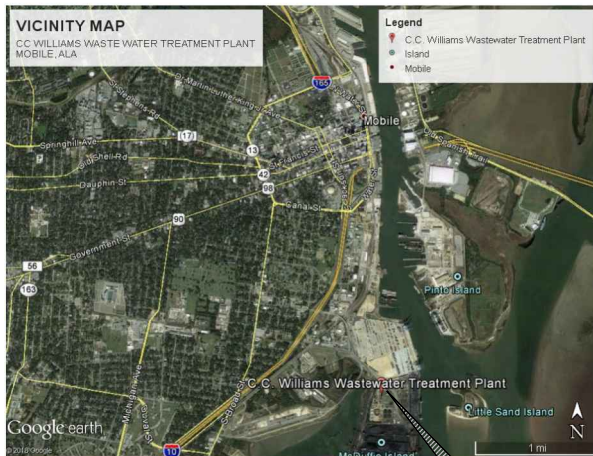


CC WILLIAMS WWTP DEWATERING AND OTHER IMPROVEMENTS



PROJECT VICINITY MAP

CC WILLIAMS WWTP

Board Members:

Walter A. Bell, Chair
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Barabra Drummond
Kenneth W. Nichols
Maria Gonzalez
Raymond L. Bell Jr.

Director:

Bud McCrory

PREPARED FOR THE MOBILE AREA WATER AND SEWER SYSTEM MOBILE, ALABAMA

SPECIFICATIONS
VOLUME 3 OF 4

For information regarding this project, contact:

DAVID CARR, P.E.
25 W. Cedar Street
Suite 350
Pensacola, FL 32502
Office:(850) 396-4923
Mobile:(850) 781-8123

Jacobs

JACOBS D3226100

CONFORMED MAY 2021

CONFORMED DOCUMENTS

MOBILE AREA WATER AND SEWER SYSTEM

MOBILE, ALABAMA

**BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS**

for the construction of the

**CC WILLIAMS WWTP DEWATERING AND
OTHER IMPROVEMENTS**

CONFORMED DOCUMENTS

JACOBS
Pensacola, FL
May 2021

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**SECTION 40 05 15
PIPING SUPPORT SYSTEMS**

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
3. ASTM International (ASTM):
 - a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
 - c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. International Code Council (ICC):
5. International Building Code (IBC).
6. International Mechanical Code (IMC).
7. Manufacturers' Standardization Society (MSS):
 - a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
 - b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.02 DEFINITIONS

A. 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. Catalog information and drawings of piping support system, locating each support, sway brace, lateral brace, hanger, guide, component, and anchor for piping 6 inches and larger and 4 inches and smaller. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
2. Calculations for each type of pipe support, attachment and anchor.

3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
4. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. 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 Alabama.

1.05 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.
2. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Seismic loads in accordance with governing codes and as shown on Structural General Drawings.
3. Wind loads in accordance with governing codes and as shown on Structural General Drawings.
4. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
 - a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
 - b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.

- 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. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load.

PART 2 PRODUCTS

2.01 GENERAL

- A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.
- B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.
- C. Materials: In accordance with Table 1 and Table 2, attached as Supplements at end of section.

2.02 HANGERS

- A. Clevis: MSS SP 58, Type 1:
 - 1. Anvil; Figure 260 for steel pipe and Figure 590 for ductile-iron pipe, sizes 1/2 inch through 30 inches.
 - 2. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2 inch through 16 inches.
 - 3. B-Line; Figure B3100, sizes 1/2 inch through 30 inches.
- B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6:
 - 1. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
 - 2. B-Line; Figure B3171, sizes 3/4 inch through 8 inches.
- C. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43:
 - 1. Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1 inch through 30 inches.
 - 2. B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.

D. Pipe Rollers and Supports: MSS SP 58, Type 44:

1. Anvil; Figure 175, sizes 2 inches through 30 inches.
2. B-Line; Figure B3120, sizes 2 inches through 24 inches.

2.03 WALL BRACKETS, SUPPORTS, AND GUIDES

A. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy-duty):

1. Anvil; Figure 199, 3,000-pound rating.
2. B-Line; Figure B3067, 3,000-pound rating.

B. Adjustable “J” hanger MSS SP 58, Type 5:

1. Anvil; Figure 67, sizes 1/2 inch through 8 inches.
2. B-Line; Figure B3690, sizes 1/2 inch through 8 inches.

C. Offset Pipe Clamp: Anvil; Figure 103, sizes 3/4 inch through 8 inches.

D. Channel Type:

1. Unistrut.
2. Anvil; Power-Strut.
3. B-Line; Strut System.
4. Aickinstrut (FRP).

2.04 PIPE SADDLES

A. Provide 90-degree to 120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

1. In accordance with Standard Detail 4005-515.
2. Sizes 20 inches through 60 inches, Piping Technology & Products, Inc.; Fig. 2000.

B. Saddle Supports, Pedestal Type:

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP , Type 37 with U-bolt.
 - a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.
 - b. B-Line; Figure B3095, sizes 1 inch through 36 inches with B3088S base.

3. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
 - a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
 - b. B-Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.

2.05 CHANNEL TYPE SUPPORT SYSTEMS

- A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.
- B. Members and Connections: Design for loads using one-half of manufacturer's allowable loads.
- C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.
- D. Manufacturers and Products:
 1. B-Line; Strut System.
 2. Unistrut.
 3. Anvil; Power-Strut.
 4. Aickinstrut (FRP System).
 5. Enduro-Durostrut (FRP Systems).

2.06 FRP PIPE SUPPORTS SYSTEMS

- A. General:
 1. FRP with UV additive, protective veil, and vinyl ester resins resistance to chemicals listed in Supplement at end of section.
 2. Fire Retardant: ASTM E84.
 3. Include hangers, rods, attachments, and fasteners.
- B. Clevis Hangers:
 1. Factor of Safety: 3 to 1.
 2. Minimum Design Load: 200 pounds.
- C. Design:
 1. Design pipe supports spacing, hanger rod sizing based upon manufacturer's recommendations.
 2. Identify and highlight nonFRP fasteners or components in Shop Drawing.

D. Manufacturers:

1. Aickinstrut.
2. Enduro.
3. Century Composite.

2.07 PIPE CLAMPS

A. Riser Clamp: MSS SP 58, Type 8.

1. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
2. B-Line; Figure B3373, sizes 1/2 inch through 30 inches.

2.08 ELBOW AND FLANGE SUPPORTS

- A. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base.
- B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base.
- C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89.

2.09 INTERMEDIATE PIPE GUIDES

A. Type: Hold down pipe guide.

1. Manufacturer and Product: B-Line; Figure B3552, 1-1/2 inches through 30 inches.

B. Type: U-bolts with double nuts to provide nominal 1/8-inch to 1/4-inch clearance around pipe; MSS SP 58, Type 24.

1. Anvil; Figure 137 and Figure 137S.
2. B-Line; Figure B3188 and Figure B3188NS.

2.10 PIPE ALIGNMENT GUIDES

A. Type: Spider.

B. Manufacturers and Products:

1. Anvil; Figure 255, sizes 1/2 inch through 24 inches.
2. B-Line; Figure B3281 through Figure B3287, sizes 1/2 inch through 24 inches.

2.11 PIPE ANCHORS

- A. Type: Anchor chair with U-bolt strap.
- B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

2.12 SEISMIC RESTRAINTS

- A. Solid pipe bracing attachment to pipe clevis with clevis cross brace and angle rod reinforcement.
- B. Manufacturers:
 - 1. Mason Industries.
 - 2. B-Line.
 - 3. Anvil.

2.13 ACCESSORIES

- A. Anchor Bolts:
 - 1. Size and Material: Sized by Contractor for required loads, and as specified in Section 05 50 00, Metal Fabrications.
 - 2. Bolt Length (Extension Above Top of Nut):
 - a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
 - b. Maximum Length: No more than a full nut depth above top of nut.
- B. Dielectric Barriers:
 - 1. Plastic coated hangers, isolation cushion, or tape.
 - 2. Manufacturer and Products:
 - a. B-Line; B1999 Vibra Cushion.
 - b. B-Line; Iso Pipe, Isolation Tape.
- C. Insulation Shields:
 - 1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.
 - 2. Manufacturers and Products:
 - a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
 - b. B-Line; Figure B3151, sizes 1/2 inch through 24 inches.

D. Welding Insulation Saddles:

1. Type: MSS SP 58, Type 39.
2. Manufacturers and Products:
 - a. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
 - b. B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.

E. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing.
2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger.

F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

G. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
3. Welded Beam Attachment: MSS SP 58, Type 22.
 - a. Anvil; Figure 66.
 - b. B-Line; Figure B3083.
4. U-Channel Concrete Inserts: As specified in Section 05 50 00, Metal Fabrications.
5. Concrete Attachment Plates:
 - a. Anvil; Figure 47, Figure 49, or Figure 52.
 - b. B-Line; Figure B3084, Figure B3085, or Figure B3086.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.
3. Support piping connections to equipment by pipe support and not by equipment.
4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.

5. Support no pipe from pipe above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
10. Install lateral supports for lateral loads at changes in direction.
11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
12. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
 - a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
 - b. Grouped Pipes: Trapeze hanger system.
2. Horizontal Piping Supported from Walls:
 - a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
 - b. Stacked Piping: Wall mounted framing system and “J” hangers acceptable for pipe smaller than 3-inch.
 - c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.
3. Horizontal Piping Supported from Floors:
 - a. Saddle Supports:
 - 1) Pedestal Type, elbow and flange.
 - 2) Provide minimum 1-1/2-inch grout beneath baseplate.
 - b. Floor Mounted Channel Supports:
 - 1) Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
 - 2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
 - 3) Attach pipe to channel with clips or pipe clamps.
 - c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.

4. Insulated Pipe:
 - a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
 - b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
 - c. Wall-mounted pipe clips not acceptable for insulated piping.
5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
 - a. Single point attachment to ceiling allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
 - b. Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
 - 1) These lines include air operated diagram pumps and other lines, if any, as identified below:
2. Existing Concrete Ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
 - a. Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
 - b. Where there is vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
 - 1) These lines include air operated diagram pumps and other lines, if any, as identified below:
3. Steel Beams: I-beam clamp or welded attachments.
4. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
5. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
6. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

- D. Saddles for Steel or Concrete Pipe: Provide 90-degree to 120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.

E. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

F. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.
3. Dielectric Barrier:
 - a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
 - b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

- A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09 90 00, Painting and Coating.

3.03 SUPPLEMENTS

- A. The supplements listed below, following “End of Section,” are a part of this Specification:
1. Table 1: Nonchemical Areas.
 2. Table 2: Chemical Areas.

END OF SECTION

Table 1 Nonchemical Areas	
Exposure Conditions	Support Material
Office Areas	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Shops and Warehouse Areas	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Pipe Galleries	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Process Areas: High Humidity or Hydrogen sulfide In BFP Room	Stainless steel or FRP
Process Areas: Wetted or Submerged	Stainless steel or FRP
Pipes conveying chemicals listed in Table 2	Provide with corresponding support per Table 2.
Notes: 1. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol). 2. Stainless steel to be Type 304. 3. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M. 4. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.	

Table 2 Chemical Areas		
Exposure Conditions	Support for Direct Exposure	Support for Remote Exposure
Chlorine Gas	FRP	Precoated steel
Sulfur Dioxide	FRP	Precoated steel
Polymers	FRP	Precoated steel
<p>Notes:</p> <ol style="list-style-type: none"> 1. Direct exposure includes entire area within containment area; area within 20 feet horizontal and 10 feet vertical of chemical pumps or chemical mixing stations; or as specified. 2. Remote exposure is area beyond area defined as direct exposure, but within designated building. 3. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol). 4. Stainless steel to be Type 304. 5. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M. 		

SECTION 40 27 00
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. Air Force: A-A-58092, Tape, Antiseize, Polytetrafluorethylene.
 2. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges.
 3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
 4. American Society of Mechanical Engineers (ASME):
 - a. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
 - b. B1.20.1, Pipe Threads, General Purpose (Inch).
 - c. B16.1, Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
 - d. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
 - e. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
 - f. B16.9, Factory-Made Wrought Buttwelding Fittings.
 - g. B16.11, Forged Fittings, Socket-Welding and Threaded.
 - h. B16.15, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
 - i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
 - j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500.
 - l. B16.25, Buttwelding Ends.
 - m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
 - n. B31.1, Power Piping.
 - o. B31.3, Process Piping.
 - p. B31.9, Building Services Piping.
 - q. B36.10M, Welded and Seamless Wrought Steel Pipe.

5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing.
6. American Water Works Association (AWWA):
 - a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
 - b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
 - d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - f. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast.
 - g. C153/A21.53, Ductile-Iron Compact Fittings.
 - h. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
 - i. C606, Grooved and Shouldered Joints.
7. American Welding Society (AWS):
 - a. Brazing Handbook.
 - b. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
 - c. D1.1/D1.1M, Structural Welding Code - Steel.
 - d. QC1, Standard for AWS Certification of Welding Inspectors.
8. ASTM International (ASTM):
 - a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
 - b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
 - d. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
 - e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - f. A135/A135M, Standard Specification for Electric-Resistance-Welder Steel Pipe.
 - g. A139/A139M, Standard Specification for Electro-Fusion (Arc)–Welded Steel Pipe (NPS 4 Inches and Over).
 - h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - i. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.

- j. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
- k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
- l. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
- m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
- n. A197/A197M, Standard Specification for Cupola Malleable Iron.
- o. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
- p. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- q. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- r. A276, Standard Specification for Stainless Steel Bars and Shapes.
- s. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- t. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- u. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- v. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
- w. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
- x. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- y. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- z. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
- aa. A536, Standard Specification for Ductile Iron Castings.
- bb. A563, Standard Specification for Carbon and Alloy Steel Nuts.
- cc. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
- dd. A743/A743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.

- ee. A744/A744M, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.
- ff. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
- gg. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
- hh. B32, Standard Specification for Solder Metal.
- ii. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
- jj. B61, Standard Specification for Steam or Valve Bronze Castings.
- kk. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- ll. B75/B75M, Standard Specification for Seamless Copper Tube.
- mm. B88, Standard Specification for Seamless Copper Water Tube.
- nn. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
- oo. B462, Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, and UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
- pp. B464, Standard Specification for Welded UNS N08020 Alloy Pipe.
- qq. B474, Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe.
- rr. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
- ss. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
- tt. D413, Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
- uu. D543, Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
- vv. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
- ww. D1330, Standard Specification for Rubber Sheet Gaskets.
- xx. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

- yy. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- zz. D2000, Standard Classification System for Rubber Products in Automotive Applications.
- aaa. D2310, Standard Classification for Machine-Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- bbb. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- ccc. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- ddd. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- eee. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- fff. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
- ggg. D2996, Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- hhh. D3222, Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
- iii. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- jjj. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
- kkk. D4894, Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials.
- lll. D4895, Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion.
- mmm. F423, Standard Specification for Polytetrafluoroethylene (PTFE) Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges.
- nnn. F436, Standard Specification for Hardened Steel Washers.
- ooo. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- ppp. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- qqq. F441/F441M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
- rrr. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
- sss. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- ttt. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

9. FM Global (FM).
10. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP-43, Wrought and Fabricated Butt-Welding Fittings for Low-Pressure, Corrosion Resistant Applications.
11. NSF International (NSF):
 - a. ANSI 61: Drinking Water System Components - Health Effects.
 - b. ANSI 372: Drinking Water System Components - Lead Content.
12. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.
13. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.02 DEFINITIONS

A. Submerged or Wetted:

1. Zone below elevation of:
 - a. Roof of digester, including structure pipe penetrations.
 - b. Liquid surface or within 3 feet above top of liquid surface.
 - c. Top of tank wall or under tank cover.

1.03 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. Building Service Piping: ASME B31.9, as applicable.
 - a. Sanitary Building Drainage and Vent Systems: ICC International Plumbing Code and.
 3. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
 4. Thrust Restraints:
 - a. Design for test pressure shown in Piping Schedule.
 - b. Allowable Soil Pressure: 1,000 pounds per square foot.
 - c. Low Pressure Pipelines:
 - 1) When bearing surface of the fitting against soil provides an area equal to or greater than area required for thrust restraint, concrete thrust blocks will not be required.
 - 2) Determine bearing area for fittings without thrust blocks by projected area of 70 percent of internal diameter multiplied by chord length for fitting centerline curve.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Fabricated Piping:
 - a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, 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.
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: Product data.
5. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer's Certification of Compliance, in accordance with Section 01 61 00, Common Product Requirements:
 - a. Pipe and fittings.
 - b. Factory applied resins and coatings.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Flanged Pipe and Fittings: Manufacturer's product data sheets for gaskets including torquing requirements and bolt tightening procedures.
4. Qualifications:
 - a. Nondestructive Testing Personnel: SNT-TC-1A Level II certification and qualifications.
 - b. AWS QC1 Certified Welding Inspector (CWI): Submit evidence of current certification prior to commencement of welding activities.
 - c. Welders:
 - 1) Continuity log for welders and welding operators.
 - 2) Welder qualification test records conducted by Contractor or manufacturer.
5. Welding Procedures: Qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
6. Nondestructive inspection and testing procedures.
7. Test logs.

8. Pipe coating applicator certification.
9. CWI inspection records and NDE test records.
10. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection and Testing.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Inspection and Testing Agency:
 - a. Ten years' experience in field of welding and welded pipe and fittings' testing required for this Project.
 - b. Calibrated instruments and equipment, and documented standard procedures for performing specified testing.
 - c. Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Project.
 - d. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.
 - e. Verification Welding Inspector: AWS QC1 Certified.
2. Welding Procedures: In accordance with ASME BPVC SEC IX (Forms QW-482 and QW-483) or AWS D1.1/D1.1M (Annex N Forms).
3. Welder Qualifications: In accordance ASME BPVC SEC IX (Form QW-484) or AWS D1.1/D1.1M (Annex N Forms).
4. Contractor's CWI: Certified in accordance with AWS QC1, and having prior experience with specified welding codes. Alternate welding inspector qualifications require approval by Engineer.
5. Solvent Welder For Double Wall Containment Piping: Qualified in accordance with Chapter VII of the ASME B31.3 Code, Part 9, Paragraph A328.

B. Quality Assurance: Contractor to provide services of an independent CWI inspection and testing agency for welding operations.

1. Note, the presence of independent Verification CWI does not relieve Contractor from performing their own quality control, including 100 percent visual inspection of welds.

1.06 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.

3. Linings and Coatings: Prevent excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPING

- A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section.
- B. Diameters Shown:
 1. Standardized Products: Nominal size.
 2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.
 3. Cement-Lined Steel Pipe: Lining inside diameter.

2.03 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 higher pressure rating than required for piping.
- B. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

C. Mechanical Joint Anchor Gland Follower:

1. Ductile iron anchor type, wedge action, with break-off tightening bolts.
2. Thrust rated to 250 psi minimum.
3. Rated operating deflection not less than:
 - a. 3 degrees for sizes through 12 inches.
 - b. 2 degrees for sizes 14 inches through 16 inches.
 - c. 1.5 degrees for sizes 18 inches through 24 inches.
 - d. 1 degree for sizes 30 inches through 48 inches.
4. UL and FM approved.

D. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturers:
 - a. Pipeline Products Corp.
 - b. Fernco Joint Sealer Co.

E. Mechanical connections of high-density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through-flanged connections consisting of the following:

1. Polyethylene stub end thermally butt-fused to end of pipe.
2. ASTM A240/A240M, Type 304 stainless steel backing flange, 125-pound, ASME B16.1 standard. Use insulating flanges where shown.
3. Bolts and nuts of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard. Retorque nuts after 4 hours.
4. Gaskets as specified on Data Sheet.

2.04 GASKET LUBRICANT

- A. Lubricant shall be supplied by pipe manufacturer and no substitute or "or-equal" will be allowed.

2.05 DOUBLE WALL CONTAINMENT PIPING SYSTEM

- A. System components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

2.06 PIPE CORROSION PROTECTION

- A. Coatings: See Paragraph 3.10 of this section for coating systems which are identified by a coating system number for example, "System No. 2. See corresponding coating system number in Section 09 90 00, Painting and Coating, for technical requirements of the coating including minimum surface preparation, coating formulation, application thickness, etc.
- B. Zinc Coating: Zinc coating where required shall include an exterior layer of zinc applied to conform to ISO 8179 standard. The mass of zinc applied shall be 200 g/m² of pipe surface area.
- C. Polyethylene Encasement (Bagging):
 - 1. Encasement Tube: Black polyethylene encasement tube, 8 mils minimum thickness, conforming to AWWA C105/A21.5, free of gels, streaks, pinholes, foreign matter, undispersed raw materials, and visible defects such as tears, blisters, and thinning at folds.
 - 2. Securing Tape: Thermoplastic tape, 8 mils minimum thickness, 1 inch wide, pressure sensitive adhesive face capable of bonding to metal, bituminous coating, and polyethylene encasement tube.

2.07 THRUST BLOCKS

- A. Concrete thrust blocks will not be accepted.

2.08 THRUST TIES

- A. Steel Pipe: Fabricated lugs and rods in accordance with details shown on Drawings. or Joint harness as specified in Section 40 27 01, Process Piping Specialties.
- B. 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.

2.09 VENT AND DRAIN VALVES

- A. Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.
- B. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

2.10 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. Shop fabricate flanged pipe in shop, not in field, and delivered to Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by manufacturer.

2.11 FINISHES

- A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) Piping Schedule and paragraph 3.10 of this section.
- B. Galvanizing:
 - 1. Hot-dip applied, meeting requirements of ASTM A153/A153M.
 - 2. Electroplated zinc or cadmium plating is unacceptable.
 - 3. Stainless steel components may be substituted where galvanizing is specified.

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 09 90 00, Painting and Coating, 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 manufacturer's instructions, except for damaged glass-lined pipe or PVDF-lined pipe that is to be promptly removed from Site.

3.03 WELDING

- A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.3 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.
- B. Weld Identification: Keep paper record of which welder welded each joint.
- C. Pipe End Preparation:
 - 1. Machine Shaping: Preferred.
 - 2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
 - 3. Beveled Ends for Butt Welding: ASME B16.25.
- D. Surfaces:
 - 1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
 - 2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
 - 3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.
- E. Alignment and Spacing:
 - 1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
 - 2. Root Opening of Joint: As stated in qualified welding procedure.
 - 3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1 inch, whichever is greater.

F. Climatic Conditions:

1. Do not perform welding if there is impingement of any rain, snow, sleet, or wind exceeding 5 mph on the weld area, or if ambient temperature is below 32 degrees F.
2. Stainless Steel and Alloy Piping: If ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.

G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.

H. Surface Defects: Chip or grind out those affecting soundness of weld.

I. Weld Quality: Meet requirements of governing welding codes.

3.04 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 or grooved joint flange adapter manufacturer.

D. Threaded and Coupled Joints:

1. Conform to ASME B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. Soldered Joints:

1. Use only solder specified for particular service.
2. Cut pipe ends square and remove fins and burrs.
3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
4. Wipe excess solder from exterior of joint before hardened.
5. Before soldering, remove stems and washers from solder joint valves.

F. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.

G. PVC and CPVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

H. 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, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.

I. PVDF-Lined Steel Pipe Installation:

1. Cut, make up, and install pipe in accordance with pipe manufacturer's written instructions.
2. Weld vent extension half-couplings in-place prior to lining pipe.
3. Do not weld on pipe after lining is installed.
4. Prevent plugging of vent extensions with insulation or paint.

J. Fiberglass Reinforced Piping:

1. Cut, fabricate, and install in accordance with manufacturer's written instructions.
2. Provide manufacturer's representative for instructing workers on proper installation and jointing methods.
3. Installation shall be made by workers experienced in FRP pipe lay-up techniques.

3.05 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 40 05 15, Piping Support Systems.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. 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.

F. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of 7 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. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
7. 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.

3.06 INSTALLATION—BURIED PIPE

A. Joints:

1. Dissimilar Buried Pipes:
 - a. Provide flexible mechanical compression joints for pressure pipe.
 - b. Provide concrete closure collar for gravity piping or as shown.
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 31 23 23.15, 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. Special mitered joints.
 - c. 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. PVC or HDPE Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:

1. Deflection from Horizontal Line, Except PVC or HDPE: 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.

3.07 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.

3.08 INSTALLATION—DOUBLE WALL CONTAINMENT PIPING SYSTEM

- A. Install according to manufacturer's instructions.
- B. Valves and equipment shall be supported independently from pipe. Anchor valves such that turning moment resulting from their operation will not be transmitted to 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 containment pipe on fabricated pieces.
 - 2. Install centering devices such that leak detection cable (if specified) will be unrestricted and such that 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.

3.09 LEAK DETECTION SYSTEM FOR DOUBLE WALL CONTAINMENT PIPING

- A. Install in accordance with system manufacturer's instructions and recommendations.

3.10 PIPE CORROSION PROTECTION

- A. Ductile Iron Pipe:
 - 1. Exposed: As specified in Section 09 90 00, Painting and Coating, and as shown in Piping Schedule.
 - 2. Buried: Zinc coated and wrapped with polyethylene bagging.
 - 3. Submerged or Embedded: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating, System No. 2. If in potable water service, use NSF/ANSI 61 approved epoxy.
- B. Carbon Steel Pipe:
 - 1. Exposed: As specified in Section 09 90 00, Painting and Coating, System No. 5 unless otherwise noted in the Piping Schedule supplement at the end of this section.

2. Buried:
 - a. Pipe: Wrap with tape coating system as specified in Section 09 90 00, Painting and Coating, System No. 8.
 - b. Joints: Wrap with tape coating system as specified in Section 09 90 00, Painting and Coating, or heat shrink wrap as specified herein.
 3. Submerged or Embedded: Shop coat with coal-tar epoxy (System No. 2) as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF/ANSI 61 approved epoxy.
- C. Copper Pipe:
1. Exposed: As specified in Section 09 90 00, Painting and Coating, System No. 5.
- D. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating, System No. 5.
- E. Piping Accessories:
1. Exposed:
 - a. Field paint black and galvanized steel, brass, copper, and bronze piping components with System No. 5 as specified in Section 09 90 00, Painting and Coating, 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. Ferrous Metal and Stainless Steel Components: Coat with coal-tar epoxy (System No. 2) as specified in Section 09 90 00, Painting and Coating.
 - b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
 - c. Flexible Couplings and Similar Items: Wrap with heat shrink wrap.
 - d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.
 - e. Cement-Coated Pipelines: Cement coat appurtenances same as pipe.
- F. Polyethylene Encasement: Install in accordance with AWWA C105/A21.5 and manufacturer's instructions.

