh. PI-654 Blower #5. Discharge Pressure
iii. TI-655 Blower #5. Discharge Temperature
jjj. XF-650 Blower #5. System Fail
kkk. XW-650 Blower #5. System Warning
lll. SI-650 Blower #5. Speed Indication

2. CONTROL POINTS
   a. MC-610 Blower #1. Start/Stop
   b. SC-610 Blower #1. Speed Control
   c. MC-620 Blower #2. Start/Stop
   d. SC-620 Blower #2. Speed Control
   e. MC-630 Blower #3. Start/Stop
   f. SC-630 Blower #3. Speed Control
   g. MC-640 Blower #4. Start/Stop
   h. SC-640 Blower #4. Speed Control
   i. MC-650 Blower #5. Start/Stop
   j. SC-650 Blower #5. Speed Control

3. OPERATION
   a. The Aeration Basins are provided air via 5 blowers. The blowers are configured with 1 blower per basin, and a standby blower. The blowers operate on a variable frequency drive provided by the blower manufacturer.

4. CONTROL
   a. Automatic Operation
      1) In general, the blowers are operated to maintain a constant pressure in the air distribution header. As the control valves on the diffuser drop legs open, and the pressure in the air header drops below the set point, the speed of the blower in operation increases, and/or additional blowers are called for to maintain the setpoint. Likewise,

the speed of the blower decreases, and/or /blowers are taken out of service to decrease the pressure in the air header.

2) The operator will select at the HMI the Manual or Automatic alternation of the blower. In manual alternation, the PLC will start/stop the blower based on the blower matrix configuration, the operator will change the lead and lags blower selection manually at the matrix.

3) A blower envelope curve including operating ranges with different blower combinations is shown in the figure at the end of this section. Variable frequency drives will control the air flow from individual blowers to maintain a constant pressure in the discharge header. When the lead blower is operating at full speed, pressure in the discharge header is less than set point lag blower will start, at this point the lead blower will slow down to its minimum speed.

4) When a blower is shut down for any reason (either by an Operator depressing the stop button, by power failure, by automatic shutdown or resulting from an alarm condition) an adjustable Blower Start Delay Timer $T_{BSD}$ in the PLC shall be started. The timer shall be set for 10 minutes by default and shall lockout the blower from operation. The Blower Start Delay Timer prevents a unit from accidentally being restarted while the shaft is still spinning.

5) When the PLC starts a blower, a timer will start. If the blower is not running after the timer times out, an alarm will be displayed at the HMI.

6) If a blower fails during startup, the PLC will start a blower time delay $T_{BSD}$ and generated an alarm in the HMI. The number of stating that each blower can perform in 24 hours shall be entered by the plant operator in the HMI. The parameter will be accessible through security password protection implemented in the HMI.

E. AREA 17 BNR ALUM SYSTEM

1. MONITORING POINTS

a. LI-700 Alum Day Tank #1. Level

b. LI-701 Alum Storage Tank #2. Level

c. FH-702 Emergency Eyewash 1. Hi Flow

d. MA-705 Alum Tks Transfer Pump #1. Remote

e. MN-705 Alum Tks Transfer Pump #1. Run Status

f. MF-705 Alum Tks Transfer Pump #1. Fail

g. MC-705 Alum Tks Transfer Pump #1. Control Motor

h. MA-710 Skid Alum Pump #1. Remote

i. MN-710 Skid Alum Pump #1. Run Status

j. MF-710 Skid Alum Pump #1. Fail

k. SI-710 Skid Alum Pump #1. Speed Indication

l. MA-720 Skid Alum Pump #2. Remote

m. MN-720 Skid Alum Pump #2. Run Status
n. MF-720 Skid Alum Pump #2. Fail
o. SI-720 Skid Alum Pump #2. Speed Indication
p. MA-730 Skid Alum Pump #3. Remote
q. MN-730 Skid Alum Pump #3. Run Status
r. MF-730 Skid Alum Pump #3. Fail
s. SI-730 Skid Alum Pump #3. Speed Indication
t. MA-740 Skid Alum Pump #4. Remote
u. MN-740 Skid Alum Pump #4. Run Status
v. MF-740 Skid Alum Pump #4. Fail
w. SI-740 Skid Alum Pump #4. Speed Indication
x. MA-750 Skid Alum Pump #5. Remote
y. MN-750 Skid Alum Pump #5. Run Status
z. MF-750 Skid Alum Pump #5. Fail
aa. SI-750 Skid Alum Pump #5. Speed Indication
bb. MA-760 Skid Alum Pump #6. Remote
cc. MN-760 Skid Alum Pump #6. Run Status
dd. MF-760 Skid Alum Pump #6. Fail
ee. SI-760 Skid Alum Pump #6. Speed Indication

2. CONTROL POINTS
   a. SC-710 Skid Alum Pump #1. Speed Control
   b. MC-710 Skid Alum Pump #1. Control Motor
   c. SC-720 Skid Alum Pump #2. Speed Control
   d. MC-720 Skid Alum Pump #2. Control Motor
   e. SC-730 Skid Alum Pump #3. Speed Control
   f. MC-730 Skid Alum Pump #3. Control Motor
   g. SC-740 Skid Alum Pump #4. Speed Control
   h. MC-740 Skid Alum Pump #4. Control Motor
   i. SC-750 Skid Alum Pump #5. Speed Control
   j. MC-750 Skid Alum Pump #5. Control Motor
   k. SC-760 Skid Alum Pump #6. Speed Control
   l. MC-760 Skid Alum Pump #6. Control Motor

3. OPERATION
   a. The six chemical feed pumps provide alum to the basins. The pumps are divided into two skids with three pumps each. There are four operating pumps and two standby pumps configured.

b. A matrix shall be used in the control system to provide control for one alum pump to each of the four basins.

4. CONTROL

a. Automatic Operation

1) Pump controls include the following:

a) Flow paced using manual dose input by operator (feed forward control)

b) Flow paced using analog flow signal and secondary input signal from analyzer.

c) Operator input to start/stop, forward, remote % speed commands

F. PUMP LEVEL CONTROLS CONSTANT SPEED - AREA 5 SCUM PUMPING STATION (TYPICAL)

1. MONITORING POINTS (REFER TO IO LIST)

2. CONTROL POINTS (REFER TO IO LIST)

3. OPERATION

a. The duplex pump stations with level control shall operate in a lead/lag sequence.

4. CONTROL

a. Automatic Operation

1) The Pumps will be operated by the motor controls and will be controlled by the individual Hand-Off-Auto selector switches on the local control panel.

2) The Hand and Off positions of the H/O/A selector switches provide manual start/stop control of the pumps.

3) When its switch is in the Hand position, the pump may be manually started, speed controlled, or stopped.

4) When its switch is in the Off position, the pump cannot start.

5) When the pump H/O/A switches are in Auto position, the pumps are automatically controlled through the PLC based on maintaining a constant level range by controlling number of pumps operating, and programmed wet well level set points:

a) High Level - Alarm

b) Lag On

c) Lead On

d) Lag Off

e) Lead Off

6) When the wet well rises to the Lead On set-point, the PLC will start the Lead pump.

7) If the sewage level cannot be maintained by the lead pump the PLC will start the Lag pump and the Lead and Lag pump will run,

8) When the level decreases to the Lag Off set-point, after a time delay, the PLC will turn off the Lag pump. The Lead will continue to run.

9) When the level decreases to the Lead Off set-point, after a time delay, the PLC will turn off the Lead pump.

G. PUMP LEVEL CONTROLS CONSTANT SPEED - AREA 5 SCUM PUMPING STATION (TYPICAL)

1. MONITORING POINTS (REFER TO IO LIST)

2. CONTROL POINTS (REFER TO IO LIST)

3. OPERATION

a. The duplex pump stations with level control shall operate in a lead/lag sequence.

4. CONTROL

a. Automatic Operation

1) The Pumps will be operated by the motor controls and will be controlled by the individual Hand-Off-Auto selector switches on the local control panel.

2) The Hand and Off positions of the H/O/A selector switches provide manual start/stop control of the pumps.

3) When its switch is in the Hand position, the pump may be manually started, speed controlled, or stopped.

4) When its switch is in the Off position, the pump cannot start.

5) When the pump H/O/A switches are in Auto position, the pumps are automatically controlled through the PLC based on maintaining a constant level range by controlling number of pumps operating, and programmed wet well level set points:

a) High Level - Alarm

b) Lag On

c) Lead On

d) Lag Off

e) Lead Off

6) When the wet well rises to the Lead On set-point, the PLC will start the Lead pump.

7) If the sewage level cannot be maintained by the lead pump the PLC will start the Lag pump and the Lead and Lag pump will run,

8) When the level decreases to the Lag Off set-point, after a time delay, the PLC will turn off the Lag pump. The Lead will continue to run.

9) When the level decreases to the Lead Off set-point, after a time delay, the PLC will turn off the Lead pump.

H. PUMP LEVEL CONTROLS VARIABLE SPEED - AREA 17 DEWATERING DRAIN PUMPING STATION, EXISTING DRAIN PUMPING STATION NO. 1 (TYPICAL)

1. MONITORING POINTS (REFER TO IO LIST)

2. CONTROL POINTS (REFER TO IO LIST)

3. OPERATION

   a. The duplex pump stations with level control shall operate in a lead/lag sequence.

4. CONTROL

   a. Automatic Operation

      1) The Pumps will be operated by the motor controls and will be controlled by the individual Hand-Off-Auto selector switches on the local control panel.

      2) The Hand and Off positions of the H/O/A selector switches provide manual start/stop control of the pumps.

      3) When its switch is in the Hand position, the pump may be manually started, speed controlled, or stopped.

      4) When its switch is in the Off position, the pump cannot start.

      5) When the pump H/O/A switches are in Auto position, the pumps are automatically controlled through the PLC based on maintaining a constant level range by controlling number of pumps operating, and programmed wet well level set points:

         a) High Level - Alarm

         b) Lag On

         c) Lead On

         d) Lag Off

         e) Lead Off

      6) Pump Speed Configuration and Set-Points:

         a) A minimum speed set-point will be configured at each VFD to meet requirements of minimum continuous flow provided by the pump manufacturer.

         b) A minimum Lead pump speed will be set at the PLC.

         c) A minimum Lag pump speed, slightly higher than the Lead pump speed, will be set at the PLC and used when two pumps (Lead and Lag) are in operation.

         d) The intent is to maintain the Constant Control Level with the fewest number of pumps in use.