- G. Tape Coating System: As specified in Section 09 90 00, Painting and Coating, System No. 8.
- H. Heat Shrink Wrap: Apply in accordance with manufacturer's instructions to surfaces that are cleaned, prepared, and primed.

3.11 THRUST RESTRAINT

A. Location:

1. Buried Piping: Where shown and where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist because of hydrostatic testing and normal operating pressure.
2. Exposed Piping: At all joints in piping.

B. Thrust Ties:

1. Steel Pipe: Attach with joint harness specified in Section 40 27 01, Process Piping Specialties.
2. Ductile Iron Pipe: Attach with socket clamps anchored against grooved joint coupling or flange.
3. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through 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 40 27 01, Process Piping 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 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 tapping boss of a fitting, valve body, or equipment casting.
2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
3. Limitations: Threaded taps in pipe barrel are unacceptable.

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 33 13 00, Disinfecting of Water Utility Distribution.

3.16 FIELD FINISHING

- A. Notify Engineer at least 3 days prior to start of surface preparation or coating application work.
- B. As specified in Section 09 90 00, Painting and Coating.

3.17 PIPE IDENTIFICATION

- A. As specified in Section 10 14 00, Signage.

3.18 FIELD QUALITY CONTROL

- A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.
- B. Minimum Duties of Welding Inspector:
1. Job material verification and storage.
 2. Qualification of welders.
 3. Certify conformance with approved welding procedures.
 4. Maintenance of records and preparation of reports in a timely manner.
 5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.

C. Required Weld Examinations:

1. Perform examinations in accordance with Piping Code, ASME B31.3 for Normal Fluid Service.
2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for piping covered by this section.
3. Examine at least one of each type and position of weld made by each welder or welding operator.
4. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

- D. Test containment piping leak detection system in accordance with system manufacturer's instructions and recommendations to verify proper operation.

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. Blow clean of loose debris natural gas, instrument air lines with and similar lines specified to be pneumatically pressure test with compressed air at 4,000 fpm. Do not flush with water.
- C. Following hydrastatic pressure testing, Chlorine and Sulfur Dioxide gas lines in pressurized service shall be dried by passing steam through the lines from the high end until the lines are thoroughly heated. While steaming allow condensate and foreign matter to drain out. The steam supply shall then be disconnected and all the pockets and low spots in the line drained. While the line is still warm, dry air with a dew point of minus 40 degrees F or below shall be blown through the line until the exiting air has minus degrees F. Following dry air purging, the lines shall be capped until final connections are made and the lines pressurized with the respective process gas.
- D. 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.

- E. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.
- F. 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. Piping Schedule Legend.
- 2. Piping Schedule.
- 3. Data Sheets.

Number	Title
40 27 00.01	Cement-mortar and Ceramic-Epoxy-Lined Ductile Iron Pipe and Fittings
40 27 00.02	Carbon Steel Pipe and Fittings—Special Service
40 27 00.03	Carbon Steel Pipe and Fittings—General Service
40 27 00.05	Glass, Rubber, and Polypropylene-Lined Carbon Steel Pipe and Fittings
40 27 00.08	Stainless Steel Pipe and Fittings—General Service
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings
40 27 00.11	Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings
40 27 00.13	Copper and Copper Alloy Pipe Tubing and Fittings

END OF SECTION

PIPING SCHEDULE LEGEND**SERVICE**

A	Air
BYP	Bypass
CLGP	Chlorine Gas, Pressurized
CLGV	Chlorine Gas, Vacuum
CLS	Chlorine Solution (See Piping Schedule for General or Special Service Pipe Specifications)
D	Sanitary Drain
DS	Digested Sludge
DR	Process Drain
FOR	Fuel Oil Return
FOS	Fuel Oil Supply
HW	Hot water
NG	Natural Gas
POLY	Neat Polymer
POS	Polymer Solution
RD	Roof Drain
SA	Sample
SOG	Sulfur Dioxide Gas
SOS	Sulfur Dioxide Solution
SR	Spillage Return
SS	Sanitary Sewer
SSFM	Sanitary Sewer Forcemain
V	Vents

C.C. Williams WWTP Dewatering

W1	Water, Potable
W2	Water, Backflow Prevented Potable
W3	Water, Reclaimed Wastewater

EXPOSURE

ALL	All
BUR	Buried
EXP	Exposed
SUB	Submerged
ENC	Concrete Encased

MATERIAL

CLDI	Cement-Lined Ductile Iron
COP	Copper
CSTL	Carbon Steel
CELDI	Ceramic Epoxy-Lined Ductile Iron
CPVC	Chlorinated Polyvinyl Chloride
FRPX	Fiberglass Reinforced Plastic Pipe Type (X = 1 to 3)
NYL	Nylon Tubing
PVC	Polyvinyl Chloride
PVC-DWV	Polyvinyl Chloride Drain, Waste and Vent
SST	Stainless Steel

JOINT TYPE

FL	Flanged
GR	Grooved
HU	Hub and spigot
PRJ	Proprietary Restrained
RM	Restrained Mechanical
S	Screwed
W	Welded (including solvent and fusion)

PRESSURE TEST

G	Gravity Service: Test pressure is not shown on gravity services. Test to highest liquid level that pipe can be subject to.
H	Hydrostatic
I	In Service
P	Pneumatic
PC	Test per Uniform Plumbing Code

ABBREVIATIONS

IAW	In Accordance With
NA	Not Applicable

MOBILE AREA WATER AND SEWER SYSTEM C.C. WILLIAMS WWTP PIPING SCHEDULE										
Flowstream /Service	Flowstream Abbreviation	Size(s) (Inches)¹	Exposure	Piping Material	Specification Section	Joint Type	Interior Lining/Exterior Coating²	Test Pressure and Type (psig-x), x = Type indicated in Legend	Pipe Color/ Label Text Color³	Remarks
Chlorine Gas, Pressurized	CLGP	1	EXP	CSTL	40 27 00.02	See Spec.	NA/System No. 5	Per Chlorine Institute	See Note 5	
		1/4	EXP	See Remarks				Per Chlorine Institute	See Note 5	Flexible tubing per manufacturer's standard
Chlorine Gas, Vacuum	CLGV	All	EXP	CPVC	40 27 00.10	W	NA/System No. 25	Per Chlorine Institute	See Note 5	
Chlorine Solution	CLS	3	EXP/BUR	PVC	40 27 00.10	W	NA/System No. 25	120H	See Note 5	
Condenser Water Supply Condenser Water Return	CWS/CWR	ALL	EXP	PVC Sch 80	23 21 13 40 27 00.10	W		100H	Green/ White	All CWS/CWR that is outside of a return air plenum unless noted otherwise on the plans. May be used in the mechanical room except the boiler connection.
Condenser Water Supply Condenser Water Return	CWS/CWR	ALL	EXP	Type L Copper	23 21 13 40 27 00.13	Solder		120H	Green/ White	All CWS/CWR that is in a return air plenum. Use copper for connection to the boiler.
Digested Sludge	DS	ALL	BUR/EN C	CELDI	40 27 00.01	RM/PRJ	Zinc coated	150H	See Note 5	
			EXP	CELDI	40 27 00.01	FL	EXP-No. 4	150H	See Note 5	
Drain, Process	DR	< 4"	BUR	PVC	40 27 00.10	W		G	See Note 5	Concrete Encased when underneath or within concrete
		>=4"	BUR	PVC-SDR26	33 05 01.12	HU		G	See Note 5	

MOBILE AREA WATER AND SEWER SYSTEM C.C. WILLIAMS WWTP PIPING SCHEDULE										
Flowstream /Service	Flowstream Abbreviation	Size(s) (Inches) ¹	Exposure	Piping Material	Specification Section	Joint Type	Interior Lining/Exterior Coating ²	Test Pressure and Type (psig-x), x = Type indicated in Legend	Pipe Color/ Label Text Color ³	Remarks
Fuel Oil Return	FOR	1/2 to 2	EXP	CSTL	40 27 00.03	See Spec.	NA/System No. 4	20-P	Yellow/ Black	
Fuel Oil Supply	FOS	1/2 to 3	EXP	CSTL	40 27 00.03	See Spec.	NA/System No. 4	20-P	Yellow/ Black	
Hot Water, Potable	HW	ALL	ALL	Type L Copper	22 10 01 40 27 00.13	Solder		120H	See Note 5	For all HW that is exposed to the return air plenum in and around the restrooms.
Hot Water Return, Potable	HWR	ALL	ALL	Type L Copper	22 10 01 40 27 00.13	Solder		120H	See Note 5	For all HW that is exposed to the return air plenum in and around the restrooms.
Natural Gas	NG	3/4 to 3	EXP	CSTL	40 27 00.03	See Spec.	NA/System No. 5	20-P	Yellow/ Black	
			BUR	PE	22 10 01.12	See Spec.	NA	20-P	NA	
Neat Polymer	POLY	ALL	EXP/ENC	PVC	40 27 00.10	W	EXP-No. 25		See Note 5	
Polymer Solution	POS	ALL	EXP	PVC	40 27 00.10	W	EXP-No. 25		See Note 5	
			BUR	NYL		FL/S			See Note 5	Nylon tubing to be installed within PVC carrier pipe.
Sulfur Dioxide Gas	SOG	ALL	EXP	PVC	40 27 00.10	W	EXP-No. 25	Per Chlorine Institute	See Note 5	
Sample	SA	ALL	BUR	PVC	40 27 00.10	W	NA/System No. 25	120H	See Note 5	
Spillage Return	SR	1/2 to 1	EXP	CSTL	40 27 00.03	See Spec.	NA/System No. 5	20-P	Federal Safety Red/White	

MOBILE AREA WATER AND SEWER SYSTEM C.C. WILLIAMS WWTP PIPING SCHEDULE										
Flowstream /Service	Flowstream Abbreviation	Size(s) (Inches) ¹	Exposure	Piping Material	Specification Section	Joint Type	Interior Lining/Exterior Coating ²	Test Pressure and Type (psig-x), x = Type indicated in Legend	Pipe Color/ Label Text Color ³	Remarks
Sulfur Dioxide Solution	SOS	ALL	EXP/BUR	PVC	40 27 00.10	W	EXP-No. 25	120H	See Note 5	
Sanitary Drain	D	ALL	BUR/EXP	PVC-DWV	22 10 01.02	W		5 Feet Head of Water	See Note 5	
Sanitary Sewer	V	ALL	EXP	CISP	22 10 01.03	W		PC	See Note 5	For all Sanitary Vent that is exposed to the return air plenum in and around the restrooms.
Sanitary Sewer	SS	< 4"	BUR	PVC	40 27 00.10	W		G	See Note 5	Concrete Encased when underneath or within concrete
		>=4"	BUR	PVC-SDR26	33 05 01.12	HU		G	See Note 5	
Sanitary Sewer Force Main	SSFM	<=4"	ALL	PVC	40 27 00.10	W		100H	See Note 5	
		>4"	ALL	CELDI	40 27 00.01	RM/PRJ	EXP-No.4 BUR-Zinc coated	150H	See Note 5	
Vent, Sanitary	V	ALL	EXP	CISP	22 10 01.03	W		PC	See Note 5	For all Sanitary Vent that is exposed to the return air plenum in and around the restrooms.
Vent, Sanitary	V	ALL	EXP	PVC-DWV	22 10 01.02	W		PC	See Note 5	For all Sanitary Vent that is below grade or concealed. Not allowed in return air plenum.

MOBILE AREA WATER AND SEWER SYSTEM C.C. WILLIAMS WWTP PIPING SCHEDULE										
Flowstream /Service	Flowstream Abbreviation	Size(s) (Inches) ¹	Exposure	Piping Material	Specification Section	Joint Type	Interior Lining/Exterior Coating ²	Test Pressure and Type (psig-x), x = Type indicated in Legend	Pipe Color/ Label Text Color ³	Remarks
Vent	V	ALL	EXP	See Remarks	See Remarks	See Remarks	See Remarks	I	See Remarks	Piping materials, Specifications, coating, etc. to match that of associated flowstream. ⁴
Water, Potable	W1	All	All	CPVC Sch 80	22 10 01 40 27 00.10	W		120H	See Note 5	Applies to all W1 piping that in the process rooms.
Water, Potable	W1	<3"	ALL	Type L Copper	22 10 01 40 27 00.13	Solder		120H	See Note 5	Applies to all piping in and around the Restrooms and the Mechanical Rooms.
Water, Potable	W1	<4"	EXP/ENC	SST	40 27 00.08	S		150H	See Note 5	
			BUR	PVC	40 27 00.10	W		100H	See Note 5	Piping buried underneath concrete slabs is to be SST.
		>=4"	ALL	CLDI	40 27 00.01	RM/PRJ/FL	EXP No. 4 BUR–Zinc coated	150H	See Note 5	
Water, Backflow Prevented and Water, Reclaimed Wastewater	W2 and W3	<4"	EXP/ENC	SST	40 27 00.08	S		150H	See Note 5	
			BUR	PVC	40 27 00.10	W		100H	See Note 5	Piping buried underneath concrete slabs is to be SST.
		>=4"	ALL	CLDI	40 27 00.01	RM/PRJ/FL	EXP No. 4 BUR–Zinc coated	150H	See Note 5	Piping underneath buildings or concrete slabs to be concrete encased.

MOBILE AREA WATER AND SEWER SYSTEM C.C. WILLIAMS WWTP PIPING SCHEDULE										
Flowstream /Service	Flowstream Abbreviation	Size(s) (Inches) ¹	Exposure	Piping Material	Specification Section	Joint Type	Interior Lining/Exterior Coating ²	Test Pressure and Type (psig-x), x = Type indicated in Legend	Pipe Color/ Label Text Color ³	Remarks
<div><div>¹“>” Greater Than “<” Less Than “<=” Less Than or Equal To “>=” Greater Than or Equal To “All” All Sizes</div><div>²Coating system technical requirements as specified in Article Pipe Corrosion Protection of this section. Coating system number as specified in Section 09 90 00, Painting and Coating. ³Pipe identification labels required for all piping per Section 10 14 00, Signage. ⁴For example, vent piping associated with fuel oil service piping to be CSTL with exterior coating/no lining, etc. ⁵ Per current edition of Recommended Standards for Wastewater Facilities (10 State Standards)</div></div>										

SECTION 40 27 00.01 CEMENT-MORTAR AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	Description
General	<p>Materials in contact with potable water shall conform to NSF 61 acceptance.</p> <p>Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of specified diameters, dimensions, and standards for a period of not less than 10 years.</p> <p>Testing of pipe required by AWWA C151/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).</p>
Pipe	<p>Buried Liquid Service Using Push-on, Mechanical, or Proprietary Restrained Joints: AWWA C111/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.</p> <p>Buried Air Service Using Mechanical , or Proprietary Restrained Joints: 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.</p> <p>Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.</p>

SECTION 40 27 00.01 CEMENT-MORTAR AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	Description
Lining	<p>Cement mortar: AWWA C104/A21.4</p> <p>Ceramic Epoxy: Pipe and fittings to be ceramic-epoxy lined shall not have been previously lined. Surface preparation shall be made to surfaces free of grease, oil, or other substance with abrasive blasting using clean sand or grit abrasive. Lining shall be done within 8 hours of surface preparation and surfaces shall be reblasted if rusting appears before lining. Line with a total dry film thickness of 40 mils of ceramic epoxy. Ceramic epoxy shall be amine-cured Novolac epoxy with 20 percent minimum volume ceramic quartz pigment, Perma-Shield PL Series 431 by TNEMEC and Permox CTF, "or-preapproved-equal", for sewer service. Lining shall be applied above 40 degrees F ambient temperature and shall not be applied to flange faces. Lining thickness shall be tested using a magnetic film thickness gauge. Lining integrity shall be tested on surfaces with a nondestructive, 2,500-volt dielectric resistance test.</p>
Fittings	<p>Lined and coated same as pipe.</p> <p>Mechanical: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 ductile iron, 250 psi minimum working pressure. Follower glands shall be ductile iron.</p> <p>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. Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted.</p> <p>Grooved End: AWWA C606 and AWWA C110/A21.10, ductile iron, 250 psi minimum working pressure; Victaulic.</p> <p>Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face. Gray cast iron will not be allowed.</p>

SECTION 40 27 00.01 CEMENT-MORTAR AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	Description
Joints	<p>Mechanical: 250 psi minimum working pressure.</p> <p>Proprietary Restrained: 150 psi minimum working pressure. American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex.</p> <p>Grooved End: Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure; Victaulic.</p> <p>Flange: Dimensions per AWWA C110/A21.10 flat face, or ASME B16.1 Class 250 raised face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed.</p> <p>Branch connections 3 inches and smaller, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties.</p>
Couplings	<p>Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.</p> <p>Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.</p>
Bolting	<p>Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard.</p> <p>Flanged: ASTM A307, Grade B carbon steel heavy hex head or stud bolts, ASTM A563, Grade A carbon steel heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.</p> <p>Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M heavy hex head or stud bolts; ASTM A194/A194M, Grade 8M heavy hex nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.</p>

SECTION 40 27 00.01 CEMENT-MORTAR AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	Description
Gaskets	<p>General: Gaskets in contact with potable water shall be NSF ANSI 61 certified.</p> <p>Mechanical , and Proprietary Restrained Joints; Water and Sewage Service: Halogenated butyl or EPDM, Shore A hardness durometer 60, conforming to AWWA C111/A21.11.</p> <p>Flanged, Water, Sewage and Hot Air Services: 1/8-inch-thick, homogeneous black rubber (EPDM), hardness 60-80 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D2000.</p> <p>Full face for flat-faced flanges, flat-ring type for raised-face flanges. Blind flanges shall be epoxy-lined in accordance with the system specified above.</p> <p>Gasket pressure rating to equal or exceed the system hydrostatic test pressure.</p>
Joint Lubricant	Manufacturer's standard.

END OF SECTION

SECTION 40 27 00.02 CARBON STEEL PIPE AND FITTINGS—SPECIAL SERVICE		
Item	Size	Description
Pipe	All	Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B, Butt-welded, grooved end, and flanged joints:
	Welded: 2" and larger	Schedule 80.
Joints	1-1/2" & smaller	Socket-welded; flanged at equipment as required or shown.
	2" & larger	Butt-welded or flanged at valves and equipment.
Fittings	1-1/2" & smaller	Socket-welded; flanged carbon steel, ASTM A105/A105M, 2,000-pound or 3,000-pound WOG (3,000-pound chlorine service, conforming to ASME B16.11; bore to match pipe inside diameter.
	2" & larger	Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ASME B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
Branch Connections	1-1/2" & smaller	Threadolet or socket in conformance with Fittings above.
	2" & larger	Butt-welding tee in accordance with Fittings above.
Flanges	1-1/2" & smaller	Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 300 socket-weld, 1/16-inch raised face.
	2" & larger	Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 300 weld neck style, 1/16-inch raised face. Weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings.

SECTION 40 27 00.02 CARBON STEEL PIPE AND FITTINGS—SPECIAL SERVICE		
Item	Size	Description
Unions	1-1/2" & smaller	<p>Chlorine Gas Services: Threaded or socket-weld end ammonia type tongue-and-groove flange union, ASTM A105/A105M forged carbon steel, 1,500-pound two-bolt oval type.</p> <p>Other Gas Service: Socket-weld, forged carbon steel, ASTM A105/A105M, 2,000-pound or 3,000-pound WOG, integral ground steel-to-steel, seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.</p>
Bolting	All	<p>Carbon steel ASTM A193/A193M, Grade B7 studs; ASTM A194/A194M, Grade 2H hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</p> <p>When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts; ASTM A563, Grade A heavy hex nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</p>
Gaskets	All flanges	<p>Chlorine Unions: Chemical lead, 2 percent to 4 percent antimony, 1/8-inch-thick.</p> <p>Other Service Gas: 1/16-inch-thick compressed nonasbestos composition flat ring type, rated 400 degrees F continuous. Garlock Blue-Gard 3000; Durlon 7950.</p>
Thread Lubricant	1-1/2" & smaller	<p>Chlorine Service: 100 percent virgin PTFE Teflon tape.</p> <p>Other Service Gas: 100 percent virgin PTFE Teflon tape.</p>

END OF SECTION

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Pipe	All	Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW. Threaded, butt-welded, and flanged joints.
	Threaded: 1-1/2" & smaller	Standard weight.
	Welded: 2" thru 12"	Standard weight.
Joints	1-1/2" & smaller	Threaded. Flanged where necessary to connect to valves and equipment flange ends.
	2" & larger	Butt-welded. Flanged where necessary to connect to valves and equipment flange ends.
Fittings	1-1/2" & smaller	Threaded: 150-pound or 300-pound malleable iron, ASTM A197/A197M or ASTM A47/A47M, dimensions in accordance with ASME B16.3. Fire sprinkler fittings to be UL listed.
	2" & larger	Butt Welded: Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ASME B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
Branch Connections	1-1/2" & smaller	For Threaded Pipe: Threaded, straight, or reducing tees in conformance with Fittings specified above. For welded pipe, use threadolet.
	2" & larger	Butt-welding tee in conformance with Fittings specified above.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Flanges	1-1/2" & smaller	Forged carbon steel, ASTM A105/A105M, Grade II, ASME B16.5 Class 150 socket-weld or threaded, 1/16-inch raised face.
	2" & larger	<p>Butt-Welded Systems Standard Flange (RFWN): Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 slip-on or welding neck, 1/8-inch raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside.</p> <p>Butt-Welded Systems Standard Flange (FFWN): Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 slip-on or welding neck, 1/8-inch flat face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside.</p>
		<p>Butt-Welded Systems Blind Flange: Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150, 1/8-inch flat face.</p> <p>Cast Iron Mating Flange: AWWA C207, Class D or E, hub or ring type to mate with ASME B16.1, Class 125 cast-iron flange.</p>
Unions	1-1/2" & smaller	Threaded malleable iron, ASTM A197/A197 or ASTM A47/A47M, 150-pound or 300-pound WOG, meeting the requirements of ASME B16.3.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Couplings	2" & larger	Screwed End: Malleable iron, ASTM A197/A197M or ASTM A47/A47M.
Bolting	All	Flanges: Carbon steel ASTM A307, Grade A hex head bolts; ASTM A563, Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
		<p>When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts; ASTM A563, Grade A heavy hex nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</p> <p>Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M hex head bolts; ASTM A194/A194M, Grade 8M hex nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</p>

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Gaskets	All flanges	<p>Water, Steam, and Air Services: Gasket, inorganic aramid fiber with nitrile binder, CL150, 1/8-inch thick, Shore A 80 Durometer, ASME B16.21 and ASME B16.5, ASTM D2000, NSF 61, full-face gasket for raised-face flange, extended to inner edge of bolt.</p> <p>Fuel Gas Service: 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated 250 degrees F continuous and conforming to ASME B16.21, ASTM D1330, Steam Grade.</p> <p>Blind Flanges: Gasketed covering the entire inside face with the gasket cemented to the blind flange. Gasket, inorganic aramid fiber with nitrile binder, CL150, 1/8-inch thick, Shore A 80 Durometer, ASME B16.21 and ASME B16.5, ASTM D2000, NSF 61, flat-ring gasket for flat-face flange.</p>
		<p>Insulating Gasket: ASME B16.21 and ASME 16.5, fabric reinforced phenolic neoprene faced gasket, sleeves, washers, CL150, 1/8-inch thick, 175 degrees F Step-Ko Type E DW or approved equal.</p>
Thread Lubricant	1-1/2" & smaller	<p>General Service: 100 percent virgin PTFE Teflon tape.</p> <p>Fuel Gas Service: Yellow Teflon tape designed for fuel gas service, Air Force A-A-58092, AA Thread Seal Tape, Inc.</p>

END OF SECTION

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Pipe	2-1/2" & smaller	Schedule 40S: ASTM A312/A312M, Type 316 seamless, pickled and passivated.
	3" thru 6"	Schedule 10S: ASTM A312/A312M, Type 316L, pickled and passivated.
	8" & larger	Schedule 5S: ASTM A312/A312M, Type 316L, pickled and passivated.
Joints	1-1/2" & smaller	Threaded or flanged at equipment as required or shown.
	2" & larger	Butt-welded or flanged at valves and equipment.
Fittings	1-1/2" & smaller	Threaded: Forged 1,000 CWP minimum, ASTM A182/A182M, Grade F316 or cast Class 150, ASTM A351/A351M, Grade CF8M/316.
	2" & 2-1/2"	Butt Welded: ASTM A403/A403M, Grade WP316L conforming to ASME B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
	3" & larger	Butt-Welded: ASTM A403/A403M Type 316L pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Branch Connections	1-1/2" & smaller	Tee or reducing tee in conformance with fittings above.
	2" & larger	Butt-welding tee or reducing tee in accordance with fittings above.
Flanges	All	<p>Forged Stainless Steel: ASTM A182/A182M, Grade F316L, ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face. Weld slip-on flanges inside and outside.</p> <p>Cast Carbon Steel: ASTM A216/A216M Grade WCA, drilled, ASME B16.5 Class 150 or Class 300 Van Stone Type with stainless steel stub ends, ASTM A240/A240M Type 316L “as-welded grade”, conforming to MSS SP 43, wall thickness same as pipe.</p> <p>Blind Flanges, exposed to the atmosphere and not buried nor immersed in liquid, may be either stainless steel or Class 125 ductile iron or Class 150 carbon steel with gaskets as specified herein.</p>
Unions	2" & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Bolting	All	<p>Forged Flanges: Type 316 stainless steel, ASTM A320/A320M Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</p> <p>Van Stone Flanges and anywhere mating flange on equipment is cast iron and gasket is flat ring: Carbon steel ASTM A307 Grade B hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</p> <p>Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M hex head bolts and ASTM A194/A194M, Grade 8M hex nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</p>
Gaskets	All Flanges	<p>Flanged, Water, Hot Air, Fuel Gas and Sewage Services: 1/8 inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 250 degrees F. continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade.</p> <p>Blind Flanges: Gasketed covering entire inside face with gasket cemented to blind flange.</p>
Thread Lubricant	2" & smaller	General Service: 100 percent virgin PTFE Teflon tape.

END OF SECTION

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	Size	Description
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	Size	Description
Gaskets	All	<p>Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber.</p> <p>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.</p>
Solvent Cement	All	<p>Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer, except solvent weld cement for PVC pipe joints in chlorine or sulfur dioxide service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service. Certification shall be submitted. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.</p>
Thread Lubricant	All	Teflon Tape.

END OF SECTION

SECTION 40 27 00.11 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	Size	Description
Pipe	All	Schedule 80 CPVC: Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM F441/F441M. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded nipples shall be Schedule 80.
Fittings	All	Schedule to Match Pipe Above: Conforming to the requirements of ASTM F439 for socket weld type and Schedule 80 ASTM F437 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub Type CPVC flat face flange in accordance with Fittings above; ASME B16.1, Class 125 drilling.
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts hot dipped galvanized per ASTM A153/153M and as specified in 05 50 00, Metal Fabrications, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber 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.

SECTION 40 27 00.11 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	Size	Description
Solvent Cement	All	Socket type joints shall be made employing primer and solvent cements that meet or exceed requirements of ASTM F493 and primers that meet or exceed requirements of ASTM F656, resistant to the fluid service and as recommended by pipe and fitting manufacturer, except solvent weld cement for CPVC pipe joints in chlorine and sulfur dioxide service shall be free of silica filler and shall be certified by manufacturer to be suitable for that service. Certification shall be submitted. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon tape.

END OF SECTION

SECTION 40 27 00.13 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	Description
General	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	Oxygen Service: Red brass, seamless, standard wall thickness, conforming to ASTM B43.
Tubing	Seamless, conforming to ASTM B88 as follows: Oxygen service Type K, hard drawn Water (buried) Type K, soft or hard temper Water (exposed) Type L, hard drawn Domestic hot water Type L, hard drawn Compressed air service Type L, hard drawn Laboratory air service Type L, hard drawn Laboratory vacuum service Type L, hard drawn Refrigerant service Type L, hard drawn P-Trap priming service Type L, soft temper Sample line service Type L, hard drawn Laboratory gas service Type L, hard drawn
Fittings	Oxygen Service: Class 250, ASTM B62 bronze, screwed, dimensions conforming to ASME B16.15 or ASTM B75/B75M wrought copper, socket joint, dimensions conforming to ASME B16.22. Other Services: ASTM B75/B75M commercially pure wrought copper, socket joint, dimensions conforming to ASME B16.22.
Flanges	Oxygen Service: Class 150, ASTM B61 bronze, screwed, ASME B16.24 standard. Other Services: Class 150, ASTM B75/B75M commercially pure wrought copper, socket joint, ASME B16.24 standard.
Bolting	Oxygen Service: ASTM A320/A320M, stainless steel Type 304, Grade B8 bolts, copper silicon hex nuts conforming to ASTM B98 Grade A hard and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Other Services: ASTM A307, carbon steel, Grade A hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

SECTION 40 27 00.13 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	Description
Gaskets	1/16-inch-thick nonasbestos compression type, full face, Cranite, John Manville.
Solder	<p>Oxygen Service: Silver brazing alloy, 15 percent silver content, 1,185 degrees F to 1,300 degrees F melting range, conforming to AWS A5.8M/A5.8.</p> <p>Other Services:</p> <p>Joints 2-1/2 Inch and Smaller: Wire solder (95 percent tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder.</p> <p>Joints Larger Than 2-1/2 Inch: Wire solder, melt range approximately 440 degrees F to 660 degrees F, conforming to ASTM B32 Alloy Grade HB or HN. Do not use cored solder.</p>

END OF SECTION

SECTION 40 27 01
PROCESS PIPING SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
 - b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
 2. American Water Works Association (AWWA):
 - a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
 - b. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
 - c. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
 - d. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - e. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
 - f. Manual M11, Steel Pipe—A Guide for Design and Installation.
 3. ASTM International (ASTM):
 - a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
 4. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
 5. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

- A. Action Submittals:
1. Manufacturer's data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).

2. Metal Bellows Field Finishing:
 - a. Manufacturer's recommended weld procedures for joining welded carbon steel piping to stainless steel bellows.
 - b. Welder qualifications for joining welded carbon steel piping to stainless steel bellows.
 - c. Product data for field-applied System No. 4, high temperature, epoxy lining and coating in accordance with Section 09 90 00, Painting and Coating.
 3. Chemical Injectors:
 - a. Type, size, quantity, materials, and model number of each.
 - b. Sketch of each showing major parts, main pipe, and dimensions.
 - c. Details and model number of each support system and component.
 - d. Details and model of connects (for example, service saddle, weld-o-let).
- B. Informational Submittals:
1. Coupling Harness:
 - a. Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.
 - b. Weld procedure qualifications.
 - c. Load proof-testing report of prototype restraint for any size coupling.
 2. Basket Strainer:
 - a. Manufacturer's written/printed installation instructions.
 - b. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
- C. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.
- B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.

- C. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
1. Use or reuse of components and materials without a traceable certification is prohibited.

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 ASME B16.5 standard.
3. Working Pressure Rating: 140 psi, minimum, at 120 degrees F.
4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
 - a. Garlock; Style 214.
 - b. Resistoflex; No. R6904.
 - c. Unisource Manufacturing, Inc.; Style 112.
 - d. Proco Products, Inc.; Series 442.

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 ASME 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. Unisource Manufacturing, Inc.; Style 1501.
 - d. Proco Products, Inc.; Series 220.

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: 50 psig at 300 degrees F.
5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.
6. Manufacturers and Products:
 - a. U.S. Bellows, Inc.; Universal Tied Expansion Joint.
 - b. Metraflex; Model MN.
 - c. Senior Flexonics Pathway, Inc.; Expansion Joints.

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 degrees F.
5. Length: Minimum manufacturer recommendation for vibration isolation.
6. Manufacturers:
 - a. U.S. Hose Corp.; Series 300.
 - b. Anamet Industrial, Inc.
 - c. Unisource Manufacturing, Inc.
 - d. Proco Products, Inc.

E. Closure Collar Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

F. Quick Connect Couplings for Chemical Services:

1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
2. Materials: Glass-filled polypropylene or PVDF with EPDM, Viton-A or Teflon gaskets as recommended for the service by manufacturer.
3. End Connections: NPT threaded or flanged to match piping connections. Hose shank for chemical installations.
4. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.
5. Pressure Rating: 125 psi, minimum, at 70 degrees F.
6. Manufacturers and Products:
 - a. OPW; Kamlock.
 - b. Ryan Herco; 1300 Series.

2.03 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.
2. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 150 psi.
3. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.
4. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11 or as shown on Drawings.
5. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

B. Flexible Sleeve Type Coupling:

1. Manufacturers and Products:
 - a. Steel Pipe:
 - 1) Dresser Piping Specialties; Style 38.
 - 2) Smith-Blair, Inc.; Style 411.
 - b. Ductile Iron Pipe:
 - 1) Dresser Piping Specialties; Style 253.
 - 2) Smith-Blair, Inc.; Style 441.

C. Transition Coupling for Steel Pipe:

1. Manufacturers and Products:
 - a. Dresser Piping Specialties; Style 162.
 - b. Smith-Blair, Inc.; Style 413.

D. Flanged Coupling Adapter:

1. Anchor studs where required for thrust restraint.
2. Manufacturers and Products:
 - a. Steel Pipe:
 - 1) Dresser Piping Specialties; Style 128.
 - 2) Smith-Blair, Inc.; Style 913.
 - b. Ductile Iron Pipe:
 - 1) Dresser Piping Specialties; Style 128.
 - 2) Smith-Blair, Inc.; Style 912.

E. Restrained Flange Adapter:

1. Pressure Rating:
 - a. Minimum Working Pressure Rating: Not less than 150 psi.
 - b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.
2. Thrust Restraint:
 - a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
 - b. Products employing set screws that bear directly on pipe will not be acceptable.
3. Manufacturer and Product: EBAA Iron Sales Co.; Mega-Flange.

F. Restrained Dismantling Joints:

1. Pressure Rating:
 - a. Minimum working pressure rating shall not be less than rating of the connecting flange.
 - b. Proof testing shall conform to requirements of AWWA C219 for bolted couplings.
2. Manufacturers and Products:
 - a. Dresser Piping Specialties; Style 131.
 - b. Smith Blair, Inc.; Model 975.

G. Exposed Metallic Piping Plain End Couplings:

1. Plain end pipe couplings shall be self-restrained against hydrostatic thrust forces equal to not less than two times the working pressure rating of the coupling. Couplings shall accommodate 4 degrees angular deflection at the time of installation and subsequent to pressurization.
2. Casing, bolts, and nuts shall be Type 304 or Type 316 stainless steel. The sealing sleeve shall be EPDM or NBR elastomer as best suited for the fluid service.
3. Couplings manufacturer and products shall be Straub Couplings, Grip-L or Metal Grip, or equal.

2.04 EXPANSION JOINTS

A. Elastomer Bellows:

1. Type: Reinforced molded wide arch.
2. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with split galvanized steel retaining rings.

3. Washers: Over retaining rings to help provide leak-proof 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: 3/4 inch, minimum.
 - b. Burst Pressure: Four times the working pressure.
 - c. Compression deflection and minimum working pressure as 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 and Products:
 - 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 ASME B16.5 standard.
3. Working Pressure Rating: 100 psig, minimum, at 120 degrees F.
4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
 - 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: ASME 150-pound carbon steel flanges.
4. Minimum Design Working Pressure: 50 psig at 300 degrees F.

5. Length: Minimum of eight convolutions and minimum axial compression of 3/4 inches.
6. Manufacturers and Products:
 - a. U.S. Bellows, Inc.; Universal Tied expansion joint.
 - b. Metraflex, Model MN.
 - c. Senior Flexonics Pathway, Inc.; Expansion Joints.

D. Copper Pipe Expansion Compensator:

1. Material: Stainless steel bellows with female copper solder joint ends.
2. Working Pressure Rating: 175 psig, minimum.
3. Accessories: Anti-torque device to protect bellows.
4. Manufacturers and Products:
 - a. Senior Flexonics; Model HB.
 - b. Hyspan; Model 8510.
 - c. Unisource Manufacturing, Inc.; Style EC-FFS.

2.05 FLEXIBLE EXPANSION JOINTS

A. Design:

1. Ball and socket type for earth settlement compensation.
2. Joints shall be double ball assemblies rated for 15-degree minimum deflection and not less than 4 inches offset from centerline of connecting piping.
3. Assembly shall accommodate up to 4 inches of expansion in length.
4. Ductile iron conforming to AWWA C153/A21.53.
5. Rated for 350 psi.
6. Components shall be lined and coated by manufacturer with fusion-bonded epoxy on all surfaces not bearing gaskets.
7. End Connections: Flanged or mechanical joint as shown and as required by connecting pipe and fittings.
8. Joint connecting to mechanical joint shall be thrust restrained.
9. Bonding:
 - a. Manufacturer shall factory install thermite welded joint bonds for assembled expansion joint.
 - b. Provide 24-inch bond wires for field bonds to adjacent metallic piping.
 - c. Bond wires shall be 2 AWG with two 12-inch-long THHN insulated 12 AWG wire pigtails.

B. Manufacturer and Product: EBAA Iron Sales Co.; Flex-Tend.

2.06 SEAL WATER HOSE

- A. Product as specified for water hose, except 3/8 inch with male NPT ends, in 2-foot lengths.

2.07 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 outside diameter of pipe on which saddle is installed.
3. Taps: Iron pipe threads.
4. Materials:
 - a. Body: Malleable or ductile iron.
 - b. Straps: Galvanized steel.
 - c. Hex Nuts and Washers: Steel.
 - d. Seal: Rubber.
5. Manufacturers and Products:
 - a. Smith-Blair; Series 313 or 366.
 - b. Dresser; Style 91.

B. Nylon-Coated Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Materials:
 - a. Body: Nylon-coated iron.
 - b. Seal: Buna-N.
 - c. Clamps and Nuts: Stainless steel.
4. Manufacturer: Smith-Blair; Style 315 or 317.

2.08 OUTLET/TAPPING SADDLES

A. Materials:

1. Straps: Alloy steel with 3/4-inch threaded ends.
2. Seal: O-Ring SBR rubber gasket.
3. Compatible with ductile iron pipe.

B. Connection: As shown.

- C. Pressure Rating: Capable of withstanding 250 psi internal pressure without leakage over stressing.
- D. Manufacturer and Product: American Ductile Iron; Outlet/Tapping Saddle.

2.09 PIPE SLEEVES

A. Steel Pipe Sleeve:

- 1. Minimum Thickness: 3/16 inch.
- 2. Seep Ring:
 - a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness.
 - b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
 - c. Continuously fillet weld on each side all around.
- 3. Factory Finish:
 - a. Galvanizing:
 - 1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
 - 2) Electroplated zinc or cadmium plating is unacceptable.
 - b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Molded Polyethylene Pipe Sleeve:

- 1. Molded HDPE with integral water stop ring not less than 3 inches larger than sleeve.
- 2. Provided with end caps for support during concrete placement.
- 3. Manufacturer and Product: Century-Line, Model CS sleeves as manufactured by PSI-Thunderline/Link-Seal.

C. Insulated and Encased Pipe Sleeve:

- 1. Manufacturer and Product: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.

D. 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:
 - a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
 - b. Pressure plates shall be reinforced nylon polymer.

3. Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening .
4. Manufacturer: Thunderline Corp., Link-Seal Division.

2.10 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Ductile Iron Wall Pipe:

1. Diameter, Lining, 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 applicable Pipe Data Sheet.
4. Thrust Collars:
 - a. Rated for thrust load developed at 250 psi.
 - b. Safety Factor: 2, minimum.
 - c. Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.
5. Manufacturers:
 - a. American Cast Iron Pipe Co.
 - b. U.S. Pipe and Foundry Co.

B. Steel or 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:
 - a. Outside Diameter: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe.
 - b. Continuously fillet welded on each side all around.

2.11 CHEMICAL INJECTOR SYSTEM

A. Chemical Injectors:

1. Type, size, quantity, and materials as shown on Drawings and Standard Details.
2. Manufacturer: SAF-T-FLO.

B. Support System:

1. Stainless steel Unistrut or FRP Aickenstrut.
2. Materials compatible with chemical service and subject to Engineer approval.

C. Connectors: Stainless steel service saddle or weld-o-let, as shown on Drawings.

2.12 MISCELLANEOUS SPECIALTIES

A. Pump Seal Water Sight Flow Indicators:

1. Bronze body, 3/8-inch, horizontal, ball action with tempered glass.
2. Rated 125 psi with NPT screwed ends.
3. Operate with a minimum flow of 0.25 gpm.
4. Manufacturers and Products:
 - a. Eugene Ernst Co.; Series E-57-4.
 - b. Jacoby Tarbox Co.

PART 3 EXECUTION

3.01 GENERAL

- ### A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

A. General:

1. Thrust restraint shall be provided as specified in Section 40 27 00, Process Piping—General.
2. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.

- #### B. Flexible Joints at Concrete Backfill or Encasement: Install within 18 inches or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

C. Flexible Joints at Concrete Structures:

1. Install 18 inches or less from 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 first joint.
 - b. Pipe Diameter Larger than 18 Inches: Within two to three pipe diameter of first joint.

- #### D. Flexible expansion joints shall be provided to compensate for earth settlement at buried piping connections to structure wall pipes. Wrap complete joint assembly in a double layer of polyethylene encasement, as specified in Section 40 27 00, Process Piping—General.

3.03 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 or in accordance with NFPA 24.
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 there are at least two flexible joints between closure and pipe entering 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.

3.04 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:

1. Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.
2. Nonmetallic Pipe: Teflon bellows expansion joint.
3. Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.

4. Air and Water Service above 120 Degrees F: Metal bellows expansion joint.
5. Pipe Run Offset: Flexible metal hose.

C. Weld-End Metal Bellows Installation:

1. Field Weld: Stainless steel bellows beveled ends joined to ALP carbon steel piping in accordance with approved welding procedures.
2. Lining:
 - a. System No. 4, high-temperature epoxy, in accordance with Section 09 90 00, Painting and Coating.
 - b. Field apply lining to protect bellows and piping from rust at welded joint.
 - c. Line both ends inside bellows, entire length of extension stub end, and from weld joint to a distance of 1 foot inside length of the carbon steel pipe.
3. Coating:
 - a. System No. 4, high-temperature epoxy, in accordance with Section 09 90 00, Painting and Coating.
 - b. Field apply coating to protect bellows and piping from weather and rust at welded joint.
 - c. Coat both ends outside bellows, entire length of extension stub end, and from weld joint to a distance of 1 foot outside length of the carbon steel pipe.

- D. Anchors: Install as specified in Section 40 05 15, Piping Support Systems, to withstand expansion joint thrust loads and to direct and control thermal expansion.

3.05 SERVICE SADDLES

- A. Ferrous Metal Piping (except stainless steel): Double-strap iron.
- B. Plastic Piping: Nylon-coated iron.

3.06 OUTLET/TAPPING SADDLE

- A. Install in accordance with manufacturer's written instructions.

3.07 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.

3.08 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. Copper Piping: Flexible metal hose connector.
 3. Compressor and Blower Discharge: Metal bellows connector.
 4. All Other Piping: Elastomer bellows connector.
- C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.09 PIPE SLEEVES

- A. Application:
 1. As specified in Section 40 27 00, Process Piping—General.
 2. Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.
 3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.
 4. Alternatively, Molded Polyethylene Pipe Sleeve as specified may be applied.
- B. Installation:
 1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.
 2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications with wall penetration seal.

3.10 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 09 90 00, Painting and Coating.
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

3.11 CHEMICAL EJECTOR SYSTEM

- #### A.
- See Specification Section 44 44 16, Wastewater Chlorinators and Sulfonators for details.

END OF SECTION

SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Gas Association (AGA): 3, Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids.
 2. American National Standards Institute (ANSI): Z21.15, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
 3. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - b. B16.44, Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi.
 4. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
 5. American Water Works Association (AWWA):
 - a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - b. C500, Metal-Seated Gate Valves for Water Supply Service.
 - c. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
 - d. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
 - e. C509, Resilient-Seated Gate Valves for Water Supply Service.
 - f. C510, Double Check Valve Backflow Prevention Assembly.
 - g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
 - h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
 - i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
 - j. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
 - k. C542, Electric Motor Actuators for Valves and Slide Gates.
 - l. C550, Protective Interior Coatings for Valves and Hydrants.
 - m. C606, Grooved and Shouldered Joints.
 - n. C800, Underground Service Line Valves and Fittings.

6. ASTM International (ASTM):
 - a. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 - d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
 - e. B61, Standard Specification for Steam or Valve Bronze Castings.
 - f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - g. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
 - h. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
 - i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
 - j. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
 - k. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
 - l. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
 - m. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
 - n. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
7. Canadian Standards Association, Inc. (CSA): 9.1, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
8. Chlorine Institute (CI): Pamphlet 6, Piping Systems for Dry Chlorine.
9. FM Global (FM).
10. Food and Drug Administration (FDA).
11. International Association of Plumbing and Mechanical Officials (IAPMO).
12. Manufacturers Standardization Society (MSS):
 - a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
 - b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
 - c. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
 - d. SP-88, Diaphragm Valves.
 - e. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

13. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
14. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
15. Underwriters Laboratories (UL).
16. USC Foundation for Cross-Connection Control and Hydraulic Research.

1.02 SUBMITTALS

A. 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. Certification for compliance to NSF/ANSI 61 for valves used for drinking water service.
 - d. Power and control wiring diagrams, including terminals and numbers.
 - e. For each power actuator provided, manufacturer's standard data sheet, with application specific features and options clearly identified.
 - f. Sizing calculations for open-close/throttle and modulating valves.
 - g. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for:
 - a. Electric actuators; full compliance with AWWA C542.
 - b. Butterfly valves; full compliance with AWWA C504.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection and Testing.

4. Tests and inspection data.
5. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

PART 2 PRODUCTS

2.01 GENERAL

- A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.
- B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.
- C. Valve same size as adjoining pipe, unless otherwise called out on Drawings or in Supplements.
- D. Valve ends to suit adjacent piping.
- E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.
- F. Size operators and actuators to operate valve for full range of pressures and velocities.
- G. Valve to open by turning counterclockwise, unless otherwise specified.
- H. Factory mount operator, actuator, and accessories.
- I. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 SCHEDULE

- A. Additional requirements relative to this section are shown on Electric Actuated Valve Schedule and Self-Regulated Valve Schedule located at the end of this section.

2.03 MATERIALS

- A. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.
 - 1. Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
 - 2. Stainless steel Alloy 18-8 may be substituted for bronze.
- B. Valve materials in contact with or intended for drinking water service to meet the following requirements:
 - 1. Materials to comply with requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.
 - 2. Coatings materials to be formulated from materials deemed acceptable to NSF/ANSI 61.
 - 3. Supply certification product is certified as suitable for contact with drinking water by an accredited certification organization in accordance with NSF/ANSI 61. Provide certification for each valve type used for drinking water service.

2.04 FACTORY FINISHING

- A. General:
 - 1. Interior coatings 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 09 90 00, Painting and Coating.
 - 3. Material in contact with potable water shall conform to NSF/ANSI 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 as follows:
 - 1. In accordance with AWWA C550.
 - 2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
 - 3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2.05 VALVES

A. Gate Valves:

- 1. General:
 - a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
 - 1) Provide 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller.
 - 2) Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 14 inches and larger.
 - 3) Provide Affidavit of Compliance per the applicable AWWA standard for AWWA gate valves.
 - 4) Mark AWWA gate valves with manufacturer’s name or mark, year of valve casting, valve size, and working water pressure.
 - 5) Repaired AWWA gate valves shall not be submitted or supplied.
 - 6) Supply AWWA gate valves with stainless steel bolting.
 - 7) AWWA C509 and AWWA C515 valves may be substituted for each other.
- 2. Type V100 Gate Valve 3 Inches and Smaller:
 - a. All-bronze, screwed bonnet, packed gland, single solid wedge gate, nonrising stem, Class 125 rated 200 psi CWP, complies with MSS SP-80 Type 1.
 - b. Manufacturers and Products:
 - 1) Crane; Figure 438, NPT threaded ends.
 - 2) Stockham; Figure B103, NPT threaded ends.
 - 3) Crane; Figure 1324, soldered ends.
 - 4) Stockham; Figure B104, soldered ends.
 - 5) American Flow Control.
 - 6) Or equal in accordance with MAWSS standard specifications.

3. Type V120 Gate Valve 3 Inches to 48 Inches for Water Service:
 - a. AWWA C500, iron body, bronze mounted, flanged ends, double-disc gate, nonrising bronze stem, working water pressure 200 psi for 3 inches through 12 inches and 150 psi for 14 inches through 48 inches.
 - b. Manufacturers and Products:
 - 1) M&H Valve Company; Style 67.
 - 2) Clow Valve Company; AWWA C500.
 - 3) American Flow Control.
 - 4) Or equal in accordance with MAWSS standard specifications.
4. Type V122 Gate Valve 3 Inches to 48 Inches for Buried Water Service:
 - a. AWWA C500, iron body, bronze mounted, mechanical joint ends, double-disc gate, nonrising bronze stem, 2-inch operating nut, and O-ring sealed stuffing box, working water pressure of 200 psi for 3 inches through 12 inches and 150 psi for 14 inches through 48 inches.
 - b. Manufacturers and Products:
 - 1) M&H Valve Company; Style 67.
 - 2) Clow Valve Company; AWWA C500.
 - 3) American Flow Control.
 - 4) Or equal in accordance with MAWSS standard specifications.

B. Globe Valves:

1. Type V236 Globe Style Hose Valve 1 Inch to 3 Inches:
 - a. All-bronze, NPT threaded ends, inside screw-type rising stem, TFE disc, cast brass male NPT by male NHT adapter with hexagonal center wrench nut, complies with MSS SP-80, rated 300 WOG.
 - b. Manufacturers and Products:
 - 1) Stockham; Figure B-22T.
 - 2) Crane Co.; Cat. No. 7TF.
 - 3) Nibco; Figure T-235-Y.
2. Type V237 Angle Pattern Hose Valve 1 Inch to 2 Inches:
 - a. All-bronze, NPT threaded ends, inside screw-type rising stem, TFE disc, cast brass male NPT by male NHT adapter with hexagonal center wrench nut, complies with MSS SP-80, rated 300 WOG.
 - b. Manufacturers and Products:
 - 1) Stockham; Figure B-222T.
 - 2) Crane Co.; Cat. No. 17TF.
 - 3) Nibco; Figure T-335-Y.

3. Type V295 Globe Valve for Dry Chlorine Gas Service 1/2 Inch to 2 Inches:
 - a. Chlorine Institute, Pamphlet 6 compliant, ASME B16.34 compliant, forged steel, ASTM A105 body and bonnet, blow-out proof stem, NPS threaded ends, conventional port, Monel/Hastelloy trim, disc with Teflon insert, pressure rating 1,975 psi at 100 degrees F.
 - b. Round bolted bonnet with spiral wound gasket, outside screw and yoke, bolted gland, and renewable seat.
 - c. Manufacturers and Products:
 - 1) Vogt, Class 800, Series 22141MT.
 - 2) Or approved equal.