      7) Automated pump operation is as follows:

         a) The level sensor will sense the sewage level in the wet well.

b) When the wet well rises to the Lead On set-point, the PLC will start the Lead pump and vary the pump speed to maintain the Constant Control Level.

- If the sewage level cannot be maintained at the Constant Control Level, and it rises to the Lag On set-point, the PLC will start the Lag pump and the Lead and Lag pump will run at Maximum Speed (adjustable). After a time delay, the PLC will vary both pump speeds together to maintain the Constant Control Level.
- If the sewage level cannot be maintained by two pumps and it increases to the Wet Well High Level an alarm will sound.

c) If the level in the wet well decreases below the Constant Control level set point, the PID loop will decrease speed of all operating pumps.

- When the level decreases to the Lag Off set-point, after a time delay, the PLC will turn off the Lag pump. The Lead pump will run, and the PLC will vary the Lead pump speed to maintain the level set-point.
- When the level decreases to the Lead Off set-point, after a time delay, the PLC will turn off the Lead pump.

I. AREA 10 UV DISINFECTION AND POST AERATION

1. MONITORING POINTS

| | | |
|---|---|---|
| a. | FI-1000 | UV Influent Flow |
| b. | LI-1011 | UV System Influent Level |
| c. | LI-1012 | UV System Effluent Level |
| d. | LL-1013 | UV System Low Level |
| e. | AI-1011 | UV System Transmittance |
| f. | JN-1010 | UV System. Control Power |
| g. | XA-1010 | UV System. Remote |
| h. | YN-1010 | UV System. E-Stop |
| i. | XF-1010 | UV System. Fail |
| j. | YN-1010 | Lamp Status ON |
| k. | YF-1010 | Wiper Fault |
| l. | YA-1010 | Cleaning Auto |
| m. | AI-1010 | Lamp UV Intensity |
| n. | MA-1014 | UV Effluent Sluice Gate 1. Remote |
| o. | ZH-1014 | UV Effluent Sluice Gate 1. Open |
| p. | ZL-1014 | UV Effluent Sluice Gate 1. Close |
| q. | ZF-1014 | UV Effluent Sluice Gate 1. Fail |
| r. | MA-1015 | PA Tank 1 Sluice Gate 1. Remote |

| | | |
|---|---|---|
| s. | ZH-1015 | PA Tank 1 Sluice Gate 1. Open |
| t. | ZL-1015 | PA Tank 1 Sluice Gate 1. Close |
| u. | ZF-1015 | PA Tank 1 Sluice Gate 1. Fail |
| v. | AI-1020 | Post Aeration Tk 1 DO Level |
| w. | MA-1025 | PATank 2 Sluice Gate 1. Remote |
| x. | ZH-1025 | PATank 2 Sluice Gate 1. Open |
| y. | ZL-1025 | PATank 2 Sluice Gate 1. Close |
| z. | ZF-1025 | PATank 2 Sluice Gate 1. Fail |
| aa. | AI-1030 | Post Aeration Tk 2 DO Level |
| bb. | AI-1040 | Post Aeration Dropbox Turbidity |
| cc. | PI-1047 | PA Air Supply Pressure 1 |
| dd. | MA-1048 | PA Air Valve 5. Remote |
| ee. | ZH-1048 | PA Air Valve 5. Open |
| ff. | ZL-1048 | PA Air Valve 5. Close |
| gg. | ZF-1048 | PA Air Valve 5. Fail |
| hh. | ZL-1040 | Blower #1 Air Valve 1. Closed |
| ii. | ZH-1040 | Blower #1 Air Valve 1. Open |
| jj. | MA-1040 | Blower #1. Remote |
| kk. | PD-1041 | Blower #1. Filter Alarm |
| ll. | MN-1040 | Blower #1. Run Status |
| mm. | PI-1042 | Blower #1. Suction Pressure |
| nn. | TI-1043 | Blower #1. Oil Temperature |
| oo. | PI-1044 | Blower #1. Discharge Pressure |
| pp. | TI-1045 | Blower #1. Discharge Temperature |
| qq. | XF-1040 | Blower #1. System Fail |
| rr. | XW-1040 | Blower #1. System Warning |
| ss. | SI-1040 | Blower #1. Speed Indication |
| tt. | PI-1057 | PA Air Supply Pressure 2 |
| uu. | ZL-1050 | Blower #2 Air Valve 2. Closed |
| vv. | ZH-1050 | Blower #2 Air Valve 2. Open |
| ww. | MA-1050 | Blower #2. Remote |
| xx. | PD-1051 | Blower #2. Filter Alarm |
| yy. | MN-1050 | Blower #2. Run Status |
| zz. | PI-1052 | Blower #2. Suction Pressure |
| aaa. | TI-1053 | Blower #2. Oil Temperature |