C. Ball Valves:

1. Type V300 Ball Valve 3 Inches and Smaller for General Water and Air Service:
 - a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110. For steam service, provide stainless steel ball and stem.
 - b. Manufacturers and Products:
 - 1) Threaded:
 - a) Conbraco Apollo; 70-100.
 - b) Nibco; T-580-70.
 - 2) Soldered:
 - a) Conbraco Apollo; 70-200.
 - b) Nibco; S-580-70.
2. Type V307 Stainless Steel Ball Valve 2 Inches and Smaller:
 - a. Three-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end pieces, Type 316 stainless steel ball, NPT threaded ends, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout-proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 800 psig to 1,000 psig CWP, complies with MSS SP-110.
 - b. Manufacturers and Products:
 - 1) Conbraco Apollo; 86R-100/86-500 Series.
 - 2) Nibco; T-595-S6-R-66-LL.

3. Type V309 Instrument Air Shutoff Valve 1/8 Inch to 3/4 Inch:
 - a. Stainless steel body ball valve, nylon handle, tube fitting ends, PTFE seats and seals, panel nut, rated 1,500 psi minimum.
 - b. Manufacturers and Products:
 - 1) Swagelok; 40 Series.
 - 2) Parker Hannifin; B Series.
4. Type V310 Ball Valve for Chlorine Liquid and Gas:
 - a. 600-pound WOG, carbon steel body, monel ball and stem, reinforced Teflon seat, Teflon seals, double stem seal, lever operator, screwed ends, nonlubricated, and comply with the requirements of Chlorine Institute Pamphlet 6.
 - b. Manufacturer and Product: ITT Camtite.
5. Type V330 PVC Ball Valve 2 Inches and Smaller:
 - a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions. Provide pressure relief hole drilled on low pressure side of ball.
 - b. Manufacturers and Products:
 - 1) Nibco; Chemtrol Tru-Bloc.
 - 2) ASAHI/America; Type 21.
 - 3) Spears; True Union.
6. Type V331 PVC Ball Valve 3 Inches and 4 Inches:
 - a. Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade 1 PVC full port body, Teflon seat, EPDM O-ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ASME B16.1. Provide pressure relief hole drilled on low pressure side of ball.
 - b. Manufacturers and Products:
 - 1) Nibco; Chemtrol Tru-Bloc.
 - 2) ASAHI/America; Type 21.

D. Plug Valves:

1. Type V405 Eccentric Plug Valve 3 Inches to 12 Inches:
 - a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joint ends, unless otherwise shown.

- b. Plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N, seats welded nickel, stem bearings lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber, grit seals on both upper and lower bearings.
 - c. For buried service, provide external epoxy coating.
 - d. Operators:
 - 1) 3-Inch to 4-Inch Valves: Wrench lever manual.
 - 2) 6-Inch to 12-Inch Valves: Totally enclosed, geared, manual operator with handwheel, 2-inch nut or chain wheel. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.
 - e. Manufacturers and Products:
 - 1) Pratt; Ballcentric.
 - 2) DeZurik; Style PEC.
 - 3) Milliken; Millcentric Series 600.
2. Type V420 Nonlubricated Plug Valve 3 inches and Smaller for Fuel Oil Service:
- a. Ductile iron or carbon steel body, straight-way rectangular ports, Teflon sleeves, screwed ends, wrench operator.
 - b. Class: 150, rated for 275 pounds WOG.
 - c. Manufacturers and Products:
 - 1) Duriron Co.; Figure No. G432.
 - 2) Tufline; Figure 066.
3. Type V462 Gauge Cock 1/8 Inch to 1/4 Inch:
- a. 1/4-inch bronze body, hexagon end pattern, tee head, male ends, rated 125-pound SWP.
 - b. Manufacturer and Product: United Brass Works; Figure 973.
4. Type V464 Corporation Stop 1/2 Inch to 2 Inches:
- a. AWWA C800 type, tapered threaded inlet, except when connecting to tapped fittings which require IPS tapered threads, outlet compression connection or IPS threads to suit connecting pipe, stops 1 inch and smaller rated 100 psi, larger stops rated 80 psi.
 - b. Manufacturers and Products:
 - 1) Ford Meter Box Co.
 - 2) Mueller Co.

E. Check and Flap Valves:

1. Type V608 Swing Check Valve 2 Inches to 24 Inches:
 - a. Per MAWSS Standard Specifications as identified as V-200 by MAWSS.
 - b. DeZurik is an approved equal.
2. Type V642 Reduced Pressure Principle Backflow Prevention Assembly 3/4 Inch to 10 Inches:
 - a. Two resilient seated check valves with an independent relief valve between the valves, two nonrising stem resilient seated isolation valves, test checks, in accordance with AWWA C5111, rated 175 psi maximum working pressure, meets requirements of USC Foundation For Cross Connection Control and Hydraulic Research.
 - b. Manufacturers and Products:
 - 1) FEBCO; Model 860.
 - 2) Danfoss Flomatic; Model RPZE/RPZ.
 - 3) Watts; Series 009/909.
 - 4) Apollo; Model RPLF4A.

F. Self-Regulated Automatic Valves: Type V752 Sewage Air Release Valve 2 Inches to 4 Inches: Per MAWSS Standard Specifications.

G. Miscellaneous Valves:

1. Type V940 Solenoid Valve 1/4 Inch to 2 Inches:
 - a. Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA insulation Class F, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (when de-energized) as indicated on Drawings.
 - b. Minimum operating pressure differential no greater than 5 psig, maximum operating pressure differential not less than 200 psig.
 - c. Manufacturers and Products:
 - 1) ASCO.
 - 2) Skinner.
2. Type V-953 Foot Style Check Valves 2 Inches and Smaller for Fuel Oil Service:
 - a. Bronze body, seat and poppets. Buna-N seal with 20 mesh inlet strainer.
 - b. Double poppet style pressure rated for 200 psi.
 - c. Threaded end style.
 - d. Manufacturers and Products:
 - 1) OPW; Figure 92 Foot Valve.
 - 2) Or equal.

3. Type V-954 Fusible Link Shut Off Valve for Fuel Oil Service:
 - a. Ductile iron body.
 - b. Pressure rated for 200 psi WO6.
 - c. Threaded end style.
 - d. Manufacturers and Products:
 - 1) Morrison Bros. Co.; Figure 346DI.
4. Type V-955 Process Solenoid Valves 3/4 Inch Size to 2 Inches for Fuel Oil Service:
 - a. Pilot operated type with orifice size not less than 80 percent of pipe size. Valves suitable for operation with fuel oil. Materials shall be aluminum body, Buna N seals and discs, and stainless steel core, core tube, and spring. Valves shall operate from 0 to 150 psi pressure differential, up to 180 degrees F fluid temperature, and have a working pressure of no less than 250 psig. Solenoids shall be continuous duty epoxy-encapsulated coils suitable for operation on 120-volt ac, 60 Hz, and shall have Type 7, watertight and explosion proof rated enclosures. Valves shall be configured for normally closed operation, and be provided with manual position lock feature.
 - b. Manufacturers and Products:
 - 1) OPW; Figure 821 Solenoid Valve.
 - 2) Or equal.
5. Type V964 Overfill Prevention Valve 3 Inches and Smaller for Fuel Oil Service:
 - a. Valve assembly design meets the following requirements:
 - 1) prevents overfilling of tank, providing a positive shut off during pressurized fill, yet allowing for full flow to shut-off point.
 - 2) provides cushioned shut-off without line shock. Outfitted with Integral pressure relief device allowing non-pressurized uncoupling upon completion of fill operation.
 - 3) shutoff level setting field adjustable through use of standard length pipe nipples. Valve design allows the minimum shut off height to be 2-inches below the tank's interior overhead.
 - 4) furnished with tube adaptor accepting either 2 or 3-inch drop tubes. Fill tube length adjusted at factory to terminate 8-inches above invert of storage tank.
 - 5) rated for not less than 150 gpm fuel delivery flowrate at a pressure drop across the valve less than or equal to 8 psig.
 - 6) possesses manual test mechanism allowing float to be activated during filling thereby verifying overfill prevention operation.

- b. Valve body, plunger/dashpot and adaptor to be passivated, cast aluminum. Shaft/linkage and hardware to be Type 304 stainless steel. Hard coated aluminum poppet and Nitrile (BUNA-N) float.
- c. Manufacturers and Products:
 - 1) OPW; Figure 61fSTOP-2000 with 61FT drop tube.
 - 2) Morrison Bros. Co.; Figure 9095AA or 9095X.

2.06 OPERATORS AND ACTUATORS

A. Manual Operators:

- 1. General:
 - a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
 - b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
 - c. Operator self-locking type or equipped with self-locking device.
 - d. Position indicator on quarter-turn valves.
 - e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator's threaded steel reach rod with internally threaded bronze or ductile iron nut.
- 2. Exposed Operator:
 - a. Galvanized and painted handwheel.
 - b. Cranks on gear type operator.
 - c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
 - d. Valve handles to take a padlock, and wheels a chain and padlock.
- 3. Buried Operator:
 - a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
 - b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
 - c. Buried valves shall have extension stems, bonnets, and valve boxes.

B. Electric Operators, 120 Volts:

1. General:
 - a. Unit shall be low profile to reduce amount of required space and weigh 15 pounds or less.
 - b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of the valve.
 - c. Provide operator mounting bracket to mount operator to valve providing minimal torque to piping system when operating.
2. Operator Operation, General:
 - a. Suitable for full 90-degree rotation of quarter-turn valves.
 - b. Manually override handwheel.
 - c. Mechanical valve position indication.
3. Electronic Control:
 - a. Torque Limiting Switches: Two single pole, double throw mechanical switches. Switches operate at any point in valve travel.
 - b. Jammed-valve detection and protection.
 - c. Motor over-temperature detection and protection.
 - d. Travel limit switches, single pole double throw.
4. Open-Close (O/C) Service:
 - a. Duty cycle for intermittent ON-OFF operation shall be 25 percent.
 - b. Operator shall power to OPEN and power to CLOSE.
 - c. Local Indication and Control:
 - 1) Integral mechanical valve POSITION indication, 0 percent to 100 percent OPENED.
 - 2) Integral OPENED and CLOSED indication lights.
 - 3) Integral LOCAL-OFF-REMOTE (L-O-R).
 - 4) Integral OPEN maintained switch which causes the valve to stroke full OPENED, even if OPEN switch is released, while L-O-R switch is in LOCAL.
 - 5) Integral CLOSE maintained switch which causes valve to stroke full CLOSED, even if CLOSED switch is released, while L-O-R switch is in LOCAL.
 - d. Remote Indication and Control:
 - 1) Relay contact that closes when valve is capable of being controlled remotely (L-O-R switch in REMOTE) for connection to and monitoring by plant control system.
 - 2) Limit switch that closes when valve is fully OPENED for connection to and monitoring by plant control system.
 - 3) Limit switch that closes when valve is fully CLOSED for connection to and monitoring by plant control system.

- e. Modulating (M) Service:
 - 1) Operator rated for continuous duty with servo shall be rated for 100 percent modulating operation.
 - 2) Operator shall modulate based on an externally applied 4 mA to 20 mA dc signal.
 - 3) Operator shall be equipped with an electronic servo module for valve modulation.
 - a) Module shall provide serial communications with provided cable for setup of valve operation.
- f. Local Indication and Control:
 - 1) Integral mechanical valve POSITION indication, 0 percent to 100 percent OPENED.
 - 2) Integral OPENED and CLOSED indication lights.
 - 3) Integral LOCAL-OFF-REMOTE (L-O-R).
 - 4) Integral OPEN momentary switch which causes valve to stroke towards OPENED, as long as OPEN switch is held, while L-O-R switch is in LOCAL.
 - 5) Integral CLOSE momentary switch which causes valve to stroke towards CLOSED, as long as CLOSED switch is held, while L-O-R switch is in LOCAL.
 - 6) Position valve proportionally 0 to 100 percent OPEN with external 4 mA to 20 mA dc signal while in REMOTE.
- g. Remote Indication and Control:
 - 1) Relay contact that closes when valve is capable of being controlled remotely (L-O-R switch in REMOTE) for connection to and monitoring by plant control system.
 - 2) Limit switch that closes when valve is fully OPENED for connection to and monitoring by plant control system.
 - 3) Limit switch that closes when valve is fully CLOSED for connection to and monitoring by plant control system.
 - 4) Current Position Transmitter, 4 mA to 20 mA dc signal in proportion to 0 percent to 100 percent OPENED, with 0.5 percent accuracy and 0.5 percent repeatability, capable of driving a 750-ohm load, for connection to and monitoring by Plant Control System.
- 5. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.
- 6. Manufacturer and Product: Flowserve Limitorque or Rotork.

C. Electric Motor Actuators, 480 Volts:

1. General:
 - a. Comply with latest version of AWWA C542.
 - b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of valve.
 - c. Controls integral with actuator and fully equipped as specified in AWWA C542.
 - d. Stem protection for rising stem valves.
2. Actuator Operation—General:
 - a. Suitable for full 90-degree rotation of quarter-turn valves or for use on multiturn valves, as applicable.
 - b. Manual override handwheel.
 - c. Valve position indication.
 - d. Operate from FULL CLOSED to FULL OPEN positions or the reverse in the number of seconds given in Electric Actuated Valve Schedule.
 - e. Nonintrusive Electronic Control: Local controls, diagnostics, and calibration, including limit and torque settings, shall be accomplished nonintrusively. Electronic valve position display with capability to show continuous torque output. If applicable, provide two hand-held configuration units for every 10 actuators provided, two minimum.
3. Open-Close(O/C)/Throttling(T) Service:
 - a. Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.
 - b. Actuator suitable for throttling operation of valve at intermediate positions.
 - c. LOCAL-OFF-REMOTE Selector Switch, padlockable in each position:
 - 1) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in LOCAL position.
 - 2) Remote OPEN-STOP-CLOSE momentary control dry contact inputs in REMOTE position. Integral seal-in circuits for remote OPEN and CLOSE commands; valve travel stops when remote STOP contact opens.
 - 3) Auxiliary contact that closes in REMOTE position.
 - d. OPEN and CLOSED indicating lights.
 - e. Integral reversing motor starter with built-in overload protection.

4. Modulating (M) Service:
 - a. Size actuators for continuous modulating duty.
 - b. Feedback potentiometer, or equivalent, and integral electronic positioner/comparator circuit to maintain valve position.
 - c. HAND-OFF-AUTO (Local-Off-Remote) Selector Switch, padlockable in each position:
 - 1) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in HAND (Local) position.
 - 2) 4 mA to 20 mA dc input signal to control valve in AUTO (Remote) position.
 - 3) Auxiliary contact that closes in AUTO (Remote) position.
 - d. OPEN and CLOSED indicating lights.
 - e. Ac motor with solid state reversing starter or dc motor with solid state reversing controller, and built-in overload protection. Controller capable of 1,200 starts per hour.
 - f. Duty cycle limit timer and adjustable band width, or equivalent, to prevent actuator hunting.
 - g. Valve position output converter that generates isolated 4 mA to 20 mA dc signal in proportion to valve position, and is capable of driving into loads of up to 500 ohms at 24 volts dc.
5. Limit Switch:
 - a. Single-pole, double-throw (SPDT) type, field adjustable, with contacts rated for 5 amps at 120 volts ac.
 - b. Each valve actuator to have a minimum of two auxiliary transfer contacts at end position, one for valve FULL OPEN and one for valve FULL CLOSED.
 - c. Housed in actuator control enclosure.
6. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.
7. Manufacturers and Products: Flowserve Limitorque or Rotork.
8. Accessories:
 - a. Pilot Solenoid Valve:
 - 1) Solenoid valve shall pilot control actuator in appropriate configuration for type of open-close actuator being controlled. Double acting actuator shall have four-way solenoid valve, and spring return actuator shall have three-way solenoid valve. Dual coil valve shall not change position unless one coil is energized while the other is de-energized.
 - 2) Pilot operated diaphragm type solenoid valve with brass body and resilient seat. Valve with minimum operating pressure differential no greater than 10 psig and maximum operating pressure differential no less than 150 psig. Internal parts corrosion-resistant. Solenoid valve to have Class F molded coils for operation on 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure as defined in NEMA 250, Type 4X.

3) Manufacturers and Products:

- a) Asco Red Hat.
- b) C. A. Norgren Co.

2.07 ACCESSORIES

- A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve, bearing valve tag number shown on Self-Regulating Valve Schedule or Drawings.
- B. Limit Switch:
 - 1. Factory installed NEMA 4X limit switch by actuator manufacturer.
 - 2. SPST, rated at 5 amps, 120 volts ac.
- C. Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.
 - 1. Manufacturers and Products:
 - a. Pratt.
 - b. DeZurik.
- D. Cast-Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 5-1/4-inch ID shaft.
 - 1. Box: Cast iron with minimum depth of 9 inches.
 - 2. Lid: Cast iron, minimum depth 3 inches, nonlocking type, marked WATER, SEWER or GAS as applicable.
 - 3. Extensions: Cast iron, ABS, or PVC pipe.
 - 4. Two-piece box and lid for valves 4 inches through 12 inches, three-piece box and lid for valves larger than 12 inches with base sized for valve.
 - 5. Valve extension stem for valves with operating nuts 3 feet or greater below finish grade.
 - 6. Manufacturers and Products:
 - a. East Jordan Iron Works; Cast-Iron Valve Boxes.
 - b. Bingham & Taylor; Cast-Iron Valve Boxes.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flange Ends:

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:

1. Clean threads by wire brushing or swabbing.
2. Apply joint compound.

C. PVC and CPVC Valves: Install using solvents approved for valve service conditions.

D. Valve Installation and Orientation:

1. General:

- a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
- b. Install valves in location for easy access for routine operation and maintenance.
- c. Install valves per manufacturer's recommendations.

2. Gate, Globe, and Ball Valves:

- a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
- b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.

3. Eccentric Plug Valves:

- a. Unless otherwise restricted or shown on Drawings, install valve as follows:
 - 1) Liquids with suspended solids service with horizontal flow: Install valve with stem in horizontal position with plug up when valve is open. Install valve with seat end upstream (flow to produce unseating pressure).
 - 2) Liquids with suspended solids service with vertical flow: Install valve with seat in highest portion of valve (seat up).
 - 3) Clean Liquids and Gas Service: Install valve with seat end downstream of higher pressure when valve is closed (higher pressure forces plug into seat).

4. Butterfly Valves:
 - a. Unless otherwise restricted or shown on Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.
 - b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.
 - c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
 - d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
 - e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.
 5. Check Valves:
 - a. Install valve in accordance with manufacturer's instructions and provide required distance from immediate upstream fitting.
 - b. Install valve in vertical flow (up) piping only for gas services.
 - c. Install swing check valve with shaft in horizontal position.
 - d. Install double disc swing check valve to be perpendicular to flow pattern when discs are open.
 6. Solenoid Valves: Install in accordance with manufacturer's instructions.
- E. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.
- F. Install safety isolation valves on fuel oil.
- G. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.
- H. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet above finish floor. Install chain to within 3 feet of finish floor. Where chains hang in normally traveled areas, use appropriate "L" type tie-back anchors. Install chains to within operator horizontal reach of 2 feet 6 inches maximum, measured from normal operator standing location or station.

3.02 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

- C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.
- D. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.
- E. Set, verify, and record set pressures for relief and regulating valves.
- F. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.
- G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.03 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is part of this Specification.
 - 1. Self-Regulated Valve Schedule.

END OF SECTION

Self-Regulated Valve Schedule							
Tag No.	Valve Type No.	Size (inches)	Inlet* Pressure	Outlet* Pressure	Maximum psig	Flow (gpm)	Fluid
20-ARV-71-1	V752	2	0	25	150	1800	SS
20-ARV-22-(2-5)	V752	2	0	30	150	300	DS
*Inlet Pressure = Set pressure for pressure relief valve or downstream set pressure for pressure reducing valve.							

SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

- 1. Testing Plan:**
 - a. Submit prior to testing and include at least the information that follows.**
 - 1) Testing dates.**
 - 2) Piping systems and section(s) to be tested.**
 - 3) Test type.**
 - 4) Method of isolation.**
 - 5) Calculation of maximum allowable leakage for piping section(s) to be tested.**
- 2. Certifications of Calibration: Testing equipment.**
- 3. 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. Pressure test piping at the pressures identified in the Piping Schedule supplement of Section 40 27 00, Process Piping-General.**
- 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. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests.**
 - 3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.**
 - 4. Chlorine and Sulfur Dioxide Piping: Test, dry, and clean in accordance with requirements of Chlorine Institute Pamphlet 6.**

5. For Fuel Oil Service Piping: Pressure test with clean, dry compressed air with a pressure dew point of minus 40 degrees Fahrenheit at the testing pressure specified.
 6. 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.
 7. Test Pressure: As indicated on Piping Schedule, or as specified by equipment manufacturer .
- D. Test section may be filled with water and allowed to stand under low pressure prior to testing.
- E. 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. Pipe 42 Inches Diameter and Larger: Joint testing device may be used to isolate and test individual joints.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

- A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.
- B. Testing procedures in accordance with MAWSS standard specifications.
- C. 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 6 hour, 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.

D. 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. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 6 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

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

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. |

7. Correct leakage greater than allowable, and retest as specified.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.
2. Piping larger than 18 inches.
3. Buried and other non-exposed piping.

B. Testing Fluid: Oil-free, dry air with pressure dew point as specified hereinbefore for the intended service.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.

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

3.04 HYDROSTATIC TEST FOR GRAVITY PIPING

- A. Test in accordance with MAWSS standard specifications.
- B. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.
- C. Maximum Allowable Leakage: 0.16 gallon(s) per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.
- D. 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.
- E. 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.
- F. Infiltration Test:
1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

- G. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.
- H. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.05 PNEUMATIC TEST FOR GRAVITY PIPING

A. Equipment:

1. Calibrate gauges with standardized test gauge provided by Engineer at start of each testing day. Engineer will witness calibration.
2. Install gauges, air piping manifolds, and valves at ground surface.
3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.
4. Restrain plugs used to close sewer lines to prevent blowoff.

B. Procedure:

1. Require that no person enter manhole where pipe is under pressure.
2. Slowly introduce air into pipe section until internal air pressure reaches 4 psi greater than average back pressure of groundwater submerging pipe.
3. Allow 2 minutes minimum for air temperature to stabilize.

- C. Allowable Leakage: Test section will be considered defective when time required for pressure to decrease from 3.5 psi to 2.5 psi greater than average back pressure of groundwater submerging pipe is less than that computed using values from following table:

Table 1*					
A Pipe Diameter (Inches)	B Time per Foot up to Length in Col C (Seconds)	C Test Length (Feet)	D Test Time for any Length Between Col C & E (Min:Sec)	E Length at Which Time in Col F Applies (Feet)	F Time per Foot for Total Length (Seconds)
4	0.18	636	1:54	1,114	0.10
6	0.40	424	2:50	743	0.23
8	0.71	318	3:47	557	0.41
10	1.11	255	4:43	446	0.63
12	1.60	212	5:40	371	0.91

Table 1*					
A Pipe Diameter (Inches)	B Time per Foot up to Length in Col C (Seconds)	C Test Length (Feet)	D Test Time for any Length Between Col C & E (Min:Sec)	E Length at Which Time in Col F Applies (Feet)	F Time per Foot for Total Length (Seconds)
15	2.50	170	7:05	297	1.42
18	3.62	141	8:30	248	2.06
21	4.92	121	9:55	212	2.81
24	6.42	106	11:20	187	3.67
<p>Example: 15-inch diameter pipe: For 150 feet, T = 2.50 sec (Col B) x 150 ft = 375 sec = 6:15 For 250 feet, T = 7:05 (Col D) For 500 feet, T = 1.42 sec (Col F) x 500 ft = 710 sec = 11:50</p> <p>*Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.</p>					

- D. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.
- E. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.06 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

**SECTION 40 90 00
INSTRUMENTATION AND CONTROL
FOR PROCESS SYSTEMS**

PART 1 GENERAL

1.01 SUMMARY

- A. This section gives general requirements for Process Instrumentation and Control (PIC). The following PIC subsections expand on requirements of this section:
1. Section 40 91 00, Instrumentation and Control Components.
 2. Section 40 94 13, Operational Technology (OT) Components.
 3. Section 40 95 80, Fiber Optic Communication System.
 4. Section 40 96 00, Applications Software.
 5. Section 40 96 02, OT Networking Software.
- B. Major Work Items: Includes but is not limited to engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete PIC.
1. Base Bid. Includes but is not limited to:
 - a. Level instrumentation for the new Biosolids Tanks.
 - b. Pressure instrumentation for the Digested Sludge Pumps.
 - c. Pressure instrumentation for the Smith Sludge Pumps.
 - d. Local control panel 20-LCP-12-1, Smith Sludge Pumps Control Panel.
 - e. Level instrumentation for the Polymer Storage Tanks.
 - f. Local control panel 20-LCP-49-1, Polymer Truck Fill Panel.
 - g. Local control panel 20-LCP-30-10, Conveyor Gate Control Panel.
 - h. Level and Pressure instrumentation for the new Plant Drain Pump Station.
 - i. Instrument power and/or signal surge suppression as shown on P&ID drawings.
 - j. Programmable Automation Controller (PAC) Control Panel 20-CP-1 (Dewatering Building) and Remote Input/Output (RIO) Panels 85-CP-1 (Secondary Digester Building), and 83-CP-1 (Final Clarifiers Electrical Building).
 - k. Programmable Automation Controller (PAC) Control Panel 82-CP-1 (Blower Building).

- l. Modifications to convert existing Emerson Bristol Babcock PAC control panels to Allen-Bradley ControlLogix control panels. This work includes a new subpanel for 83-CP-2 (Sidestream Pump Station Control Panel). Remove existing Panelview operator interface from the panel door and cover the opening with a plate of matching color and material.
- m. Provision of all labor (including terminations) for retrofit work associated with converting existing Emerson Bristol PACs to Allen-Bradley PACs. For the base bid, this includes panels 83-CP-1, 83-CP-2, and 85-CP-1.
- n. Provision of Trihedral's VTScada software and licensing. Load and configure VTScada software onto virtual machines as specified in Sections 40 94 13, Operational Technology (OT) Components, and 40 96 02, OT Networking Software.
- o. Relocation of existing Wonderware Archestra SCADA system to temporary control room facilities during construction of the Dewatering Building. SCADA system shall remain fully functional during construction. Coordinate with Owner to relocate existing network and WAN communication equipment as necessary.
- p. Provide fiber optic cable and appurtenances for the SCADA network fiber optic networks; both temporary and final. Terminate and test all fibers in accordance with Specifications.
- q. Provide fiber optic cable and appurtenances (including fiber optic patch panels and jumpers) for the Security network fiber optic ring. Terminate and test all fibers in accordance with Specifications.
- r. Coordinate with Owner to support connecting the incoming fiber optic cable from the Wesley A. James Operations Center to the appropriate equipment in the existing Administration Building electrical/communication room.
- s. For the temporary control network, coordinate with Owner and provide fiber optic cable, connections, jumpers, and patch panels to accommodate extending the incoming fiber optic cable from the Administration Building electrical/communication room to the existing Maintenance Building and into the temporary server room.
- t. For the final control network, coordinate with Owner and provide fiber optic cable, connections, jumpers, and patch panels to accommodate extending the incoming fiber optic cable from the Administration Building electrical/communication room to the new Dewatering Building and into the business rack in the new server room on the second floor.

- u. Facilitate specified workshops with the Owner and Engineer to discuss and refine MAWSS Hardware and Software standards referenced by this Project. All changes shall be documented.
- v. Provide document updates to all MAWSS Hardware and Software Standards referenced by this Project. Updates shall be in the form of Word documents with “track changes” enabled.
- w. Applications Software (programming):
 - 1) All PAC, OIU, and SCADA programs shall conform to the MAWSS Standards documents. Contractor shall obtain a copy of the latest MAWSS standards before beginning any programming activities.
 - 2) Configure the PAC controllers in 20-CP-1 as a redundant PAC system. Program specified control strategies for the Dewatering Building and its related subsystems.
 - 3) Implement 82-CP-1 as an independent PAC for equipment in the Blower Building. Convert existing Bristol PAC equipment functionality (currently in RTU-1 which will be demolished) to the Allen-Bradley CompactLogix platform. Control strategy logic shall reside in the 82-CP-1 PAC controller.
 - a) Note - During the temporary operations phase of the project, the existing Wonderware Archestra application will continue to monitor and control the plant. The RTU-1 tags shall be converted within the application to interface with new 82-CP-1. Provide any necessary additional Wonderware I/O driver licensing and configuration to allow communications using the appropriate Allen-Bradley protocol.
 - 4) Implement 85-CP-1 as a Device Level Ring (DLR) remote I/O rack for equipment in the Secondary Digester Building. Convert existing Bristol PAC equipment functionality to the Allen-Bradley ControlLogix platform. Control strategy logic shall reside in the redundant PAC controllers in 20-CP-1.
 - 5) Implement 83-CP-1 as a DLR remote I/O rack for equipment in the existing Final Clarifiers Electrical Building. Convert existing Bristol PAC equipment functionality to the Allen-Bradley ControlLogix platform. Control strategy logic shall reside in the redundant PAC controllers in 20-CP-1.
 - 6) Implement 83-CP-2 as a DLR remote I/O rack for equipment in the existing Sidestream Pump Station PAC in the existing Final Clarifiers Electrical Building. Convert existing Allen-Bradley PLC-5 equipment functionality to the Allen-Bradley ControlLogix platform. Control strategy logic shall reside in the redundant PAC controllers in 20-CP-1.

- 7) Implement Trihedral's VTScada product for the plant SCADA software. Existing SCADA software is Wonderware Archestra. All C.C. Williams in-plant systems shall be converted to VTScada. Configure the built-in Historian and Roster Call-out/Dialer. Configure plant reports as specified. The VTScada system and all of its features shall be fully redundant.
- 8) Perform a Physical to Virtual (P2V) conversion of the existing Wonderware Archestra servers. Port to virtual machines hosted on the SCADA servers in the Dewatering Building Server Room. External interfaces to support legacy systems (including the Wright-Smith WWTP and telemetry sites) shall be relocated and shall remain fully functional using the legacy Archestra servers.
- 9) Integrate vendor packaged control panels into the VTScada system. These include, but are not limited to:
 - a) Belt Filter Press Control Panels:
 - (1) 20-VCP-20-1.
 - (2) 20-VCP-20-2.
 - (3) 20-VCP-20-3.
 - (4) 20-VCP-20-4.
 - b) Generator Control Panel, 20GEN-CP-1.
 - c) Headworks Control Panels (existing).
 - (1) MCP-1, Screening Train 1&2.
 - (2) MCP-2, Screening Train 3&4.
 - (3) MCP-3, Grease/Septage Receiving.
 - (4) LCP-1, Grit Removal Train 1&2.
 - (5) LCP-2, Grit Removal Train 3&4.
2. Additive Alternate #1:
 - a. Chlorine leak detection instrumentation.
 - b. Sulfur Dioxide leak detection instrumentation.
 - c. Leak Detection Alarm Panels 50-FP-4, 50-FP-5, 50-FP-6, and 50-FP-7
 - d. Remote Input/Output (RIO) Panel 50-CP-1 (Chlorine/SO2 Building).
 - e. Applications Software (programming):
 - 1) Implement 50-CP-1 as a DLR remote I/O rack for equipment in the new Chlorine/SO2 Building. Control strategy logic shall reside in the redundant PAC controllers in 20-CP-1.
3. Additive Alternate #9:
 - a. Modifications to convert existing Emerson Bristol Babcock PAC control panels to Allen-Bradley ControlLogix control panels. This work includes a new subpanel for 91-CP-1 (Headworks Main Control Panel). PICS supplier is allowed to provide a new enclosure to ease installation logistics.

- b. Provision of all labor (including terminations) for retrofit work associated with converting the existing Emerson Bristol PAC to the Allen-Bradley PAC for 91-CP-1.
- c. Applications Software (programming):
 - 1) Implement 91-CP-1 as a DLR remote I/O rack for equipment in the existing Headworks Electrical Building. Convert existing Bristol PAC equipment functionality to the Allen-Bradley ControlLogix platform. Control strategy logic shall reside in the redundant PAC controllers in 20-CP-1.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section and other PIC subsections:
 - 1. American National Standards Institute (ANSI).
 - 2. ASTM International (ASTM):
 - a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - d. B32, Standard Specification for Solder Metal.
 - e. B88, Standard Specification for Seamless Copper Water Tube.
 - 3. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
 - 4. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - 5. International Society of Automation (ISA):
 - a. RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety.
 - b. S5.1, Instrumentation Symbols and Identification.
 - c. S5.4, Instrument Loop Diagrams.
 - d. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
 - e. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
 - 6. International Conference on Energy Conversion and Application (ICECA).
 - 7. National Electrical Code (NEC).

8. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. ICS 1, Industrial Control and Systems General Requirements.
9. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
10. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
11. Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels.

1.03 DEFINITIONS

A. Abbreviations:

1. AFD: Adjustable Frequency Drive.
2. DLR: Device Level Ring
3. FDT: Factory Demonstration Test.
4. HMI: Human-Machine Interface.
5. HVAC: Heating, Ventilating, and Air Conditioning.
6. I&C: Instrumentation and Control.
7. I/O: Input and Output.
8. IT: Information Technology.
9. OIU: Operator Interface Unit.
10. OT: Operational Technology.
11. O&M: Operation and Maintenance.
12. P&ID: Process and Instrument Diagram.
13. PAC: Programmable Automation Controller.
14. PC: Personal Computer.
15. PIC: Process Instrumentation and Control.
16. RIO: Remote Input/Output (I/O).
17. RTU: Remote Terminal Unit.
18. SCADA: Supervisory Control and Data Acquisition.
19. SLDC: Single Loop Digital Controller.
20. WAN: Wide Area Network.

B. Enclosure: Control panel, console, cabinet, or instrument housing.

C. Instructor Day: Eight hours of actual instruction time.

- D. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.
 - 1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc.); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus; spam, spyware, etc.) debugging aids; and diagnostics.
 - 2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for, data acquisition (I/O driver, OPC servers, etc.), monitoring, alarming, human-machine interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.
 - 3. Controller Programming Software: Software packages for the configuring of PACs, RTUs, DCUs, SLDC, and fieldbus devices.

- E. Application Software: Software to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:
 - 1. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.
 - 2. Programming in any programming or scripting language.

- F. Rising/Falling: Define action of discrete devices about their setpoint.
 - 1. Rising: Contacts close when an increasing process variable rises through setpoint.
 - 2. Falling: Contacts close when a decreasing process variable falls through setpoint.

- G. Signal Types:
 - 1. Analog Signal, Current Type:
 - a. 4 to 20 mA dc signals conforming to ISA S50.1.
 - b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
 - 1) Transmitter Type: Number 2, two-wire.
 - 2) Transmitter Load Resistance Capacity: Class L.
 - 3) Fully isolated transmitters and receivers.
 - 2. Analog Signal, Voltage Type: 1 to 5 volts dc within panel where common high precision dropping resistor is used.

3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
4. Pulse Frequency Signals:
 - a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
 - b. Pulses generated by contact closures or solid state switches.
 - c. Power source less than 30V dc.
5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. Complete detailed design of PIC components and PIC drawings.
2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.
3. PIC design as shown and specified includes:
 - a. Functional requirements, performance requirements, and component specifications.
 - b. P&IDs, block diagrams, and network diagrams.
4. Typical drawings for installation details, control panel layouts, control panel schedules, PAC I/O module wiring, panel power, and control diagrams.

B. MAWSS-approved PIC System Integrators include the following (no exceptions). Listed alphabetically:

1. Automation Control Service, LLC.
2. Hargrove and Associates, Inc.
3. Prism Systems, Inc.
4. Revere Control Systems, Inc.

C. MAWSS-approved PIC Systems Integrators are strongly encouraged to attend the Pre-Bid Conference and to specifically perform an inspection of the existing Emerson Bristol PACs which shall be converted to Allen-Bradley PACs.

D. Use a MAWSS-approved PIC System Integrator for at least the following work:

1. For PIC Equipment and Ancillaries:
 - a. Completing detail design.
 - b. Submittals.

- c. Equipment, enclosures, and ancillaries.
 - d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
 - e. Verify readiness for operation.
 - f. Verify correctness of final power and signal connections (lugging and connecting).
 - g. Adjusting and calibrating.
 - h. Starting up.
 - i. Testing and coordination of testing.
 - j. Training.
 - k. Assist Engineer with Functional Test Part 2 as defined in Article Field Quality Control.
2. Verify following Work not by PIC System Integrator is provided:
- a. Correct type, size, and number of signal wires with their raceways.
 - b. Correct electrical power circuits and raceways.
 - c. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.
 - d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
3. NonPIC Equipment Directly Connected to PIC Equipment:
- a. Obtain from Contractor, manufacturers' information on installation, interface, function, and adjustment.
 - b. Coordinate with Contractor to allow required interface and operation with PIC.
 - c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
 - d. Test to demonstrate required interface and operation with PIC.
 - e. Examples of items in this category, but not limited to the following:
 - 1) Valve operators, position switches, and controls.
 - 2) Chemical feed pump and feeder speed/stroke controls.
 - 3) Automatic samplers.
 - 4) Motor control centers.
 - 5) Adjustable speed and adjustable frequency drive systems.
 - f. Examples of items not in this category:
 - 1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
 - 2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

1.05 SUBMITTALS

A. General:

1. Submit proposed Submittal breakdown consisting of sequencing and packaging of information in accordance with Project Schedule.
2. Partial Submittals not in accordance with Project Schedule will not be accepted.
3. Submittal Format:
 - a. Hard Copy: Required, unless otherwise noted for specific items.
 - b. Electronic Copies: Required, unless otherwise noted for specific items.
 - 1) Manufacturers' Standard Documents: Adobe Acrobat PDF.
 - 2) Documents created specifically for Project:
 - a) Text and Graphics: Microsoft Word or Adobe Acrobat PDF.
 - b) Lists: Microsoft Excel, unless otherwise noted for specific items.
 - c) Drawings: MicroStation or AutoCAD. Coordinate with Owner.
4. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
5. Legends and Abbreviation Lists:
 - a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
 - b. Use identical abbreviations in PIC subsections.
 - c. Submit updated versions as they occur.
6. Activity Completion:
 - a. Action Submittals: Completed when reviewed and approved.
 - b. Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.

B. Action Submittals:

1. Control Room Migration Plan:
 - a. Provide detailed action plan for migrating the existing Server Room and Control Room in the existing Operations Building to the temporary facilities in the existing Maintenance Building.

- b. Action Plan shall include:
 - 1) Detailed schedule of activities. Coordinate schedule with Contractor. Include specific dates and durations. Show task dependencies.
 - a) Include plans for connecting incoming plant fiber optic cable to temporary and then to final control room facilities. Coordinate with Owner regarding MAWSS supplied fiber optic cable and connection dependencies.
 - 2) Provide list of existing components to be relocated.
 - 3) For the temporary Server Room and temporary Control Room in the Maintenance Building:
 - a) Provide proposed layout of components.
 - b) Provide proposed power plan.
 - c) Provide proposed network connection plan and block diagram.
 - c. Proposed schedule shall include a listing of critical path submittals which shall include (but is not limited to):
 - 1) Control Panel Submittal for 82-CP-1.
 - 2) Fiber Optic Cable Submittal.
 - 3) Networking Components (as required to implement and maintain the temporary PAC/SCADA fiber optic network).
 - d. Include software migration plan for relocation of existing Wonderware Archestra SCADA system.
 - 1) Note that conversion of existing RTU-1 to new PAC control panel 82-CP-1 must be included in the software migration plan. RTU-1 will be demolished with the existing Operations Building and that I/O must be re-mapped within the Wonderware application for temporary monitoring and control.
 - e. Include listing and proposed dates of necessary workshops related to the migration plan and schedule. For example, a control strategy workshop for 82-CP-1.
- 2. Bill of Materials: List of required equipment.
 - a. Group equipment items by enclosure and field, and within an enclosure, as follows:
 - 1) PIC Components: By component identification code.
 - 2) Other Equipment: By equipment type.
 - b. Data Included:
 - 1) Equipment tag number.
 - 2) Description.
 - 3) Manufacturer, complete model number and all options not defined by model number.

- 4) Quantity supplied.
 - 5) Component identification code where applicable.
 - 6) For panels, include panel reference number and name plate inscription.
 - c. Formats: Hard copy and Microsoft Excel.
3. Catalog Cuts: I&C components, electrical devices, and mechanical devices:
 - a. Catalog information, marked to identify proposed items and options.
 - b. Descriptive literature.
 - c. External power and signal connections.
 - d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
4. Component Data Sheets: Data sheets for I&C components.
 - a. Format:
 - 1) Similar to ISA TR20.00.01.
 - 2) Microsoft Excel, one component per data sheet.
 - 3) Submit proposed format for Component Data Sheets before completing data sheets for individual components.
 - b. Content: Specific features and configuration data for each component, including but not limited to:
 - 1) Tag Number.
 - 2) Component type identification code and description.
 - 3) Location or service.
 - 4) Service conditions.
 - 5) Manufacturer and complete model number.
 - 6) Size and scale range.
 - 7) Setpoints.
 - 8) Materials of construction.
 - 9) Options included.
 - 10) Power requirements.
 - 11) Signal interfaces.
 - 12) Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
 - c. Electronic Copies: Microsoft Excel.
5. Sizing and Selection Calculations:
 - a. Primary Elements:
 - 1) Complete calculations plus process data used. Example for Flow Elements:
 - a) Minimum and maximum values, permanent head loss, and assumptions made.
 - b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
 - c. Electronic Copies: Microsoft Excel, one file for each group of components with identical sizing calculations.

6. Panel Construction Drawings:
 - a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
 - b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
 - c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
 - d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners, and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
 - e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
 - f. Submit electronic copies of Drawings.
7. Detailed Wiring Diagrams:
 - a. Refer to Drawings for Detailed Wiring Diagrams including:
 - 1) Panel Wiring Diagrams for discrete control and power circuits.
 - 2) Loop Wiring Diagrams showing individual wiring diagram for each analog or pulse frequency loop.
 - 3) Interconnecting Wiring Diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field-mounted components.
 - b. Prepare as-built redline markup of detailed wiring diagrams. Show terminal numbers on switch blocks, relays, and internal components.
 - c. Submit electronic copies of Drawings.
8. Panel Wiring Diagrams:
 - a. Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.
 - b. Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.
 - c. Diagram Type:
 - 1) Ladder diagrams where applicable. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
 - 2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.

- d. Item Identification: Identify each item with attributes listed.
 - 1) Wires: Wire number and color. Cable number if part of multiconductor cable.
 - 2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
 - 3) Components:
 - a) Tag number, terminal numbers, and location (“FIELD”, enclosure number, or MCC number).
 - b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).
 - 4) I/O Points: PAC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
 - 5) Relay Coils:
 - a) Tag number and its function.
 - b) On right side of run where coil is located, list contact location by ladder number and sheet number.
Underline normally closed contacts.
 - 6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
 - 7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.
- e. Show each circuit individually. No “typical” diagrams or “typical” wire lists will be allowed.
- f. Ground wires, surge protectors, and connections.
- g. Wire and Cable Names: Show names and wire color for circuits entering and leaving a panel. Refer to Division 26, Electrical.
- 9. Loop Wiring Diagrams: Individual, end-to-end wiring diagram for each analog and discrete or equipment loop.
 - a. Conform to the minimum requirements of ISA S5.4.
 - b. Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraphs 2 and 6.
 - c. Show loop components within a panel and identify each component, component terminals, and panel terminals.
 - d. If a loop connects to panels or devices not provided under this section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:
 - 1) Show the first component connected to within the panel or device that is not provided under this section and its subsections.

- 2) Identify the component by tag and description.
- 3) Identify panel and component terminal numbers.
- e. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
- f. Divide each loop diagram into areas for panel face, back-of-panel, field and PAC.
- g. One Drawing Per Loop: Show each loop individually. No “typical” loop diagrams will be allowed.
- h. Show:
 - 1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
 - 2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
 - 3) Tabular summary on each analog loop diagram:
 - a) Transmitting Instruments: Output capability.
 - b) Receiving Instruments: Input impedance.
 - c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
 - d) Total loop impedance.
 - e) Reserve output capacity.
 - 4) Circuit and raceway schedule names.
10. Communications and Digital Networks Diagrams:
 - a. Scope: Includes connections to telephone system, Ethernet network, remote I/O, and fieldbus (for example, Modbus, Profibus, Foundation Fieldbus, Device Net, etc.).
 - b. Format: Network schematic diagrams for each different type of network. Include separate temporary and permanent network diagrams.
 - c. Show:
 - 1) Interconnected devices, both passive and active.
 - 2) Device names and numbers.
 - 3) Terminal numbers.
 - 4) Communication Media: Type of cable.
 - 5) Connection Type: Type of connector.
 - 6) Node and device address numbers.
 - 7) Wire and cable numbers and colors.
11. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
 - a. Required voltages, currents, and phases(s).
 - b. Maximum heat dissipations Btu per hour (or watts).
 - c. Calculations.

- d. Steady State Temperature Calculations: Provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures as specified in related sections. Include the impacts of internal heat generation, solar radiation, and shielding.
 - e. Include manufacturer's maximum temperature ratings for each panel component.
- 12. Panel Plumbing Diagrams: For each panel containing piping and tubing. Show type and size for:
 - a. Pipes and Tubes: Thickness, pressure rating, and materials.
 - b. Components: Valves, regulators, and filters.
 - c. Connections to panel-mounted devices.
 - d. Panel interface connections.
 - e. Submit electronic copies of Drawings.
- 13. Installation Details: Include modifications or further details required and define installation of I&C components.
- 14. Spares, expendables, and test equipment.
- 15. PAC I/O List: Submit I/O assignment and Rack/Slot/Point. Format - Microsoft Excel:
 - a. Where possible, distribute I/O points across PAC modules such that like equipment is assigned to different I/O modules. For example, assign Pump 1 points to Module 1, Pump 2 points to Module 2, etc.
- 16. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

C. Informational Submittals:

- 1. PICS Schedule of Values:
 - a. Upon acceptance by Engineer, incorporate in Contractor's Schedule of Values specified in Section 01 29 00, Payment Procedures.
 - b. Incorporate proposed Submittal breakdown.
- 2. PICS Progress Schedule:
 - a. Upon acceptance by Engineer, incorporate in Contractor's Detailed Progress Schedule specified in Section 01 32 00, Construction Progress Documentation.
 - b. Incorporate proposed Submittal breakdown.

3. Operation and Maintenance Data: In accordance with Section 01 78 23, Operation and Maintenance Data, and in addition the following:
 - a. General:
 - 1) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.
 - 2) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittals, heading Submittal Format.
 - b. Final versions of Legend and Abbreviation Lists.
 - c. Process and Instrumentation Diagrams: Marked up copy of revised P&ID to reflect as-built PIC design.
 - d. Provide the following items as defined under heading Action Submittals:
 - 1) Bill of materials.
 - 2) Catalog cuts.
 - 3) Instrument list.
 - 4) Component data sheets.
 - 5) Detailed Wiring Diagrams:
 - a) Panel wiring diagrams.
 - b) Loop diagrams.
 - c) Interconnecting wiring diagrams.
 - 6) Panel plumbing diagrams.
 - 7) Applications software documentation.
 - e. Manufacturer's O&M manuals for components, electrical devices, and mechanical devices:
 - 1) Content for Each O&M Manual:
 - a) Table of Contents.
 - b) Operations procedures.
 - c) Installation requirements and procedures.
 - d) Maintenance requirements and procedures.
 - e) Troubleshooting procedures.
 - f) Calibration procedures.
 - g) Internal schematic and wiring diagrams.
 - h) Component and I/O Module Calibration Sheets from field quality control calibrations.
 - 2) Provide PDF file will be linked index to all manuals.
 - f. List of spares, expendables, test equipment and tools provided.
 - g. List of additional recommended spares, expendables, test equipment, and tools. Include quantities, unit prices, and total costs.

4. Provide Manufacturer's Certificate of Proper Installation where specified.
5. Testing Related Submittals:
 - a. Factory Demonstration Test:
 - 1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - 2) Final Test Procedures:
 - a) Proposed test procedures, forms, and checklists.
 - b) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
 - 3) Test Documentation: Copy of signed off test results.
 - b. Staging Site Demonstration Test:
 - 1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - 2) Final Test Procedures: Proposed test procedures, forms, and checklists.
 - 3) Test Documentation: Copy of signed-off test results when tests are completed.
 - c. Functional Test:
 - 1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - 2) Final Test Procedures: Proposed test procedures, forms, and checklists.
 - 3) Test Documentation:
 - a) Copy of signed-off test results.
 - b) Completed component calibration sheets.
 - d. Performance Test:
 - 1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - 2) Final Test Procedures: Proposed test procedures, forms, and checklists.
 - 3) Test Documentation: Copy of signed-off test results.
6. Owner Training Plan: In accordance with Section 01 43 33, Manufacturers' Field Services.
7. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
8. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

1.06 QUALITY ASSURANCE

- A. Qualifications. PIC System Integrator shall be selected from one of the following MAWSS-approved integrators (listed alphabetically):
 - 1. Automation Control Service, LLC.
 - 2. Hargrove and Associates, Inc.
 - 3. Prism Systems, Inc.
 - 4. Revere Control Systems, Inc.
- B. PIC Coordination Meetings:
 - 1. PIC Kick-Off Meeting:
 - a. Timing: Within 30 days of Notice to Proceed
 - b. Purpose: Review scope of work required and answer questions.
 - c. Other:
 - 1) Meeting shall include an onsite walk-through with the I&C Engineer. Focus of the walk-through will be planning the conversion of Emerson Bristol PACs to Allen-Bradley PACs and the relocation of the existing Wonderware SCADA system to the temporary control facilities in the Maintenance Building.
 - 2) Provide 21-day meeting notice to Engineer.
 - 2. PIC Schedule Coordination Meeting:
 - a. Timing: Following Engineer review of PIC Schedule.
 - b. Purpose: Discuss Engineer's comments and resolve scheduling issues.
 - 3. Startup and Training Meeting:
 - a. Purpose:
 - 1) Startup and testing planning.
 - 2) Resolve required changes to proposed training plan.
 - 3) Identify specific Owner personnel to attend training.
 - 4. Software Design Workshops: Refer to 40 96 00, Applications Software, for details and quantity required.
 - 5. Provide for a minimum of 2 additional coordination meetings.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Section 01 61 00, Common Product Requirements.
- B. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

- C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.
- D. Cover panels and other elements that are exposed to dusty construction environments.

1.08 SEQUENCING AND SCHEDULING

- A. Refer to Section 01 31 13, Project Coordination, for Contractor's scheduling requirements for applications software testing.
- B. Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:
 - 1. Shop Drawing Reviews by Engineer:
 - a. Prerequisite: Engineer acceptance of Schedule of Values and Progress Schedule.
 - b. Schedule: In accordance with completed schedule of Shop Drawing and Sample submittals specified in Section 01 33 00, Submittal Procedures.
 - 2. Test Prerequisite: Associated test procedures Submittals completed.
 - 3. Training Prerequisite: Associated training plan Submittal completed, and specific training course dates submitted and approved. Coordinate training dates with Contractor's construction schedule.
 - 4. PAC and HMI Shipment to Site:
 - a. General Prerequisites:
 - 1) Approval of PIC Shop Drawings and preliminary operation and maintenance data.
 - 2) FDT completed.
 - 5. PAC and HMI Installation Prerequisite: Equipment received at Site.
 - 6. Functional Test Prerequisite: PAC and HMI installation complete.
 - 7. Performance Test Prerequisite: Functional Test(s) completed and facility started up.

1.09 MAINTENANCE

- A. Maintenance Service Agreement: Not included in this Project.