bbb. PI-1054 Blower #2. Discharge Pressure
ccc. TI-1055 Blower #2. Discharge Temperature
ddd. XF-1050 Blower #2. System Fail
eee. XW-1050 Blower #2. System Warning
fff. SI-1050 Blower #2. Speed Indication
ggg. ZL-1060 Blower #3 Air Valve 3. Closed
hhh. ZH-1060 Blower #3 Air Valve 3. Open
iii. ZL-1069 Blower #3 Air Valve 4. Closed
jjj. ZH-1069 Blower #3 Air Valve 4. Open
kkk. MA-1060 Blower #3. Remote
lll. PD-1061 Blower #3. Filter Alarm
mmm. MN-1060 Blower #3. Run Status
nnn. PI-1062 Blower #3. Suction Pressure
ooo. TI-1063 Blower #3. Oil Temperature
ppp. PI-1064 Blower #3. Discharge Pressure
qqq. TI-1065 Blower #3. Discharge Temperature
rrr. XF-1060 Blower #3. System Fail
sss. XW-1060 Blower #3. System Warning
ttt. SI-1060 Blower #3. Speed Indication
uuu. MA-1058 PA Air Valve 6. Remote
vvv. ZH-1058 PA Air Valve 6. Open
www. ZL-1058 PA Air Valve 6. Close
xxx. ZF-1058 PA Air Valve 6. Fail
yyy. AI-1040 Post Aeration Dropbox Turbidity

2. CONTROL POINTS
    a. XC-1010 UV System. Start/Stop
    b. MN-1014 UV Effluent Sluice Gate 1. Open
    c. MF-1014 UV Effluent Sluice Gate 1. Close
    d. MN-1015 PA Tank 1 Sluice Gate 1. Open
    e. MF-1015 PA Tank 1 Sluice Gate 1. Close
    f. MN-1025 PATank 2 Sluice Gate 1. Open
    g. MF-1025 PATank 2 Sluice Gate 1. Close
    h. FC-1040 Post Aeration Sample Flow
    i. MN-1048 PA Air Valve 5. Open
    j. MF-1048 PA Air Valve 5. Close

k. MC-1040 Blower #1. Start/Stop

l. SC-1040 Blower #1. Speed Control

m. MC-1050 Blower #2. Start/Stop

n. SC-1050 Blower #2. Speed Control

o. MC-1060 Blower #3. Start/Stop

p. SC-1060 Blower #3. Speed Control

q. MN-1058 PA Air Valve 6. Open

r. MF-1058 PA Air Valve 6. Close

3. OPERATION

a. The UV System is provided by the UV manufacturer.

b. The PLC in the UV building controls the valves and the post aeration blowers.

c. Three aeration blowers provide air to the post aeration basin. Dissolved Oxygen is monitored in the basin for control of the blowers.

4. CONTROL

a. Automatic Operation - UV

1) The UV Disinfection system supplier will provide a PLC with Ethernet connection to the PLC-UV.

2) The UV Disinfection System will be paced to output the required UV dose according to flowrate and UV transmittance. UV lamps will be turned on as flow increases and dimmed and/or turned off as flow decreases. UV lamps are turned on or off and are dimmed on an LPDC basis (all the lamps on one LPDC, or half module, turn on or off and/or dim concurrently).

3) Coordinate the IO with the UV manufacturer to enable and disable the UV system. Also provide control of the gates as required when the UV system is in operation or out of service.

b. Automatic Operation – Post Aeration Blowers

1) In general, the blowers are operated to maintain a constant pressure in the air distribution header. As the control valves on the diffuser drop legs open, and the pressure in the air header drops below the set point, the speed of the blower in operation increases, and/or additional blowers are called for to maintain the setpoint. Likewise, the speed of the blower decreases, and/or /blowers are taken out of service to decrease the pressure in the air header.

2) The operator will select at the HMI the Manual or Automatic alternation of the blower. In manual alternation, the PLC will start/stop the blower based on the blower matrix configuration, the operator will change the lead and lags blower selection manually at the matrix presented in Table 2.

3) A blower envelope curve including operating ranges with different blower combinations is shown in the figure at the end of this section.

Variable frequency drives will control the air flow from individual blowers to maintain a constant pressure in the discharge header. When the lead blower is operating at full speed, pressure in the discharge header is less than set point lag blower will start, at this point the lead blower will slow down to its minimum speed.

4) When a blower is shut down for any reason (either by an Operator depressing the stop button, by power failure, by automatic shutdown or resulting from an alarm condition) an adjustable Blower Start Delay Timer $T_{BSD}$ in the PLC shall be started. The timer shall be set for 10 minutes by default and shall lockout the blower from operation. The Blower Start Delay Timer prevents a unit from accidentally being restarted while the shaft is still spinning.

5) When the PLC starts a blower, a timer will start. If the blower is not running after the timer times out, an alarm will be displayed at the HMI.