1.10 EXTRA MATERIALS

- A. As specified in PIC subsections.
- B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

C. Spare Parts:

Description	Percent of Each Type and Size Used	No Less Than
dc power supplies	20	2
Fuses	20	5
Indicating light bulb	20	10
Relays	20	5
Terminal Blocks	10	10
Hand Switches and Lights	10	5
Surge Suppressors	10	2
PAC CPU Module	10	2
PAC Redundancy Module	10	2
PAC Power Supply Module	10	2
PAC Discrete Input Module	10	2
PAC Discrete Output Module	10	2
PAC Analog Input Module	10	2
PAC Analog Output Module	10	2
PAC Ethernet Module (DLR)	10	2
PAC Ethernet Module (non-DLR)	10	2
PAC Panel Ethernet Switch	10	2
Ethernet Tap (ETAP) Device, (1) Fiber Optic port	10	2
Ethernet Tap (ETAP) Device, (2) Fiber Optic ports	10	2

D. Expendables: For following items provide manufacturer's recommended 2-year supply, unless otherwise noted.

1. Corrosion-inhibiting vapor capsules. 2-year supply per panel/RTU provided.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide PIC functions shown on Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, and software whether indicated or not, necessary to effect required system and loop performance.
- B. Products shall comply with MAWSS Standards unless stated otherwise.
- C. First Named Manufacturer: PIC design is based on first named manufacturers of equipment, materials, and software.
 - 1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with the General Conditions, Article 6.05 Substitutes and “Or Equals”.
 - 2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.
 - 3. Items specified with “No Equal” or similar terminology should be supplied as specified.
- D. Like Equipment Items:
 - 1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer’s services.
 - 2. Implement same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.
- E. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 I&C COMPONENTS

- A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.
- B. Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Article Supplements. Furnish equipment that is necessary to achieve required loop performance.
- C. Control Panels: Reference Control Panel Schedule in Article Supplements.

2.03 PROGRAMMABLE AUTOMATION CONTROLLERS

- A. Reference PAC Equipment List in Article, Supplements, and PAC components in Section 40 91 00, Instrumentation and Control Components.

2.04 SERVICE CONDITIONS

- A. Standard Service Conditions: The following defines certain types of environments. PIC subsections refer to these definitions by name to specify the service conditions for individual equipment units. Design equipment for continuous operation in these environments:
 - 1. Computer Room, Air Conditioned:
 - a. Temperature: 60 degrees F to 80 degrees F.
 - b. Relative Humidity: 40 percent to 60 percent.
 - c. NEC Classification: Nonhazardous.
 - 2. Inside, Air Conditioned:
 - a. Temperature:
 - 1) Normal: 60 degrees F to 80 degrees F.
 - 2) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 105 degrees F.
 - b. Relative Humidity:
 - 1) Normal: 10 percent (winter) to 70 percent (summer).
 - 2) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
 - c. NEC Classification: Nonhazardous.
 - 3. Inside:
 - a. Temperature: 20 degrees F to 104 degrees F.
 - b. Relative Humidity: 10 percent to 100 percent.
 - c. NEC Classification: Nonhazardous.
 - 4. Inside, Corrosive:
 - a. Temperature: 20 degrees F to 104 degrees F.
 - b. Relative Humidity: 10 percent to 100 percent.
 - c. Corrosive Environment: As noted.
 - d. NEC Classification: Nonhazardous.

5. Inside, Hazardous:
 - a. Temperature: 20 degrees F to 104 degrees F.
 - b. Relative Humidity: 10 percent to 100 percent.
 - c. NEC Classification: As shown on Electrical Drawings.
 6. Outside:
 - a. Temperature: 20 degrees F to 104 degrees F.
 - b. Relative Humidity: 10 percent to 100 percent, rain, snow, freezing rain.
 - c. NEC Classification: Nonhazardous.
 7. Outside, Corrosive:
 - a. Temperature: 20 degrees F to 104 degrees F.
 - b. Relative Humidity: 0 to 100 percent, rain, snow, freezing rain.
 - c. Corrosive Environment: As Noted.
 - d. NEC Classification: Nonhazardous.
 8. Outside, Hazardous:
 - a. Temperature 20 degrees F to 104 degrees F.
 - b. Relative Humidity: 0 to 100 percent, rain, snow, freezing rain.
 - c. NEC Classification: As shown on Electrical Drawings.
- B. Standard Service Conditions for Panels and Consoles: Unless otherwise noted, in Control Panel Schedule located in Article Supplements at End of Section, design equipment for continuous operation in these environments:
1. Freestanding Panel and Consoles:
 - a. Inside, Air Conditioned: NEMA 1.
 - b. Inside: NEMA 12.
 2. Smaller Panels and Assemblies (that are not freestanding):
 - a. Inside, Air Conditioned: NEMA 12.
 - b. All Other Locations: NEMA 4X.
 3. Field Elements: Outside.

2.05 NAMEPLATES AND TAGS

- A. Panel Nameplates: Enclosure identification located on enclosure face.
1. Location and Inscription: As shown on Drawings.
 2. Materials: Laminated plastic attached to panel with stainless steel screws.
 3. Letters: 1/2-inch-high, white on black background, unless otherwise noted.

- B. Component Nameplates, Panel Face: Component identification located on panel face under or near component.
 - 1. Location and Inscription: As shown on panel drawing.
 - 2. Materials: Adhesive-backed, laminated plastic.
 - 3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.
- C. Component Nameplates, Back of Panel: Component identification located on or near component inside of enclosure.
 - 1. Inscription: Component tag number.
 - 2. Materials: Adhesive-backed, laminated plastic.
 - 3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.
- D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.
 - 1. Inscription:
 - a. Refer to table under Paragraph Standard Pushbutton Colors and Inscriptions.
 - b. Refer to table under Paragraph Standard Light Colors and Inscriptions.
 - c. Refer to P&IDs on Drawings.
 - 2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
 - 3. Letters: Black on gray or white background.
- E. Service Legends: Component identification nameplate located on face of component.
 - 1. Inscription: As shown on panel drawing.
 - 2. Materials: Adhesive-backed, laminated plastic.
 - 3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.
- F. Nametags: Component identification for field devices.
 - 1. Inscription: Component tag number.
 - 2. Materials: 16-gauge, Type 304 stainless steel.
 - 3. Letters: 3/16-inch-high, imposed.
 - 4. Mounting: Affix to component with 16-gauge or 18-gauge stainless steel wire or stainless steel screws.

2.06 MECHANICAL SYSTEM COMPONENTS

- A. Reference Section 40 91 00, Instrumentation and Control Components.

2.07 FUNCTIONAL REQUIREMENTS FOR CONTROL LOOPS

- A. Shown on Drawings, in panel control diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.
- B. Supplemented by Loop Specifications that describe requirements not obvious on P&IDs or panel control diagrams.
- C. Supplemented by standard functional requirements in PIC subsections.

2.08 LOOP SPECIFICATIONS

- A. See Article Supplements located at End of Section.
- B. Organization: By unit process and loop number.

2.09 ELECTRICAL REQUIREMENTS

- A. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.
- B. Control Panels with Three-Phase Power: As specified in Section 40 99 90, Package Control Systems, 2.04.D.
- C. Wiring External to PIC Equipment:
 - 1. Special Control and Communications Cable: Provided by PIC System Integrator as noted in Component Specifications and PIC subsections.
 - 2. Other Wiring and Cable: As specified in Section 26 05 05, Conductors.
- D. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.
- E. Wires within Enclosures:
 - 1. ac Circuits:
 - a. Type: 600-volt, Type MTW stranded copper.
 - b. Size: For current to be carried, but not less than No. 18 AWG.
 - 2. Analog Signal Circuits:
 - a. Type: 600-volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.

- b. Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Belden No. 1121A.
 - c. Size: No. 18 AWG, minimum.
 - 3. Other dc Circuits.
 - a. Type: 600-volt, Type MTW stranded copper.
 - b. Size: For current carried, but not less than No. 18 AWG.
 - 4. Special Signal Circuits: Use manufacturer's standard cables.
 - 5. Wire Identification: Numbered and tagged at each termination.
 - a. Wire Tags: Machine printed, heat shrink.
 - b. Manufacturers:
 - 1) Brady Perma Sleeve.
 - 2) Tyco Electronics.
- F. Terminate and identify wires entering or leaving enclosures as follows:
 - 1. Analog and discrete signal, terminate at numbered terminal blocks.
 - 2. Special signals terminated using manufacturer's standard connectors.
 - 3. Identify wiring in accordance with requirements in Section 26 05 05, Conductors.
 - 4. PIC Supplier shall provide all de-terminations, re-terminations, and lableing for the following control panels which are converted from Emerson Bristol PACs to Allen-Bradley PACs:
 - a. 83-CP-1.
 - b. 83-CP-2.
 - c. 85-CP-1.
 - d. 91-CP-1 (if Additive Alternate #9 is selected).
 - 5. PIC Supplier shall provide coordination for all other control panel and instrumentation terminations. Termination labor shall be provided by the Electrical Subcontractor unless specified otherwise.
- G. Terminal Blocks for Enclosures:
 - 1. Quantity:
 - a. Accommodate present and spare indicated needs.
 - b. Wire spare PAC I/O points to terminal blocks.
 - c. One wire per terminal for field wires entering enclosures.
 - d. Maximum of two wires per terminal for No. 18 AWG wire for internal enclosure wiring.
 - e. Spare Terminals: 20 percent of connected terminals, but not less than 5 per terminal block, unless otherwise shown on Drawings.
 - 2. Terminal Block Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.

H. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
 - a. Locate signal ground at dc power supply for loop.
 - b. Use to ground wire shields for loop.
4. Ground terminal block rails to ground bus.

I. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
2. Do not wire in series instruments on different panels, cabinets, or enclosures.

J. Intrinsic Safety System Installation:

1. Comply with NEC Article 504, Intrinsically Safe Systems.
2. Install intrinsically safe circuits in a separate wire way that:
 - a. Is separated from nonintrinsically safe circuits as specified by NEC.
 - b. Is colored light blue and has message "Intrinsically Safe Circuits Only" on raceway cover every 6 inches.

K. Wiring Interface: Terminate and identify wiring entering or leaving enclosures.

1. Analog and Discrete Signal Wires: Terminate at numbered terminal blocks as shown on the wiring diagrams.
2. Wiring for Special Signals: Terminate communications, digital data, and multiplexed signals using manufacturer's standard connectors for the device to which the signals terminate.

L. Electrical Transient Protection:

1. General:
 - a. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
 - b. Surge suppressors are not shown for external analog transmitters. Determine quantity and location, and show in Shop Drawings. Refer to example wiring in installation details in Drawings.

- c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
 - 1) Connection of ac power to PIC equipment including panels, consoles assemblies, and field-mounted analog transmitters and receivers.
 - 2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
- 2. Surge Suppressor Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Surge Suppressors.
- 3. Installation and Grounding of Suppressors:
 - a. As shown. See Surge Suppressor Installation Details.
 - b. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

2.10 PANEL FABRICATION

A. General:

- 1. Nominal Panel Dimensions: Refer to Control Panel Schedule in Article Supplements.
- 2. Instrument Arrangements: As shown on Drawings.
- 3. Panel Component Schedule: Refer to Control Panel Schedule in Article Supplements which provides a list by local control panel of major panel-mounted components for each panel. In case of a conflict between this list and Instrument List, Instrument List takes precedence. In case of a conflict between Panel Component Schedule and P&IDs, P&IDs take precedence.
- 4. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
- 5. Fabricate panels, install instruments and wire, and plumb at PIC System Integrator's facility. No fabrication other than correction of minor defects or minor transit damage permitted onsite.
- 6. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A or per UL 698A where applicable.
- 7. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

B. Temperature Control:

1. Cooling: Design panels to maintain components within rated operating temperature range. Include required cooling components.
 - a. Ventilated Panels:
 - 1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel and on panel.
 - 2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
 - 3) For panels without backs against wall, furnish louvers on top and bottom of panel back.
 - 4) Louver Construction: Stamped sheet metal.
 - 5) Ventilation Fans:
 - a) Furnish where required to provide adequate cooling.
 - b) Create positive internal pressure within panel.
 - c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
 - 6) Air Filters: Washable aluminum, Hoffman Series A-FLT.
 - b. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with a combination of natural convection, shielding or forced ventilation.
 - c. Air Conditioner:
 - 1) Controlled by thermostat remote digital controller to maintain internal panel temperature at 85 degrees F. Provided with internal heating package.
 - 2) NEMA 4X enclosure with coated coils and tubing.
 - 3) Side panel-mounted with open-door kill switch and cable.
 - 4) 120VAC, 60 Hz power supply.
 - 5) High temperature alarm contact.
 - 6) Provide where indicated on the Control Panel Schedule. Include sizing calculations in control panel submittal.
 - 7) Thermal Edge Inc., NE020 Series or approved equal.
2. Space Heaters:
 - a. Controlled by hygrostat to maintain internal panel temperatures above dewpoint.
 - b. Provide for Control Panels containing PACs or as indicated on Control Panel Schedule.
 - c. Hoffman or approved equal.

C. Freestanding Panel Construction:

1. Materials:
 - a. Sheet steel, unless otherwise noted in Control Panel Schedule in Article Supplements.
 - b. Minimum Thickness: 10-gauge, unless otherwise noted.
2. Panel Front:
 - a. Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.
 - b. No seams or bolt heads visible when viewed from front.
 - c. Panel Cutouts: Smoothly finished with rounded edges.
 - d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
3. Internal Framework:
 - a. Structural steel for instrument support and panel bracing.
 - b. Permit panel lifting without racking or distortion.
4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
5. Adjacent Panels: Securely bolted together so front faces are parallel.
6. Door:
 - a. Full height, fully gasketed access door where shown on Drawings.
 - b. Latch: Three-point, Southco Type 44.
 - c. Handle: "D" ring, foldable type.
 - d. Hinges: Full-length, continuous, piano-type, steel hinges with stainless steel pins.
 - e. Rear Access: Extend no further than 24 inches beyond panel when opened to 90-degree position.
 - f. Front and Side Access Doors: As shown on Drawings.
7. Manufacturers:
 - a. Hoffman Engineering Co.
 - b. Saginaw Control and Engineering (SCE).

D. Nonfreestanding Panel Construction:

1. Based on environmental design requirements and referenced in Article Environmental Requirements, provide the following unless otherwise noted in Control Panel Schedule in Article Supplements:
 - a. Panels listed as inside, air conditioned:
 - 1) Enclosure Type: NEMA 12.
 - 2) Materials: Steel.
 - b. Other Panels:
 - 1) Enclosure Type: NEMA 4X.
 - 2) Materials: Type 316 stainless steel.

2. Metal Thickness: 14-gauge, minimum.
 3. Doors:
 - a. Rubber-gasketed with continuous hinge.
 - b. Stainless steel lockable quick-release clamps.
 4. Manufacturers:
 - a. Hoffman Engineering Co.
 - b. Saginaw Control and Engineering (SCE).
- E. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels (applies to wall-mount and enclosures on floor stands):
1. Manufacturer and Product:
 - a. Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.
 - b. Hoffman; H2Omit Vent Drain.
- F. Control Panel Electrical:
1. Power Distribution within Panels:
 - a. Feeder Circuits:
 - 1) One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
 - 2) Make provisions for feeder circuit conduit entry.
 - 3) Furnish terminal block for termination of wires.
 - b. Power Panel: Furnish main circuit breaker and circuit breaker on each individual branch circuit distributed from power panel.
 - 1) Locate to provide clear view of and access to breakers when door is open.
 - 2) Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker, but not trip main breaker.
 - a) Branch Circuit Breakers: 15 amps at 250V ac.
 - 3) Breaker Manufacturers and Products: Square D; Type QO.
 - c. Circuit Wiring: P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:
 - 1) Devices on Single Circuit: 20, maximum.
 - 2) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
 - 3) Branch Circuit Loading: 12 amperes continuous, maximum.
 - 4) Panel Lighting and Service Outlets: Put on separate 15 amp, 120V ac branch circuit.
 - 5) Provide 120V ac plugmold for panel components with line cords.

2. Signal Distribution:
 - a. Signal Wiring: Separate analog signal cables from power and control within a panel and cross at right angles where necessary.
 - b. Within Panels: 4 to 20 mA dc signals may be distributed as 1V dc to 5V dc.
 - c. Outside Panels: Isolated 4 to 20 mA dc only.
 - d. Signal Wiring: Twisted shielded pairs.
 - e. RTD and Thermocouple Extension Cable:
 - 1) Continuous field to panel with no intermediate junction boxes or terminations.
 - 2) RTDs in motor windings are considered a 600-volt circuit.
 - 3) Terminate thermocouple extension wire directly to loop instrument.
3. Signal Switching:
 - a. Use dry circuit type relays or switches.
 - b. No interruption of 4 to 20 mA loops during switching.
 - c. Switching Transients in Associated Signal Circuit:
 - 1) 4 to 20 mA dc Signals: 0.2 mA, maximum.
 - 2) 1V dc to 5V dc Signals: 0.05V, maximum.
4. Relay Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.
5. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
6. Internal Panel Lights for Freestanding Panels:
 - a. Type: Switched LED light.
 - b. Quantity: One light for every 4 feet of panel width.
 - c. Mounting: Inside and in the top of back-of-panel area.
 - d. Protective metal shield for lights.
7. Service Outlets for Freestanding Panels:
 - a. Type: Three-wire, 120-volt, 15-ampere, GFCI duplex receptacles.
 - b. Quantity:
 - 1) Panels 4 Feet Wide and Smaller: One.
 - 2) Panels Larger than 4 Feet Wide: One for every 4 feet of panel width, two minimum per panel.
 - c. Mounting: Evenly spaced along back-of-panel area.
8. Internal Panel Lights and Service Outlets for Smaller Panels:
 - a. Internal Panel Light: Switched LED light.
 - b. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI duplex receptacle:
 - c. Required for panels. Refer to Control Panel Schedule in Article Supplements.

9. Standard Pushbutton Colors and Inscriptions:

a. Use following unless otherwise noted by MAWSS Standards:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCR	OPEN CLOSE REMOTE	Black Black Black
HOR	HAND OFF REMOTE	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

b. Lettering Color:

- 1) Black on white and yellow buttons.
- 2) White on black, red, and green buttons.

10. Standard Light Colors and Inscriptions:

a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted by MAWSS Standards:

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber

Tag Function	Inscription(s)	Color
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

- b. Lettering Color:
- 1) Black on white and amber lenses.
 - 2) White on red and green lenses.

G. PIC Enclosure Internal Wiring:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.
5. Connections to Screw or Compression Clamp Type Terminals:
 - a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
 - b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
6. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
7. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
8. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
9. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
10. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
11. Conductors Carrying Foreign Voltages within a Panel:
 - a. Route foreign voltage conductors into panel and land on a circuit blade disconnect type terminal block.
 - b. Use wire with pink insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with pink insulation for any other purpose.

12. Harness Wiring:
 - a. 120V ac: No. 14 AWG, MTW.
 - b. 24V dc: No. 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.
 13. Panelwork:
 - a. No exposed connections.
 - b. Allow adjustments to equipment to be made without exposing these terminals.
 - c. For power and control wiring operating above 80V ac or dc use covered channels or EMT raceways separate from low voltage signal circuits.
 14. Plastic Wire Ducts Color: Gray.
 15. Provide a communications plastic wire duct for communications cables and fiber optic cables between the communications devices in control panel and communications raceways. Design plastic wire duct design to take into account the minimum bending radius of the communications cable.
 16. Make plastic wire ducts the same depth.
 17. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.
- H. Control Relay Arrangement: Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels. Provide 20 percent space for future relays. Locate spare space in same sections as spare terminal blocks.
- I. Factory Finishing:
1. Furnish materials and equipment with manufacturer's standard finish system in accordance with Section 09 90 00, Painting and Coating.
 2. Use specific color if indicated. Otherwise use manufacturer's standard finish color, or light gray if manufacturer has no standard color.
 3. Stainless Steel and Aluminum: Not painted.
 4. Nonmetallic Panels: Not painted.
 5. Steel Panels:
 - a. Sand panel and remove mill scale, rust, grease, and oil.
 - b. Fill imperfections and sand smooth.
 - c. Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
 - d. Sand surfaces lightly between coats.
 - e. Dry Film Thickness: 3 mils, minimum.
 - f. Color: Manufacturer's standard.

2.11 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsules:

1. Areas Where Required: Refer to Part 3, Article Protection.
2. Manufacturers and Products:
 - a. Northern Instruments; Model Zerust VC.
 - b. Hoffmann Engineering; Model A-HCI.

2.12 TEST EQUIPMENT AND TOOLS

A. Digital Multimeter:

1. Type: Industrial True RMS Digital Multimeter, CAT IV 600V protection with test leads, removable test probes, long reach alligator clips, magnetic hanger, temperature probe, and carrying case.
2. Quantity: 1.
3. Manufacturers and Products:
 - a. Fluke; Model 87V/E2 Industrial Electrician Combo Kit.
 - b. Approved equal.

B. Clamp-on Ammeter:

1. Type: True RMS Digital Clamp-on meter with 3-1/2-digit display and protective case. AC/DC.
2. Quantity: 1.
3. Manufacturers and Products:
 - a. Fluke; Model 325.
 - b. Approved equal.

C. DC Digital Process Signal Calibrator:

1. Type: Portable, digital multimeter with mA loop calibrator (ability to source or simulate mA); with test leads and carrying case.
2. Quantity: 1.
3. Manufacturers and Products:
 - a. Fluke; Model 789.
 - b. Approved equal.

2.13 SOURCE QUALITY CONTROL

A. General:

1. Engineer may actively participate in any of the tests.
2. Engineer reserves right to test or retest specified functions.
3. Engineer's decision will be final regarding acceptability and completeness of testing.
4. Procedures, Forms, and Checklists:
 - a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
 - b. Describe each test item to be performed.
 - c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
6. Conducting Tests:
 - a. Provide special testing materials and equipment.
 - b. Wherever possible, perform tests using actual process variables, equipment, and data.
 - c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
 - d. Define simulation techniques in test procedures.
 - e. Test Format: Cause and effect.
 - 1) Person conducting test initiates an input (cause).
 - 2) Specific test requirement is satisfied if correct result (effect), occurs.

B. Unwitnessed Factory Test:

1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
2. Location: PIC System Integrator's facility.
3. Integrated Test:
 - a. Interconnect and test PIC, except for primary elements and smaller panels.
 - b. Exercise and test functions.
 - c. Provide stand-alone testing of smaller panels.
 - d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.

C. Factory Demonstration Tests (FDT):

1. Notify Engineer of test schedule 4 weeks prior to start of test.
2. Scope:
 - a. Test entire PIC, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
 - b. All PIC supplied control panels and backpanels are to be included in the FDT unless otherwise noted.
3. Location: PIC System Integrator's facility.
4. Correctness of wiring from panel field terminals to PAC system input/output points and to panel components.
 - a. Simulate each discrete signal at terminal strip.
 - b. Simulate correctness of each analog signal using current source.
5. Operation of communications between PACs and remote I/O and between PACs and computers.
6. Operation of communications between the PAC system, single loop controllers (SLC).
7. Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and loop specifications:
 - a. One of each type function; for example, if there are filter backwash sequence control for several identical filters, demonstrate controls for one filter.
 - b. One of each type of function in each panel; for example, but not limited to annunciator operation, controller operation, and recorder operation.
 - c. All required and shown functions for 100 percent of loops.
8. Nonloop-Specific Functions:
 - a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
 - b. Timing: Include tests for timing requirements.
 - c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
9. Correct deficiencies found and complete prior to shipment to Site.
10. Failed Tests:
 - a. Repeat and witnessed by Engineer.
 - b. With approval of Engineer, certain tests may be conducted by PIC System Integrator and witnessed by Engineer as part of Functional Test.
11. Make following documentation available to Engineer at test site both before and during FDT:
 - a. Drawings, Specifications, Addenda, and Change Orders.
 - b. Master copy of FDT procedures.

- c. List of equipment to be tested including make, model, and serial number.
- d. Approved hardware Shop Drawings for equipment being tested.
- e. Approved preliminary software documentation Submittal.
- 12. Daily Schedule for FDT:
 - a. Begin each day with meeting to review day's test schedule.
 - b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.

PART 3 EXECUTION

3.01 EXAMINATION

- A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:
 - 1. Proper installation.
 - 2. Calibration and adjustment of positioners and I/P transducers.
 - 3. Correct control action.
 - 4. Switch settings and dead bands.
 - 5. Opening and closing speeds and travel stops.
 - 6. Input and output signals.

3.02 INSTALLATION

- A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.
- B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 05, Conductors.
- C. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.
- D. Mechanical Systems:
 - 1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
 - 2. Plastic Tubing Support: Except as shown on Drawings, provide continuous support in conduit or by aluminum tubing raceway system.
 - 3. Install conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
 - 4. Tubing and Conduit Bends:
 - a. Tool-formed without flattening, and of same radius.
 - b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.

- c. Slope instrument connection tubing in accordance with installation details.
 - d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
 - e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
 - f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
 - g. Blow debris from inside of tubing.
 - h. Make up and install fittings in accordance with manufacturer's recommendations. Verify make up of tube fittings with manufacturer's inspection gauge.
 - i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
 - j. Run tubing to allow but not limited to, clear access to doors, controls and control panels; and to allow for easy removal of equipment.
 - k. Provide separate support for components in tubing runs.
 - l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
 - m. Keep tubing and conduit runs at least 12 inches from hot pipes.
 - n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
 - o. Securely attach tubing raceways to building structural members.
5. Enclosure Lifting Rings: Remove rings following installation and plug holes.

E. Field Finishing: Refer to Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. General:

- 1. Coordinate PIC testing with Owner and affected Subcontractors.
- 2. Notify Engineer of Performance Test schedule 4 weeks prior to start of test.
- 3. Engineer may actively participate in tests.
- 4. Engineer reserves right to test or retest specified functions.
- 5. Engineer's decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:

1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
2. Require PIC site representative to supervise and coordinate onsite PIC activities.
3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.

C. Testing Sequence:

1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.
2. Refer to article Sequence of Work under Section 01 31 13, Project Coordination, for a definition of project milestones.
3. Refer to Section 01 91 14, Equipment Testing and Facility Startup, for overall testing requirements.
4. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.

D. Testing:

1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation.
2. Preparation for Testing: Performed by PIC System Integrator to test and document PIC is ready for operation.
 - a. Loop/Component Inspections and Tests:
 - 1) These inspections and tests may be spot checked by Engineer.
 - 2) Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
 - 3) Provide space on forms for signoff by PIC System Integrator.
 - 4) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
 - a) Project name.
 - b) Loop number.
 - c) Tag number for each component.

- d) Checkoffs/Signoffs for Each Component:
 - (1) Tag/identification.
 - (2) Installation.
 - (3) Termination wiring.
 - (4) Termination tubing.
 - (5) Calibration/adjustment.
 - e) Checkoffs/Signoffs for the Loop:
 - (1) Panel interface terminations.
 - (2) I/O interface terminations with PACs.
 - f) I/O Signals for PACs, are Operational: Received/sent, processed, adjusted.
 - g) Total loop operational.
 - h) Space for comments.
- 5) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PACs I/O module and include the following:
- a) Project name.
 - b) Loop number.
 - c) Component tag number or I/O module number.
 - d) Component code number for I&C elements.
 - e) Manufacturer for I&C elements.
 - f) Model number/serial number for I&C elements.
 - g) Summary of Functional Requirements; For Example:
 - (1) Indicators and recorders, scale and chart ranges.
 - (2) Transmitters/converters, input and output ranges.
 - (3) Computing elements' function.
 - (4) Controllers, action (direct/reverse) and control modes (P, I, D).
 - (5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
 - (6) I/O Modules: Input or output.
 - h) Calibrations, for example, but not limited to:
 - (1) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
 - (2) Discrete Devices: Actual trip points and reset points.
 - (3) Controllers: Mode settings (P&ID).
 - (4) I/O Modules: Actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling.
 - (5) Space for comments.

- b. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.
 - c. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.
 - d. FDT-Repeat:
 - 1) Repeat FDT onsite with installed PIC equipment and software.
 - 2) As listed in PIC subsections, certain portions of FDT may not require retesting.
 - 3) Use FDT test procedures as basis for this test.
 - 4) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.
 - e. Forms: See Loop Status Report, Instrument Calibration Sheet, and I&C Valve Adjustment Sheet referenced in Article Supplements.
 - 3. Functional Test:
 - a. Scope: Confirm PIC, including applications software, is ready for operation.
 - b. Refer to PIC subsections for additional requirements.
 - c. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.
 - 4. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.
- E. Performance Test During and After Facility Startup:
- 1. Once a facility's Functional Test has been completed and that facility has been started up, perform a witnessed Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
 - 2. Loop-specific and nonloop-specific tests same as required for FDT except that entire installed PIC tested using actual process variables and functions demonstrated.
 - 3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.

4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
5. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.
6. Make O&M data available to Engineer at Site both before and during testing.
7. Follow daily schedule required for FDT.
8. Determination of Ready for Operation: When Functional Test has been completed.
9. Refer to examples of Performance Test procedures and forms in Article Supplements.

3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: As required by each PIC subsection.
- B. Specialty Equipment: For certain components or systems provided under this section, but not manufactured by PIC System Integrator, provide services of qualified manufacturer's representative during installation, startup, demonstration testing, and training. Provide original equipment manufacturer's services for: If noted in PIC subsection.

3.05 TRAINING

- A. General:
 1. Provide an integrated training program for Owner's personnel.
 2. Perform training to meet specific needs of Owner's personnel.
 3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
 4. Provide instruction as needed to accommodate the Owner's personnel schedule.
 5. Owner reserves the right to reuse video recordings of training sessions.
- B. Management Seminar:
 1. Length: One (1) instructor day.
 2. Number of Training Sessions: One (1).
 3. Location: Owner's facility.

4. Objective: Provide overview for nonoperations and maintenance personnel for understanding the PIC.
5. Attended by management, engineering, and other nonoperations and nonmaintenance personnel.
6. Primary Topics:
 - a. PIC Overview: How hardware and software are used for operation and control of facilities.
 - b. Block Diagram Presentation of PIC: How and what information flows within system and what is done by each functional unit.
 - c. Process/Operator Interface: Explanation and demonstration of how to use HMI PC to access displays, reports, and controls.
 - d. Management-oriented explanation of data management displays and printouts.
 - e. Walk-through of installed systems.

C. Operations and Maintenance Training:

1. General:
 - a. Refer to specific requirements specified in PIC Subsections.
 - b. Include review of O&M data and survey of spares, expendables, and test equipment.
 - c. Use equipment similar to that provided.
 - d. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.
2. Operations Training: For Owner's operations personnel on operation of I&C components.
 - a. Training Session Duration: Two (2) instructor days.
 - b. Number of Training Sessions: Three (3).
 - c. Location: Project Site.
 - d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.
 - e. Content: Conduct training on loop-by-loop basis.
 - 1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
 - 2) Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
 - 3) Interfaces with PIC subsystems.

3. Maintenance Training:
 - a. Training Session Duration: One (1) instructor day.
 - b. Number of Training Sessions: Two (2).
 - c. Location: Project Site.
 - d. Course Objective: Develop skills needed for routine maintenance of PIC.
 - e. Content: Provide training for each type of component and function provided.
 - 1) Loop Functions: Understanding details of each loop and how they function.
 - 2) Component calibration.
 - 3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
 - 4) Troubleshooting and diagnosis for equipment and software.
 - 5) Replacing lamps, chart paper, and fuses.
 - 6) I&C components removal and replacement.
 - 7) Periodic preventive maintenance.

3.06 CLEANING

- A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.07 PROTECTION

- A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.
- B. Periodically replace capsules based on capsule manufacturer's recommendations.

3.08 SUPPLEMENTS

- A. Supplements listed below, follows "End of Section," are part of this Specification.
 1. Loop Specifications.
 2. Instrument List.
 3. PAC and Network Equipment List.
 4. PAC Input/Output List.
 5. Control Panel Schedule.
 6. MAWSS Control System Interface Standards.

7. Preparation for Testing and Functional Test Forms:
 - a. Loop Status Report: Each sheet shows status of instruments on a loop. Also, gives functional description for loop.
 - b. Instrument Calibration Sheet: Shows details on each instrument (except simple hand switches, lights, and similar items).
 - c. I&C Valve Adjustment Sheet: Shows details for installation, adjustment, and calibration of a given valve.
8. Performance Test Sheet: Describe Performance Test for a given loop.
 - a. List requirements of the loop.
 - b. Briefly describe test.
 - c. Cite expected results.
 - d. Provide space for checkoff by witness.

END OF SECTION

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LOOP STATUS REPORT—EXAMPLE FORMAT

Rev.06.05.92

Project Name: <i>Newport News WTP</i>					Project No. <i>WDC23456.C1</i>		
FUNCTIONAL REQUIREMENTS:							
<i>1. Measure, locally indicate, and transmit RAS flow to LP-10.</i>							
<i>2. At LP-10 indicate flow and provide flow control by modulation of FCV-10-2.</i>							
<i>3. Provide high RAS flow alarm on LP-10.</i>							
COMPONENT STATUS (Check and initial each item when complete)							
Tag Number	Delivered	Tag ID Checked	Installation	Termination Wiring	Termination Tubing	Calibration	
<i>FE/FIT-10-2</i>	<i>Jan-12-90 DWM</i>	<i>Jan-12-90 DWM</i>	<i>Feb-7-90 DWM</i>	<i>Mar-5-90 DWM</i>	<i>N.A.</i>	<i>May-6-90 VDA</i>	
<i>FIC-10-2</i>	<i>Jan-12-90 DWM</i>	<i>Jan-12-90 DWM</i>	<i>Mar-5-90 DWM</i>	<i>Apr-4-90 DWM</i>		<i>May-4-90 VDA</i>	
<i>FSH-10-2</i>	<i>Jan-12-90 DWM</i>	<i>Jan-12-90 DWM</i>	<i>Mar-5-90 DWM</i>	<i>Apr-4-90 DWM</i>		<i>May-7-90 VDA</i>	
<i>FAH-10-2</i>	<i>Jan-12-90 DWM</i>	<i>Jan-12-90 DWM</i>	<i>Mar-5-90 DWM</i>	<i>Apr-4-90 DWM</i>		<i>May-7-90 VDA</i>	
<i>FCV-10-2</i>	<i>Mar-2-90 DWM</i>	<i>Mar-2-90 DWM</i>	<i>Apr-20-90 DWM</i>	<i>Apr-30-90 DWM</i>		<i>May-16-90 VDA</i>	
REMARKS: None.							
Loop Ready for Operation		By: <i>D.W. Munzer</i>		Date: <i>May-18-90</i>		Loop No.: <i>10-2</i>	

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INSTRUMENT CALIBRATION SHEET—EXAMPLE—ANALYZER/TRANSMITTER

Rev.06.05.92

COMPONENT			MANUFACTURER				PROJECT					
Code: A7			Name: Leeds & Northrup				Number: WDC30715.B2					
Name: pH Element & Analyzer/Transmitter			Model: 12429-3-2-1-7		Serial #: 11553322		Name: UOSA AWT PHASE 3					
FUNCTIONS												
Indicate? Y Record? N	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N			CONTROL? N					
	Chart:			Describe:			Action? direct / reverse Modes? P / I / D					
Transmit/ Convert? Y	Scale:	1-14	pH units				SWITCH? N					
	Input:	1-14	pH units				Unit Range:					
	Output:	4-20	mA dc				Differential: fixed/adjustable					
							Reset? automatic / manual					
ANALOG CALIBRATIONS							DISCRETE CALIBRATIONS				Note No.	
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point		Reset Pt.
			Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)		
1.0	1.0	4.0	1.0	4.0	1.0	3.9	1.	N.A.		N.A.		
2.3	2.3	5.6	2.2	5.5	2.3	5.6	2.					
7.5	7.5	12.0	7.5	11.9	7.5	12.0	3.					
12.7	12.7	18.4	12.7	18.3	12.6	18.3	4.					
14.0	14.0	20.0	14.0	20.0	14.0	20.0	5.					
CONTROL MODE SETTINGS:			P: N.A.	I:	D:		6.					
#	NOTES:									Component Calibrated and Ready for Start-up By: J.D. Sewell Date: Jun-6-92 Tag No.: AIT-12-6[pH]		
	1. Need to recheck low pH calibration solutions.											

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I&C VALVE ADJUSTMENT SHEET—EXAMPLE

Rev.06.05.92

PARTS	Project Name: <i>SFO SEWPCP</i>	Project Number: <i>SFO10145.G2</i>			
Body	Type: <i>Vee-Ball</i>	Mfr: <i>Fisher Controls</i>			
	Size: <i>4-inch</i>	Model: <i>1049763-2</i>			
	Line Connection: <i>159 # ANSI Flanges</i>	Serial #: <i>1003220</i>			
Operator	Type: <i>Pneumatic Diaphragm</i>	Mfr: <i>Fisher Controls</i>			
	Action: <i>Linear – Modulated</i>	Model: <i>4060D</i>			
	Travel: <i>3-inch</i>	Serial #: <i>2007330</i>			
Positioner	Input Signal: <i>3-15 psi</i>	Mfr: <i>Fisher Controls</i>			
	Action: <i>Direct - air to open</i>	Model: <i>20472T</i>			
	Cam: <i>Equal percentage</i>	Serial #: <i>102010</i>			
Pilot	Action:	Mfr:			
Solenoid	Rating: <i>None</i>	Model: Serial #:			
I/P Converter	Input: <i>4-20 mA dc</i>	Mfr: <i>Taylor</i>			
	Output: <i>3-15 psi</i>	Model: <i>10-T-576-3</i>			
	Action: <i>Direct</i>	Serial #: <i>1057-330</i>			
Position Switch	Settings: <i>Closed / Open 5 deg, rising</i>	Mfr: <i>National Switch</i>			
	Contacts: <i>Close / Close</i>	Model: <i>1049-67-3</i>			
		Serial #: <i>156 & 157</i>			
Power Supply	Type: <i>Pneumatic</i>	Air Set Mfr: <i>Air Products</i>			
	Potential: <i>40 psi</i>	Model: <i>3210D</i>			
		Serial #: <i>1107063</i>			
ADJUSTMENTS	Initial	Date	VERIFICATION	Initial	Date
Air Set	<i>JDS</i>	<i>Jun-06-92</i>	Valve Action	<i>JDS</i>	<i>Jun-03-92</i>
Positioner	<i>JDS</i>	<i>Jun-06-92</i>	Installation	<i>JDS</i>	<i>Jun-03-92</i>
Position Switches	<i>JDS</i>	<i>Jun-06-92</i>	Wire Connection	<i>JDS</i>	<i>Jun-04-92</i>
I/P Converter	<i>JDS</i>	<i>Jun-07-92</i>	Tube Connection	<i>JDS</i>	<i>Jun-04-92</i>
Actual Speed	<i>JDS</i>	<i>Jun-07-92</i>			
REMARKS: <i>Valve was initially installed backwards.</i>				Valve Ready for Start-up	
<i>Observed to be correctly installed May-25-92</i>				By: <i>J.D. Sewell</i>	
				Date: <i>Jun-07-92</i>	
				Tag No.: <i>FCV-10-2-1</i>	

JACOBS PERFORMANCE TEST SHEET - EXAMPLE

Rev.06.05.92

Project Name: <i>SFO SEWPCP Plant Expansion</i>			Project No.: <i>SFO12345.C1</i>
Demonstration test(s): For each functional Requirement of the loop: (a) List and number the requirement. (b) Briefly describe the demonstration test. (c) Cite the results that will verify the required performance. (d) Provide space for signoff.			
<i>1. MEASURE EFFLUENT FLOW</i>			
<i>1.a With no flow, water level over weir should be zero and</i>			
<i>FIT indicator should read zero.</i>			<i>Jun-20-92 BDG</i>
<i>2. FLOW INDICATION AND TRANSMISSION TO LP & CCS</i>			
<i>With flow, water level and FIT indicator should be related by expression</i>			
<i>$Q(MGD) = 429 * H^{2/3}$ (H = height in inches of water over weir).</i>			
<i>Vary H and observe that following.</i>			
<i>2.a Reading of FIT indicator.</i>			<i>Jun-6-92 BDG</i>
<i>2.b Reading is transmitted to FI on LP-521-1</i>			<i>Jun-6-92 BDG</i>
<i>2.c Reading is transmitted and displayed to CCS.</i>			<i>Jun-6-92 BDG</i>
<i>H(measured) 0 5 10 15</i>			
<i>Q(computed) 0 47.96 135.7 251.7</i>			
<i>Q(FIT indicator) 0 48.1 137 253</i>			
<i>Q(LI on LP-521-1) 0 48.2 138 254</i>			
<i>Q(display by CCS) 0 48.1 136.2 252.4</i>			
Forms/Sheets Verified	By	Date	Loop Accepted By Owner
Loop Status Report	<i>J.D. Sewell</i>	<i>May-18-92</i>	By: <i>J.D. Smith</i>
Instrument Calibration Sheet	<i>J.D. Sewell</i>	<i>May-18-92</i>	Date: <i>Jun-6-92</i>
I&C Valve Calibration Sheet	<i>N.A.</i>		
Performance Test	By	Date	
Performed	<i>J. Blow MPSDC Co.</i>	<i>Jun-6-92</i>	
Witnessed	<i>B. DeGlanville</i>	<i>Jun-6-92</i>	Loop No.: <i>30-12</i>

Control Strategy Narratives

C.C. Williams WWTP Dewatering Project
Mobile Area Water & Sewer System (MAWSS)



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Table(s)

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Acronyms and Abbreviations

gph	gallon(s) per hour
gpm	gallon(s) per minute
HMI	human-machine interface
lb/gal	pound(s) per gallon
LSHH	high, high level switch
LSH	high level switch
LSL	low level switch
LSLL	low, low level switch
mA	milliampere(s)
MAWSS	Mobile Area Water & Sewer System
mg/L	milligrams per liter
OIT	operator interface terminal
PID	proportional integral derivative
PAC	programmable automation controller
PV	process value
SCADA	supervisory control and data acquisition

Definitions

Refer to the Mobile Area Water & Sewer System Control System Interface Standards (Specification Section 40 90 00, Supplement 7) for a definition of the following terms:

- Auto
- Fail Reset
- Local
- Manual
- Off
- On
- Remote

Additional definitions:

Adjustable	Viewable and adjustable from the human-machine interface (HMI).
Interlock	A condition that causes the control system to force a device or devices to a pre-determined state. This state is off or closed unless otherwise noted.
Out of Service	A device can be flagged as In Service or Out of Service from the HMI. The purpose of the flag would be to notify other personnel who may be viewing the graphics that the particular device is not available for operation. This is not a replacement for proper lock out/tag out procedures. Alarms for a device will be masked when it is Out of Service. Run commands to a device will be disabled when it is Out of Service.
Permissive	A condition that must be met for a device or sequence to be activated. For example, sufficient available volume in a backwash waste tank is occasionally used as a permissive to start a backwash sequence.
Operator Adjustable	Adjustable from the HMI

1. Global Functions

1.1 Device Controls

The control narrative shall specify some functions for all motor-driven devices. If done globally, any exceptions for a specific device shall be identified specifically in that devices section of the control narrative. These functions include:

- A device in Remote/Auto shall have its run command removed and placed Off on the following (device will remain in Remote/Auto and can resume automatic function once device is once again available for operation):
 - Placement into out of service at the human-machine interface (HMI)
 - Field mode selector switch taken out of Remote (that is, in LOCAL mode)
 - Software-generated device failure
 - Field input failure
 - Power fail
- A device in Remote/Manual shall have its run command removed and be placed in Manual and Off on:
 - Placement into out of service at the human-machine interface (HMI)
 - Field mode selector switch taken out of Remote (that is, in LOCAL mode)
 - Software-generated device failure
 - Field input failure
 - Power fail
- HMI selection of In Service or Out of Service
- Runtimes and starts shall continue to be collected and displayed while a device is in LOCAL.
- **Fail Reset:** When the equipment fails because of an alarm condition, the fail reset must be used to clear the alarm and re-enable the equipment for use.
- **Fail to Start/Open:** A piece of equipment that is commanded to run/open from the programmable logic controller (PLC), but is not confirmed running/opened within 30 (device-specific) seconds generates a fail to start/open alarm. Unless otherwise noted, running is confirmed by receiving an On status input, and open is confirmed by receiving the Open status input. This alarm requires a fail reset. This alarm will remove the start command from the equipment and place the device in Remote/Auto/Off.
- **Fail to Stop/Close:** A piece of equipment that is commanded to stop/close from the PLC, but is not confirmed off/closed within 30 (device specific) seconds generates a fail to stop/close alarm. Unless otherwise noted, off is confirmed by not receiving an ON status input, and closed is confirmed by receiving the CLOSED status input. This alarm will remove the start command from the equipment and place the device in Remote/Auto/Off.
- **Elapsed Runtime:** Calculate total time (in tenths of an hour) a device has been in operation (motors only).
- **Cycle Count:** Count the number of cycles a piece of equipment undergoes. One cycle is defined as the transition from Off to On or from Closed to Open.

1.2 Alarms

Logic shall ensure that nuisance alarms are not generated. Technique shall include masking based on process status, and including deadbands and/or timers to provide delays for intermittent signal or process noise. All analog points shall have high high, high, low, and low low alarms available. Those not required shall be masked in the program and on the HMI. The high and low will typically be alarms with automatic reset. The high high and low low will typically be alarms with associated interlocks in the logic and require operator reset. All analog points shall include the ability to force a value, for use when equipment is offline (for example, for calibration). The actual field value will also be displayed during the force active. An alarm for analog signals to indicate that the input signal is out of range (less than 2 milliamperes [mA] or greater than 22 mA) shall be provided.

2. Common Functions

2.1 Duty/Standby Equipment

There are certain processes that require two identical pieces of equipment to serve as duty and standby equipment for redundancy and process reliability.

For duty/standby control to be functional, both the duty and standby pieces of equipment must be available for use. The operator shall be able to select which piece of equipment is the duty piece of equipment, and which is standby, via the supervisory control and data acquisition (SCADA) HMI, provided both pieces of equipment are available for use. Selecting a particular piece of equipment as the duty equipment shall automatically switch the redundant piece of equipment as standby, and vice versa.

Under normal operation in Auto mode, the duty equipment shall be used as the primary piece of equipment, and shall start or stop as requested based on the associated automatic process control logic. If the duty piece of equipment fails, as determined by an alarm condition or device failure, the standby equipment shall be brought online as the new duty piece of equipment, and started or stopped as required by the process. The equipment whose alarm state indicated failure shall be switched to standby mode upon failure.

Once any alarm conditions have cleared and been acknowledged, the equipment shall again be switchable between duty and standby, as described previously, by the operator via the SCADA HMI.

Any equipment that is out of service shall automatically be switched to standby, and the redundant, in-service piece of equipment shall be automatically switched to duty mode, without further operator intervention. The equipment shall not be switchable out of this mode until both pieces of equipment are again available for service.

2.2 Lead/Lag/Standby Equipment

There are certain processes with redundant pieces of equipment for a particular process, sized to handle only a portion of the process capacity. The equipment is brought online in stages, based on the process capacity requirements. Typically the first or lead piece of equipment is started to handle the minimum process capacity. As capacity requirements increase, the lag equipment is started in sequence to handle the capacity increase. There can also be more than one lag position, depending on the number of pieces of equipment used in the process.

The operator shall be able to assign the equipment to a lead, lag, or standby positions. The operator shall be able to choose at the HMI which pieces of equipment are assigned to any of the positions.

Equipment assigned to operate in this fashion shall need to be in Remote Auto mode to be included in the duty table, otherwise that particular equipment shall not be available for starting based on the process requirements. When equipment is in this mode, it shall be available to run as part of the sequencing set up in a duty table for the process.

Regardless of the control mode, the run status of all equipment associated with the particular process shall be considered when determining which equipment should run based on process requirements. For example, if a certain process requires a single pump to run, and a pump is currently running in manual, the fact that this pump is running shall be considered to determine if the process capacity requirements have been satisfied.

Under normal operation in Auto mode, the equipment shall start or stop as requested based on the associated automatic process control logic. If any piece of equipment fails, as determined by an alarm condition or network failure, the standby piece of equipment in the duty sequence table shall be started as required by the process, and this piece of equipment shall become the new lead. The equipment whose alarm state indicated failure shall be taken out of the duty table until the alarm condition is cleared and acknowledged. Once these conditions are met, the piece of equipment can be returned to the duty table in the standby position. Any equipment that is out of service shall be taken out of the duty table as well.

2.3 Proportional Integral Derivative (PID) Controller

The PID controller shall have the following features:

- Proportional, Integral and Derivative functions.
- Derivative selectable on process value or error.
- Error deadband.
- Output deadband.
- AUTO and MANUAL modes.
- LOCAL and REMOTE setpoint modes.
- Bumpless transfer between AUTO and MANUAL modes.
- Bumpless transfer between REMOTE and LOCAL setpoint modes (where REMOTE setpoint mode is implemented).
- Anti-reset windup.
- Process value signal failure response: Unless otherwise noted, the Analog control shall transfer into Manual when signal failure is detected on the Process variable. Provide an HMI alarm that indicates that the loop was set to MANUAL.
- Hold State: Output is frozen and controller values adjusted to provide bumpless transfer at exit from hold state.
- Deviation alarm: An alarm that is activated when the controller has been in AUTO and the difference between the active set point and process value is greater than a preset amount for greater than a preset period.

2.4 Chemical Tanks

In the PAC, calculate the chemical tank rate of change based on volumetric change within the tank. Provide a rate of change alarm for each chemical tank.

2.5 Control Narratives

2.5.1 Digested Sludge Pump Station (08-N-6001, 08-N-6001A)

2.5.1.1 Process Overview

The pump station consists of two (2) centrifugal pumps, 85-P-11-1 and 85-P-11-2, and an inline mechanical grinder, 20-M-14-1.

The digested sludge pumps are controlled by 85-AFD-11-1 and 85-AFD-11-2. The grinder is controlled by vendor control panel 20-LCP-14-1.

The pumps are used to maintain the level in the Biosolids Holding Tank (20-T-10-1). A level transmitter (20-LIT-10-1) is used for control.

Each pump has the standard interface described in the MAWSS Control Interface Standards.

2.5.1.2 Control Narrative

Control logic for the Digested Sludge Pumps and the Grinder will reside in the main PAC in 20-CP-1.

Hand/Off/Auto control of each pump shall be provided via the AFD. In AFD Hand, manual start/stop control and speed adjustment shall be implemented.

In AFD Auto, the associated field control station shall be in the Remote position to enable the Automatic control of the pump(s). When the field control station is in Hand, the pump shall run at a pre-configured constant speed at the AFD.

Hand/Off/Remote control of the grinder shall be provided via the LCP. In Hand, manual start/stop control shall be implemented.

The duty pump shall start at an operator-specified minimum speed and then utilize a PID level controller for speed control to maintain the desired level setpoint in the Biosolids Holding Tank. Provide adjustable level setpoints 20-LSH-10-1 and 20-LSL-10-1. Cycle pumps as follows:

- Initiate start sequence when the 20-LIT-10-1 measures below 20-LSL-10-1. Upon confirmation that the grinder is running, start the duty pump.
- Stop the duty pump and the grinder when the 20-LIT-10-1 measures above 20-LSH-10-1.

Provide Duty/Standby order control. Provide the option to select a fixed order or automatic alternation. Automatic alternation shall be triggered each time both pumps are off.

Provide each of the following as separate alarms:

- No pumps in Auto/Remote
- Grinder not in Auto/Remote (if not in Bypass Mode)

Return each pump and the grinder to its pre-power-loss AUTO or MANUAL state on return of power. Any run latches interrupted during the power outage must be re-established by low level.

LCP shall include a Grinder Fault alarm. Sludge pumps shall not be allowed to run while the grinder is faulted (unless Grinder Bypass Mode is active).

LCP shall include logic to detect and attempt to clear a Grinder Jam condition. During the detected Jam condition, the duty pump shall run at a pre-defined, operator-adjustable minimum speed. If the Grinder Bypass Mode is active, the Jam provisions for the sludge pumps do not apply.

Provide the ability to place the Grinder into Bypass Mode using the HMI. This is an operator defined condition based on the physical configuration of the grinder bypass valves and piping. There are no sludge pump interlocks in the bypass mode.