6) If a blower fails during startup, the PLC will start a blower time delay $T_{BSD}$ and generated an alarm in the HMI. The number of stating that each blower can perform in 24 hours shall be entered by the plant operator in the HMI. The parameter will be accessible through security password protection implemented in the HMI.

c. Automatic Operation – Air Valves

1) Each air control valve will be controlled by the H/O/A selector switch located on the valve actuator. When the H/O/A switch is in the "hand" position, the valve may be manually controlled by the open/stop/ close push buttons located on the valve actuator. When the H/O/A switch is in the "auto" position, the air control valve will be automatically controlled by PLC as follows:

2) An auto/manual selector switch shall be configured in the HMI software for each air control valve to select either manual or automatic control of the valve. In the "manual" mode, the plant operator may manually position the valve from the computer via the HMI software. When the auto/manual switch is in the "auto" position, the valve will be automatically controlled by PLC in response to the dissolved oxygen content of the mixed liquor in the basin as follows:

3) For each tank, the PLC will measure the actual DO and compare to the DO set-point entered by the operator ($DO_{Setpoint1}$ and $DO_{Setpoint2}$) and will increment or decrement the associated air valves position to try to match the DO measurement with the setpoint. A PID Air Valve Controller will be configured in the PLC to control the % of opening and closing of each valve at each aeration tank. The plant operator will enter the desired DO set-point to be maintained at each basin zone in the HMI.

J. AREA 11 – WAS SLUDGE PUMPS AND AERATION BLOWERS

1. MONITORING POINTS

a. SI-1110 Sludge Feed Pump #1. Speed Indication

b. MA-1110 Sludge Feed Pump #1. Remote

c. MN-1110 Sludge Feed Pump #1. Run Status
d. TH-1110 Sludge Feed Pump #1. Hi Temperature
e. YF-1110 Sludge Feed Pump #1. Seal Leak
f. MF-1110 Sludge Feed Pump #1. VFD Fail
g. SI-1120 Sludge Feed Pump #2. Speed Indication
h. MA-1120 Sludge Feed Pump #2. Remote
i. MN-1120 Sludge Feed Pump #2. Run Status
j. TH-1120 Sludge Feed Pump #2. Hi Temperature
k. YF-1120 Sludge Feed Pump #2. Seal Leak
l. MF-1120 Sludge Feed Pump #2. VFD Fail
m. SI-1130 Sludge Feed Pump #3. Speed Indication
n. MA-1130 Sludge Feed Pump #3. Remote
o. MN-1130 Sludge Feed Pump #3. Run Status
p. TH-1130 Sludge Feed Pump #3. Hi Temperature
q. YF-1130 Sludge Feed Pump #3. Seal Leak
r. MF-1130 Sludge Feed Pump #3. VFD Fail
s. MA-1160 Blower #1. Remote
t. PD-1161 Blower #1. Filter Alarm
u. MN-1160 Blower #1. Run Status
v. PI-1162 Blower #1. Suction Pressure
w. TI-1163 Blower #1. Oil Temperature
x. PI-1164 Blower #1. Discharge Pressure
y. TI-1165 Blower #1. Discharge Temperature
z. XF-1160 Blower #1. System Fail
aa. XW-1160 Blower #1. System Warning
bb. MA-1170 Blower #2. Remote
cc. PD-1171 Blower #2. Filter Alarm
dd. MN-1170 Blower #2. Run Status
ee. PI-1172 Blower #2. Suction Pressure
ff. TI-1173 Blower #2. Oil Temperature
gg. PI-1174 Blower #2. Discharge Pressure
hh. TI-1175 Blower #2. Discharge Temperature
ii. XF-1170 Blower #2. System Fail
jj. XW-1170 Blower #2. System Warning
kk. MA-1180 Blower #3. Remote

ll. PD-1181 Blower #3. Filter Alarm

mm. MN-1180 Blower #3. Run Status

nn. PI-1182 Blower #3. Suction Pressure

oo. TI-1183 Blower #3. Oil Temperature

pp. PI-1184 Blower #3. Discharge Pressure

qq. TI-1185 Blower #3. Discharge Temperature

rr. XF-1180 Blower #3. System Fail

ss. MC-1180 Blower #3. Start/Stop

2. CONTROL POINTS

a. MC-1110 Sludge Feed Pump #1. Motor Control

b. SC-1110 Sludge Feed Pump #1. Speed Control

c. MC-1120 Sludge Feed Pump #2. Motor Control

d. SC-1120 Sludge Feed Pump #2. Speed Control

e. MC-1130 Sludge Feed Pump #3. Motor Control

f. SC-1130 Sludge Feed Pump #3. Speed Control

g. MC-1160 Blower #1. Start/Stop

h. MC-1170 Blower #2. Start/Stop

i. XW-1180 Blower #3. System Warning

3. OPERATION

a. The WAS sludge pump are controlled by the RTD to provide sludge to the system. The level control in the WAS holding tank shall allow the pumps to run when the level is in an operating range.

b. The WAS blowers are constant speed blowers that will be controlled from the HMI.

4. CONTROL

a. Automatic Operation – WAS Sludge Pumps

1) When the HMI is in the auto control position, the RTD will provide a command for the WAS sludge pumps to start. A matrix will be developed on the HMI to allow the 2 of the 3 pumps to operate and feed sludge to RDT 1 and RDT 2.

2) The pumps shall vary speed to maintain a flow setpoint input by the operator. The flow shall be measured at the RDT with the RDT influent flowmeters. A PID loop shall be configured to control the pumps with the setpoint.

3) Minimum and Maximum speed setpoints shall be coordinated with the VFD and input for operation.

4) The level in the WAS tank shall be used to enable the sludge pumps for operation. The operator shall input a level range in the HMI that the WAS holding tank is required have for the pumps to run.

b. Automatic Operation – WAS Blowers

1) The WAS blowers are the repurposed SBR blowers and have reduced voltage starters for operation.

2) The blowers shall operate at full speed when requested by the operator through the HMI.

3) The operator shall have the ability to start and stop 1, 2, or 3 blowers for operation.

K. AREA 12 – DIGESTERS AND DIGESTER BLOWERS

1. MONITORING POINTS

a. LI-1200 Aerobic Digester Tank 1. Level
b. LH-1201 Aerobic Digester Tank 1. Hi Level
c. AI-1202A Aerobic Digester Tank 1 DO #1
d. AI-1202B Aerobic Digester Tank 1 DO #2
e. PI-1236 Aerobic Digester Tk 2 Air Supply Press
f. ZL-1210 Digester Blower #1 Air Valve 1. Closed
g. ZH-1210 Digester Blower #1 Air Valve 1. Open
h. ZI-1210 Digester Blower #1 Air Valve 1 Indication
i. MA-1210 Blower #1. Remote
j. PD-1211 Blower #1. Filter Alarm
k. MN-1210 Blower #1. Run Status
l. PI-1212 Blower #1. Suction Pressure
m. TI-1212 Blower #1. Oil Temperature
n. PI-1214 Blower #1. Discharge Pressure
o. TI-1215 Blower #1. Discharge Temperature
p. XF-1210 Blower #1. System Fail
q. XW-1210 Blower #1. System Warning
r. SI-1210 Blower #1. Speed Indication
s. LI-1203 Aerobic Digester Tank 2. Level
t. LH-1204 Aerobic Digester Tank 2. Hi Level
u. AI-1205A Aerobic Digester Tank 2 DO #3
v. AI-1205B Aerobic Digester Tank 2 DO #4
w. PI-1237 Aerobic Digester Tk 2 Air Supply Press
x. ZL-1220 Digester Blower #1 Air Valve 2. Closed
y. ZH-1220 Digester Blower #1 Air Valve 2. Open
z. ZI-1220 Digester Blower #1 Air Valve 2 Indication
aa. MA-1220 Blower #2. Remote

bb. PD-1221 Blower #2. Filter Alarm
cc. MN-1220 Blower #2. Run Status
dd. PI-1222 Blower #2. Suction Pressure
ee. TI-1223 Blower #2. Oil Temperature
ff. PI-1224 Blower #2. Discharge Pressure
gg. TI-1225 Blower #2. Discharge Temperature
hh. XF-1220 Blower #2. System Fail
ii. XW-1220 Blower #2. System Warning
jj. SI-1220 Blower #2. Speed Indication
kk. ZL-1230 WAS Blower #2 Air Valvec3. Closed
ll. ZH-1230 WAS Blower #2 Air Valve 3. Open
mm. MA-1230 Blower #3. Remote
nn. PD-1231 Blower #3. Filter Alarm
oo. MN-1230 Blower #3. Run Status
pp. PI-1232 Blower #3. Suction Pressure
qq. TI-1233 Blower #3. Oil Temperature
rr. PI-1234 Blower #3. Discharge Pressure
ss. TI-1235 Blower #3. Discharge Temperature
tt. XF-1230 Blower #3. System Fail
uu. XW-1230 Blower #3. System Warning
vv. SI-1230 Blower #3. Speed Indication
ww. ZL-1216 Digester Blower #2 Air Valve 1. Closed
xx. ZH-1216 Digester Blower #2 Air Valve 1. Open
yy. ZI-1216 Digester Blower #2 Air Valve 1 Indication
zz. ZL-1217 Digester Blower #2 Air Valve 2. Closed
aaa. ZH-1217 Digester Blower #2 Air Valve 2. Open
bbb. ZI-1217 Digester Blower #2 Air Valve 2 Indication

2. CONTROL POINTS
   a. ZC-1210 Digester Blower #1 Air Valve 1 Control
   b. MC-1210 Blower #1. Start/Stop
   c. SC-1210 Blower #1. Speed Control
   d. ZC-1220 Digester Blower #1 Air Valve 2 Control
   e. MC-1220 Blower #2. Start/Stop
   f. SC-1220 Blower #2. Speed Control
   g. MC-1230 Blower #3. Start/Stop

h. SC-1230 Blower #3. Speed Control

i. ZC-1216 Digester Blower #2 Air Valve 1 Control

j. ZC-1217 Digester Blower #2 Air Valve 2 Control

3. OPERATION

a. The two digesters have three aeration blowers with DO control and two air valves per digester.

4. CONTROL

a. Automatic Operation – Digester Blowers

1) In general, the blowers are operated to maintain a constant pressure in the air distribution header. As the control valves on the diffuser drop legs open, and the pressure in the air header drops below the set point, the speed of the blower in operation increases, and/or additional blowers are called for to maintain the setpoint. Likewise, the speed of the blower decreases, and/or /blowers are taken out of service to decrease the pressure in the air header.

2) The operator will select at the HMI the Manual or Automatic alternation of the blower. In manual alternation, the PLC will start/stop the blower based on the blower matrix configuration, the operator will change the lead and lags blower selection manually at the matrix.

3) A blower envelope curve including operating ranges with different blower combinations is shown in the figure at the end of this section. Variable frequency drives will control the air flow from individual blowers to maintain a constant pressure in the discharge header. When the lead blower is operating at full speed, pressure in the discharge header is less than set point lag blower will start, at this point the lead blower will slow down to its minimum speed.

4) When a blower is shut down for any reason (either by an Operator depressing the stop button, by power failure, by automatic shutdown or resulting from an alarm condition) an adjustable Blower Start Delay Timer $T_{BSD}$ in the PLC shall be started. The timer shall be set for 10 minutes by default and shall lockout the blower from operation. The Blower Start Delay Timer prevents a unit from accidentally being restarted while the shaft is still spinning.

5) When the PLC starts a blower, a timer will start. If the blower is not running after the timer times out, an alarm will be displayed at the HMI.

6) If a blower fails during startup, the PLC will start a blower time delay $T_{BSD}$ and generated an alarm in the HMI. The number of stating that each blower can perform in 24 hours shall be entered by the plant operator in the HMI. The parameter will be accessible through security password protection implemented in the HMI.

b. Automatic Operation – Air Valves

1) Each air control valve will be controlled by the H/O/A selector switch located on the valve actuator. When the H/O/A switch is in the "hand" position, the valve may be manually controlled by the open/stop/

close push buttons located on the valve actuator. When the H/O/A switch is in the "auto" position, the air control valve will be automatically controlled by PLC as follows:

2) An auto/manual selector switch shall be configured in the HMI software for each air control valve to select either manual or automatic control of the valve. In the "manual" mode, the plant operator may manually position the valve from the computer via the HMI software. When the auto/manual switch is in the "auto" position, the valve will be automatically controlled by PLC in response to the dissolved oxygen content of the mixed liquor in the basin as follows:

3) For each digester, the PLC will measure the actual DO and compare to the DO set-point entered by the operator ($DO_{Setpoint1}$ and $DO_{Setpoint2}$) and will increment or decrement the associated air valves position to try to match the DO measurement with the setpoint. A PID Air Valve Controller will be configured in the PLC to control the % of opening and closing of each valve at each digester. The plant operator will enter the desired DO set-point to be maintained at each basin zone in the HMI.

L. AREA 7 – MEMBRANE FACILITY

1. MONITORING POINTS (REFER TO IO LIST)

2. CONTROL POINTS (REFER TO IO LIST)

3. OPERATION

a. The Membrane system if provided by Suez and is a standalone system. The SI shall coordinate the IO and database to transfer data and primarily for monitoring of the system from the HMI. Refer to IO list in Section 16900 I&C attachments for Suez IO list and the PCS interface IO in the IO table for general IO connected to PLC-BNR which is the responsibility of the SI to program and integrate. All IO connected to the Suez PLC (PLC-MBR) shall be programmed by Suez.

4. CONTROL

a. Automatic Operation – refer to Suez control strategies, P&IDs, and panel drawings in Section 16900 I&C Attachments.

M. AREA 14 – COMPRESSED AIR MIXING SYSTEM

1. MONITORING POINTS (REFER TO IO LIST)

2. CONTROL POINTS (REFER TO IO LIST)

3. OPERATION

a. The compressed air system is a standalone system provided by the manufacturer and interfaced to the plant control system by the SI. The SI shall coordinate the IO and database to transfer data and primarily for monitoring of the system from the HMI. Refer to IO list for the IO requirements interfaced to the plant control system.

4. CONTROL

    a. Automatic Operation – refer to Specifications and submittal for control strategies. Coordinate with manufacturer for interfacing and operation from the HMI.

N. AREA 18 – HEADWORKS ODOR CONTROL SYSTEM

1. MONITORING POINTS (REFER TO IO LIST)

2. CONTROL POINTS (REFER TO IO LIST)

3. OPERATION

    a. The odor control system is a standalone system provided by the manufacturer and interfaced to the plant control system by the SI. The SI shall coordinate the IO and database to transfer data and primarily for monitoring of the system from the HMI. Refer to IO list for the IO requirements interfaced to the plant control system.

4. CONTROL

    a. Automatic Operation – refer to Specifications and submittal for control strategies. Coordinate with manufacturer for interfacing and operation from the HMI.

O. AREA 15 – SOLIDS HANDLING FACILITY

1. MONITORING POINTS (REFER TO IO LIST)

2. CONTROL POINTS (REFER TO IO LIST)

3. OPERATION

    a. The solids handling facility consists of the following primary equipment and process':

        1) P&ID 15-I-1

            a) Rotary Drum Thickener – Typical 2 (Provided and programmed by the manufacturer)

            b) Rotary Drum Thickener Flowmeter – Typical 2 (Instruments provided and programmed by the SI)

        2) P&ID 15-I-2

            a) Rotary Drum Thickener Polymer System – Typical 3 (System Provided by Manufacturer and programmed by the SI)

            b) Polymer System Tank (Instrumentation provided and programmed by the SI)

        3) P&ID 15-I-3

            a) BFP Feed Pumps and Instruments – Typical 3

            b) (Instrumentation provided and programmed by the SI)

            c) BFP Flowmeter – Typical 2 (Instruments provided and programmed by the SI)

4) P&ID 15-I-4

a) BFP Water Booster Pumps and Instruments - Typical 3 (Instruments provided and programmed by the SI)

b) BFP Water Booster Pumps Valves - Typical 4 (Instruments provided and programmed by the SI)

c) Belt Filter Press – Typical 2 (Provided and programmed by the manufacturer)

5) P&ID 15-I-5

a) BFP Polymer System– Typical 3 (System Provided by Manufacturer and programmed by the SI)

b) Polymer System Tank (Instrumentation provided and programmed by the SI)

6) P&ID 15-I-6

a) Sludge Conveyor System (Instruments provided by manufacturer and programmed by the SI)

7) P&ID 15-I-9

a) Dewatering Sludge Pumps and Instruments - Typical 2 (Instruments provided and programmed by the SI)

b) Sludge Hopper and Instruments - Typical 4 (Instruments provided by manufacturer and programmed by the SI)

8) P&ID 15-I-10

a) Odor Control System (System Provided by Manufacturer and programmed by the SI)

9) Veolia Dryer P&IDs – 16900 I&C Attachment

a) The Membrane system if provided by Veolia and is a standalone system. The SI shall coordinate the IO and database to transfer data and primarily for monitoring of the system from the HMI. Refer to IO list in Section 16900 I&C attachments for Veolia IO and P&IDs. SI shall provide the PCS interface IO to PLC-BNR.

4. CONTROL

a. Automatic Operation – refer to Specifications and submittal for control strategies of all the manufacturers equipment. The control strategies will be developed in a workshop with the engineer and City after all equipment submittals have been reviewed and approved. The system integrator shall coordinate with manufacturer for interfacing and operation into the PLC and the HMI.

b. Several components require programming by the SI and will require interfacing to the equipment. The SI is responsible to integrate all components for a complete system.

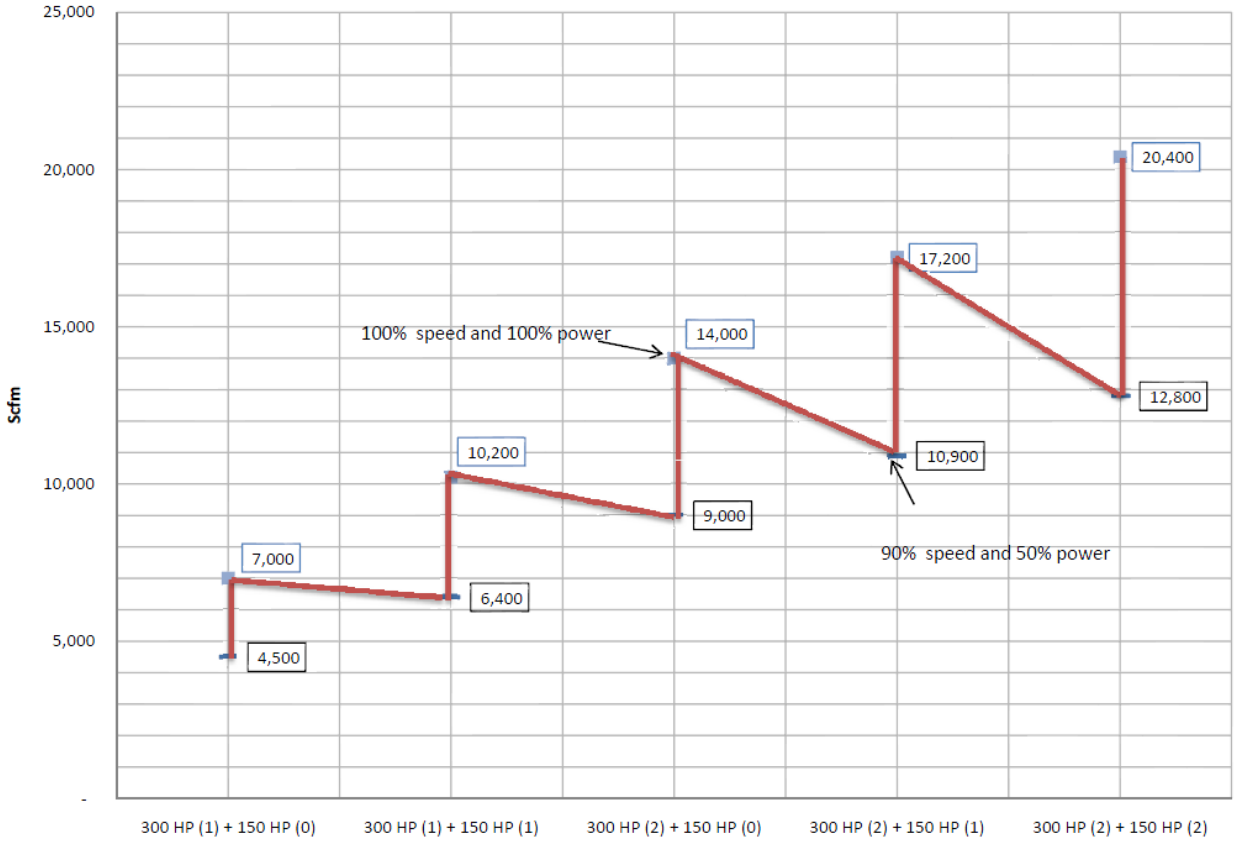


Figure 1 – Blower Envelope Curve at a Discharge Pressure of 8 psig.

END OF SECTION

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