2.5.2 Smith Sludge Pump Station (08-N-6001, 08-N-6001A)

2.5.2.1 Process Overview

The pump station consists of one positive displacement (hose) pump, 20-P-12-1; one centrifugal pump, 20-P-12-2; and an inline mechanical grinder, 20-M-13-1.

The sludge pumps are controlled by control panel 20-LCP-12-1. The grinder is controlled by vendor control panel 20-LCP-13-1.

The pumps are used to fill the Smith Biosolids Receiving Tank (20-T-10-2). A level transmitter (20-LIT-10-2) measures the level of the tank. The level is monitored by the PAC in 20-CP-1 and is re-transmitted to 20-LCP-12-1 for indication. The High-High level alarm condition, 20-LSHH-10-2, is determined by the PAC in 20-CP-1 and sent to 20-LCP-12-1.

Pressure switch 20-PSH-12-1 is mounted on the discharge of pump 20-P-12-1.

2.5.2.2 Control Narrative

Control logic for the Smith Sludge Pumps and the Grinder will reside in the LCP panels. Status shall be monitored by the PAC in 20-CP-1.

Manual Start/Stop control of each pump shall be provided via pushbuttons on 20-LCP-12-1. Activation of 20-PSH-12-1 or 20-XE-12-1 shall stop Pump 1 and prevent it from running until reset using the pushbutton on the LCP.

Hand/Off/Remote control of the grinder shall be provided via 20-LCP-13-1. In Hand, manual start/stop control shall be implemented.

With the Grinder in Remote,

- Initiate start sequence when the operator presses either Start pushbutton on 20-LCP-12-1. Upon confirmation that the grinder is running, start the pump.
- The operator must press the Stop pushbutton to stop the pump. The Grinder shall also stop.
- Activation of the LSHH condition shall energize the corresponding pilot light on the LCP and the LCP shall automatically stop the sludge pump(s) and grinder. Pumps shall not be allowed to start while the LSHH is active.

20-LCP-13-1 shall include a Grinder Fault alarm. Sludge pumps shall not be allowed to run while the grinder is faulted (unless Grinder Bypass Mode is active).

20-LCP-13-1 shall include logic to detect and attempt to clear a Grinder Jam condition. During the Jam condition, sludge pump(s) are stopped and require that the operator manually reinitiate the start sequence as previously described.

Provide the ability to place the Grinder into Bypass Mode using a selector switch on 20-LCP-12-1. This is an operator defined condition based on the physical configuration of the grinder bypass valves and piping. There are no sludge pump interlocks in the bypass mode.

In addition to the functionality previously described, provide the following at 20-LCP-12-1:

- Smith Sludge Pump Running pilot lights (2)
- Smith Sludge Pump Alarm pilot lights (2)
- Smith Sludge Pump Reset pushbuttons (2). Reset for Pump 1 shall reset the PSH condition and the motor starter overload. Reset for Pump 2 shall reset the motor starter overload.
- Smith Sludge Pump 1, 20-P-12-1, High Pressure pilot light.

2.5.3 Biosolids Tanks (08-N-6001A)

2.5.3.1 Process Overview

Each tank contains one submersible, horizontal mixer, 20-M-10-1 and 20-M-10-2 for each respective tank. The mixers are used to continuously agitate the tank contents.

Each mixer has the standard interface described in the MAWSS Control Interface Standards. Additionally, the mixers are submersible; the motor temperature is monitored. The motor temperature is used in a hardwired interlock to shut down the mixer.

Tank levels are measured by level transmitters 20-LIT-10-1 and 20-LIT-10-2.

2.5.3.2 Control Narrative

Control logic for the mixers shall reside in the PAC in 20-CP-1.

Hand/Off/Remote control of each mixer shall be provided via the MCC. In Hand, manual start/stop control shall be implemented.

Provide automatic start/stop of mixers based upon its respective tank level.

- Start the tank mixer when the level rises above the mixer start level setpoint (operator adjustable in HMI; include adjustable time delay).
- Stop the tank mixer when the level drops below the mixer stop level setpoint (operator adjustable in HMI; include adjustable time delay).

Provide each of the following as separate alarms:

- Mixer not in Auto/Remote

Return each mixer to its pre-power-loss AUTO or MANUAL state on return of power. Any run latches interrupted during the power outage must be re-established by start setpoint.

2.5.4 Sludge Feed Pumps (08-N-6001A)

2.5.4.1 Process Overview

Sludge feed pumps use AFDs to supply a consistent flow of digested sludge to the Belt Filter Presses (BFPs). Sludge feed pumps are controlled by vendor control panels 20-VCP-20-1, 20-VCP-20-2, 20-VCP-20-3, and 20-VCP-20-4.

2.5.4.2 Control Narrative

Control logic for the digested sludge pumps shall reside in the vendor control panels for the BFPs.

SCADA HMI system shall exchange data directly with the PACs in the vendor supplied control panels.

2.5.5 Belt Filter Presses (08-N-6002, 08-N-6003)

2.5.5.1 Process Overview

Belt Filter Presses (BFPs) will dewater and thicken the digested sludge so that it can hauled away for disposal. The BFPs are controlled by vendor control panels 20-VCP-20-1, 20-VCP-20-2, 20-VCP-20-3, and 20-VCP-20-4.

2.5.5.2 Control Narrative

Control logic for the BFPs and associated process equipment shall reside in the vendor control panels for the BFPs.

SCADA HMI system shall exchange data directly with the PACs in the vendor supplied control panels.

2.5.5.3 Sludge Cake Conveyors (08-N-6004, 08-N-6005)

2.5.5.4 Process Overview

The conveyor system consists of six (6) transfer conveyors (20-CONV-30-1, -2, -3, -4, -5, -6), two (2) diverter conveyor knife gates (20-G-30-5A and 20-G-30-6A), two (2) distribution conveyors (20-CONV-30-7 and 20-CONV-30-8) and six (6) distribution conveyor knife gates (20-G-30-7A, -7B, -7C and 20-G-30-8A, -8B, -8C). Conveyors in the MCC shall consist of forward and reversing starters.

The conveyor system is designed to receive cake that has been dewatered by the Belt Filter Presses (BFPs) and convey the cake into one of eight (8) drop points in the truck bay. The BFP Outlet Hopper will drop cake into the transfer conveyors. The diverter gate will divert and transfer the cake to one of two distribution conveyors. The distribution conveyors convey cake through the slide gates into one of four (4) distribution drop points. This allows each BFP to be able to fill any of the two (2) truck locations.

Each conveyor has a zero speed switch (SSL) and emergency stop pull-cord that surround the conveyor. Additionally, because Conveyors 5, 6, 7, and 8 are elevated, those conveyors also have an emergency stop pushbutton which is wall-mounted and easily accessible to the operator on the ground floor.

2.5.5.5 Control Narrative

Control logic for the conveyor shall reside in the PAC in 20-CP-1.

Hand/Off/Remote control of each conveyor shall be provided via field-mounted HOR control stations. In Hand, manual start/stop control shall be implemented. The direction of the conveyor is determined by the position of the Forward/Reverse (FR) selector switch, also located in a field mounted control station. These field mounted control stations shall be placed in a location that is easily accessible to the operator on the ground floor.

Local control panel 20-LCP-30-10 includes a Gate Master selector Local/Remote switch (20-HS-30-10) which enables or disables local Open/Close control of each gate. In Local, the Open position shall manually open the gate and Close shall manually close the gate. In Remote, the gates are all opened or closed from SCADA.

While in Local mode, the PAC gate commands shall match the local gate positions. This is required such that when the Master selector switch is changed from Local to Remote, the transfer of control is "bumpless"; i.e., the gates maintain their current manual position until further action is taken by the operator in the SCADA system.

Provide control of conveyors and gates from the SCADA when the equipment is in the Remote mode.

- The operator may utilize the HMI for remote, manual control of slide gates and conveyors to determine the desired conveyance path.
- Once a valid cake conveyance path to the selected drop point is confirmed by the PAC, a run permissive will be sent to BFP control panels which are allowed to run and send sludge cake to the conveyor system.
- The operator will monitor the filling of the truck via CCTV from the control room and can adjust the drop point in the HMI as needed to fill the truck evenly.
- If an operator changes the position of a distribution slide gate in the field (at the actuator control station) while the conveyor system is operating in remote/automatic mode, then "upstream" conveyors and gates shall hold their current state and the HMI system shall be alerted. Plant operations shall determine next steps for process control.

Activation of any conveyor system E-Stop shall shutdown all associated equipment, including upstream conveyors and related BFP systems.

Return each conveyor to its pre-power-loss AUTO or MANUAL state on return of power. Any run latches interrupted during the power outage must be re-established using normal startup procedures.

The conveyor system sequencing shall be reviewed and adjusted as necessary during the specified Control Strategy workshops.

2.5.6 Polymer Storage Tanks (08-N-6006)

2.5.6.1 Process Overview

There are two (2) polymer storage tanks, 20-T-50-1 and 20-T-50-2. Tank levels are measured by level transmitters 20-LIT-50-1 and 20-LIT-50-2.

Each tank has one progressive cavity mixing pump, 20-P-50-1 and 20-P-50-2 for each respective tank. The mixing pumps are used to periodically mix the tank contents.

Each mixing pump has the standard interface described in the MAWSS Control Interface Standards.

There is a truck fill panel, 20-LCP-49-1, which provides the truck driver to monitor the polymer storage tank level(s).

2.5.6.2 Control Narrative

Control logic for the mixing pumps shall reside in the PAC in 20-CP-1.

Hand/Off/Remote control of each mixing pump shall be provided via a local HOR selector switch. In Hand, manual start/stop control shall be implemented.

Provide automatic start/stop of mixing pumps when in Remote.

- Mixing Pump(s) shall run for an operator defined period of time. The run time and cycle time shall be adjustable in the HMI and shall be independent for each tank's mixing pump.
- Rising level rate-of-change logic in the PAC shall determine if the tank is being filled. The respective mixing pump shall be disabled from running while the tank is being filled.
- The Low-Low Level alarm for each tank level shall inhibit its respective mixing pump from running.

Tanks will be filled by delivery trucks. While filling, the tank levels can be monitored locally on 20-LCP-49-1. Logic in the PAC in 20-CP-1 shall determine when a tank is full (based on operator adjustable level setting in the HMI). The FULL signal will be sent to the LCP for annunciation. Upon receipt of the FULL signal, the LCP pilot light will illuminate, the panel horn will sound, and the panel beacon will activate. The driver/operator may press the Silence pushbutton on the LCP to silence the horn and turn off the beacon. The pilot light will remain illuminated until the FULL setting is reset by the operator via the HMI or the tank level drops.

2.5.7 Polymer Makeup Units (08-N-6006)

2.5.7.1 Process Overview

Polymer Makeup Units are packaged skids that will deliver polymer to each of the BFPs. Polymer makeup units are controlled by vendor control panels 20-VCP-52-1, 20-VCP-52-2, 20-VCP-52-3, and 20-VCP-52-4, using control signals that are hardwired from each respective BFP control panel.

2.5.7.2 Control Narrative

Control logic for the polymer makeup units shall reside in the vendor control panels for the BFPs.

SCADA HMI system shall exchange data directly with the PACs in the vendor supplied control panels. The BFP PACs shall make polymer makeup unit status and alarms available to the HMI.

2.5.8 Additive Alternate #1: Chlorination (08-N-6007)

2.5.8.1 Process Overview

Chlorination equipment and devices are packaged equipment that deliver chlorine solution primarily to the existing Chlorine Contact Basin. For Algae and Foam Control, a relatively small amount of chlorine solution is delivered to the HPO Splitter Box, HPO Reactors 1 and 2, and the Secondary Pump Station. The chlorine feed containers are arranged in two banks of four containers (four duty containers, four standby containers) in the Chlorine Feed Room and deliver pressurized gas to a common manifold.

Each bank of four containers is connected to a gas filter, vacuum regulator (chlorinator), flow control valve, vacuum monitor, and ejector. The vacuum created by water flowing through the ejector opens the inlet valve of the vacuum regulator. Gas under vacuum flows from the vacuum regulator, through the filter, through the flow control valve and vacuum monitor, and to the ejector where it is mixed with water to create the chlorine solution delivered to the application points listed above. Piping and valving allow either bank of four chlorine feed containers to feed either of the two vacuum regulators, flow control valves, or ejectors that service the Chlorine Contact Basin. A separate rotameter and ejector is provided for the Algae and Foam Control process.

Chlorine gas detection sensors shall be provided in the Chlorine Feed and Chlorine Storage Rooms.

2.5.8.2 Control Narrative

The flow control valves automatically adjust the rate at which the chlorine gas is fed to the ejectors. Panel 50-CP-1 sends a pacing command to each of the flow control valves based on plant effluent flow. The control valves send a signal to Panel 50-CP-1 indicating feed rate. Manual adjustment of the feed rate can be implemented either through the flow control valves or their associated rotameters. Chlorine feed rate to the Algae and Foam Control process is manually achieved via separate rotameter. Vacuum monitors transmit high and low vacuum alarms to Panel 50-CP-1.

Control logic for the chlorine flow control valves shall reside within each control valve, 50-FV-15-1 and 50-FV-15-2.

- Provide automatic gas feed adjustment based on pacing command from Panel 50-CP-1.

The chlorine feed containers are stored on dual container hydraulic scales when in the feed position and the weights of the containers are transmitted to Panel 50-CP-1 for monitoring via the plant SCADA system. The vacuum regulators have an integral automatic switchover function. When the in-service bank of containers becomes empty, the standby vacuum regulator senses an increase in pressure and automatically opens to allow the standby containers to feed chlorine gas through its associated filter, vacuum regulator, flow control valve, vacuum monitor, and ejector.

Electric emergency shutoff actuators are provided for each of the eight (duty + standby) chlorine feed containers. Control Panels 50-FP-1 and 50-FP-2 each control four emergency shutoff actuators. Control Panels 50-FP-1 and 50-FP-2 transmit signals to close the emergency shutoff actuators based on conditions described below.

Control logic for the emergency shutoff actuator panels shall reside within each panel, 50-FP-1 and 50-FP-2. Panels 50-FP-1 and 50-FP-2 shall transmit emergency close and system error signals to Control Panel 50-CP-1. The emergency shutoff actuator panels shall be wired together with twisted-shielded wire for concurrent operation. Reopening of the chlorine container valves after an emergency closure shall be accomplished manually. The following inputs shall cause the emergency shutoff actuator panels to send a close command to the emergency shutoff actuators:

- Depressing of any of three emergency stop pushbuttons. Emergency stop pushbuttons shall be hard-wired to panel 50-FP-1.

- Chlorine leak detection. Chlorine leak detection transmitter 50-AIT-10-1 shall be hard-wired to panel 50-FP-1.
- Shutdown command from Control Panel 50-CP-1.
 - 50-CP-1 shall send a shutdown command to panel 50-FP-1 if the gas scrubber is in operation.
 - 50-CP-1 shall send a shutdown command to panel 50-FP-1 if the Fire Alarm Control Panel is in an alarm condition.

Control logic for the chlorine gas detection transmitter (50-AIT-10-1) shall reside within control panel 50-CP-1.

- Hardwired relay logic shall receive the leak alarm from the transmitter. The relay logic shall be independent of the PLC and shall re-transmit the leak alarm to panel 50-FP-1 and the existing relocated scrubber control panel. This relay logic shall be implemented as fail-safe.
- From 50-CP-1, send leak alarm output to alarm control panels 50-FP-4, 50-FP-5, and 50-FP-6.
- From 50-CP-1, send leak alarm output to Fire Alarm Control Panel 50-FACP-1.
- From 50-CP-1, send leak alarm output to HVAC Control Panel 50-HCP-01.

2.5.9 Additive Alternate #1: De-chlorination (08-N-6008)

2.5.9.1 Process Overview

De-chlorination equipment and devices are packaged equipment that deliver sulfur dioxide solution to the existing Chlorine Contact Basin for de-chlorination. The sulfur dioxide feed containers are arranged in two banks of two containers (two duty, two standby) in the SO₂ Feed Room and deliver gas under vacuum to a common manifold.

Each sulfur dioxide feed container shall be provided with a container-mounted vacuum regulator (sulfonator). Each bank of two containers is connected to a flow control valve, vacuum monitor, and ejector. The vacuum created by water flowing through the ejector opens the inlet valve of the vacuum regulator. Gas under vacuum flows from the vacuum regulator, through the flow control valve and vacuum monitor, and to the ejector where it is mixed with water to create the sulfur dioxide solution. Piping and valving allow either bank of two sulfur dioxide feed containers to feed either of the two flow control valves or ejectors that service the Chlorine Contact Basin.

Sulfur dioxide gas detection sensors shall be provided in the SO₂ Feed and SO₂ Storage Rooms.

2.5.9.2 Control Narrative

Hard-wired signals shall be transmitted to panel 50-FP-3, the existing relocated scrubber control panel, and Control Panel 50-CP-1. The sulfur dioxide feed containers are stored on single container hydraulic scales when in the feed position and the weights of the containers are transmitted to Panel 50-CP-1 for monitoring via the plant SCADA system. When the in-service bank of containers becomes empty, the standby containers are manually placed into service to feed sulfur dioxide gas through its associated flow control valve, vacuum monitor, and ejector. The flow control valves automatically adjust the rate at which the sulfur dioxide gas is fed to the ejectors. Panel 50-CP-1 sends a pacing command to each of the flow control valves based on operator entry. The control valves send a signal to Panel 50-CP-1 indicating feed rate. Manual adjustment of the feed rate can be implemented either through the flow control valves or their associated rotameters. Vacuum monitors transmit high and low vacuum alarms to Panel 50-CP-1.

Control logic for the sulfur dioxide flow control valve shall reside within each control valve, 50-FV-32-1.

- Provide automatic gas feed adjustment based on operator-entered pacing command from SCADA to Panel 50-CP-1.

Electric emergency shutoff actuators are provided for each of the four (duty + standby) sulfur dioxide feed containers. Control Panel 50-FP-3 controls all four emergency shutoff actuators. Control Panel 50-FP-3 transmits signals to close the emergency shutoff actuators based on conditions described below.

Control logic for the emergency shutoff actuator panels shall reside within panel 50-FP-3. Panel 50-FP-3 shall transmit emergency close and system error signals to Control Panel 50-CP-1. Reopening of the sulfur dioxide container valves after an emergency closure shall be accomplished manually. The following inputs shall cause the emergency shutoff actuator panel to send a close command to the emergency shutoff actuators:

- Depressing of any of three emergency stop pushbuttons. Emergency stop pushbuttons shall be hard-wired to panel 50-FP-3.
- Sulfur Dioxide leak detection. Sulfur Dioxide leak detection transmitter 50-AIT-32-1 shall be hard-wired to panel 50-FP-3.
- Shutdown command from Control Panel 50-CP-1.
 - 50-CP-1 shall send a shutdown command to panel 50-FP-3 if the gas scrubber is in operation.
 - 50-CP-1 shall send a shutdown command to panel 50-FP-3 if the Fire Alarm Control Panel is in an alarm condition.

Control logic for the sulfur dioxide gas detection transmitter (50-AIT-32-1) shall reside within control panel 50-CP-1.

- Hardwired relay logic shall receive the leak alarm from the transmitter. The relay logic shall be independent of the PLC and shall re-transmit the leak alarm to panel 50-FP-3 and the existing relocated scrubber control panel. This relay logic shall be implemented as fail-safe.
- From 50-CP-1, send leak alarm output to alarm control panels 50-FP-4, 50-FP-5, and 50-FP-7.
- From 50-CP-1, send leak alarm output to Fire Alarm Control Panel 50-FACP-1.
- From 50-CP-1, send leak alarm output to HVAC Control Panel 50-HCP-01.

2.5.10 Plant Drain Pump Station (08-N-6009)

2.5.10.1 Process Overview

The pump station consists of two (2) submersible pumps, 20-P-70-1 and 20-P-70-2. The pumps are controlled by 20-AFD-70-1 and 20-AFD-70-2.

The pumps are used to maintain a consistent level in the plant drain wetwell. A level transmitter (20-LIT-71-1) is used for control. If the high-high float switch (20-LSHH-71-1) is activated, provide backup level control. The low-low float switch (20-LSLL-71-1) is a pump run interlock.

Each pump has the standard interface described in the MAWSS Control Interface Standards.

2.5.10.2 Control Narrative

Control logic for the Plant Drain Pumps will reside in the main PAC in 20-CP-1.

Hand/Off/Auto control of each pump shall be provided via the AFD. In AFD Hand, manual start/stop control and speed adjustment shall be implemented.

In AFD Auto, the associated field control switch (in 20-LCP-70-1) shall be in the Remote position to enable the Automatic control of the pump(s). When the field control switch is in Hand, the pump shall run at a pre-configured constant speed at the AFD.

Provide operator adjustable Lead/Lag level setpoints (20-LS-71-1, 20-LS-71-2, 20-LS-71-3, and 20-LS-71-4) for starting and stopping pumps. Cycle pumps as follows:

- Start the Lead pump when 20-LIT-71-1 measures above 20-LS-71-2. Latch the lead pump on until the level falls below 20-LS-71-1.
- Start the Lag pump when 20-LIT-71-1 measures above 20-LS-71-4. Latch the lag pump on until the level falls below 20-LS-71-3.

Pump speed shall be controlled by the operator's selection of the following options:

- Provide a PID level controller to maintain the desired level setpoint in the Plant Drain Wetwell. Level setpoint shall be operator adjustable via the HMI.
- Pumps shall run at a set speed (operator adjustable via the HMI)

The High-High and Low-Low level float switches shall provide backup pump control.

- Start Pump 1 upon activation of 20-LSHH-71-1. Latch the pump on until the level falls below float switch 20-LSLL-71-1. The pump shall run at a pre-configured constant speed at the AFD.
- Also upon activation of 20-LSHH-71-1, activate timing relay 20-KC-71-2. If the timer expires and the level is still above the LSHH, then start Pump 2. Latch the pump on until the level falls below float switch 20-LSLL-71-1. The pump shall run at a pre-configured speed at the AFD.
- Operator shall be alerted that the station is in Backup Float Mode. The station shall remain in this mode until the level subsides to below the Low-Low float position.

Provide Lead/Lag order control. Provide the option to select a fixed order or automatic alternation. Automatic alternation shall be triggered each time both pumps are off.

In all Remote modes, pumps are not allowed to run if low-low float switch 20-LSLL-71-1 is activated. In Hand mode, the low-low float switch interlock is bypassed via hardwired logic in the AFD.

Provide each of the following as separate alarms:

- No pumps in Auto/Remote

Return each pump to its pre-power-loss AUTO or MANUAL state on return of power. Any run latches interrupted during the power outage must be re-established by level setpoints.

Each pump has the standard interface described in the MAWSS Control Interface Standards. Additionally, the pumps are submersible; the motor temperature is monitored as well as moisture intrusion into the pump casing. The motor temperature is used in a hardwired interlock to shut down the pump; moisture is only to be alarmed.

2.5.11 Polymer Booster Water System (08-N-6010)

2.5.11.1 Process Overview

The Booster Water System for the polymer makeup units is a packaged skid that will deliver a consistent water flow and pressure using three (3) centrifugal pumps and pressure controllers. The system is controlled by vendor control panel 20-VCP-53-1.

2.5.11.2 Control Narrative

Control logic for the booster pumps shall reside in the vendor control panel. The pumps use vendor supplied AFDs to maintain desired process water pressure.

Signals of interest are wired to the PAC in control panel 20-CP-1 for monitoring via the HMI.

2.5.12 Generator Monitoring and Control (08-N-6011)

2.5.12.1 Process Overview

The backup generator provides emergency power to the Solids Processing equipment in the event of failure of utility power. Generator system and fuel tank information shall be gathered via the network connection to the generator control panel, 20GEN-CP-1.

2.5.12.2 Control Narrative

Upon loss of utility power, the solids process shall stop. When generator (emergency) power becomes available, the solids process shall be reinitiated by plant operations. Normal starting delays and interlocks shall apply.

While additional time-delayed starts are not anticipated on generator power, PICS programmer shall review the solids process during specified software workshop(s). If deemed necessary, program load balancing (stagger start) time delays in the PAC to prevent overloading the generator.

2.5.13 Existing DCU-1 (RTU-1)

2.5.13.1 Process Overview

This Emerson Bristol Babcock programmable controller is located in the existing Operations Building which will be demolished. DCU-1 signals which are required for continued monitoring and control shall be re-assigned to new PAC control panel 82-CP-1 in the Blower Building. These signals include:

- Train 1 and 2 Reactor Mixers
- PSA Oxygen Generation Systems
- Blower Building Alarms
- Basin O2 Lower Explosive Limit Signals
- Process Oxygen Flows
- Process Pressures
- Oxygen Flow Control Valves
- Various Alarms and Miscellaneous Signals

2.5.13.2 Control Narrative

For signals that being relocated to the PAC in 82-CP-1, functionality will be defined and documented during specified workshop sessions.

2.5.14 Existing DCU-2 (RTU-2)

2.5.14.1 Process Overview

This Emerson Bristol Babcock programmable controller is located in the existing Final Clarifiers Electrical Building and interfaces to the following signals:

- Secondary Clarifiers 1,2,3,4
- Clarifier Scum Pumps
- Clarifier Recirc/Discharge Valves
- Splitter Box Mixer
- De-chlorination Mixers
- Intermediate Pump Station Pumps and Gates
- Generators 1 and 2
- WAS Pumps
- Influent Flows
- Parshall Flume Flows
- Effluent pH, Dissolved Oxygen
- Reactor 2, Trains 3 and 4 – LEL, Pressures, and Dissolved Oxygen
- Chlorination System Monitoring and Leak Detection
- De-Chlorination System Monitoring and Leak Detection
- Various Alarms and Miscellaneous Signals

The wiring for these signals will be moved to new Remote I/O Control Panel 83-CP-1 and the existing controller logic and functionality will be ported to execute in new PAC Control Panel 20-CP-1.

The following signals are related to decommissioned components and will not be transferred to the new system:

- Screening Systems (confirm these are obsolete)
- Grit Removal Systems (confirm these are obsolete)

Additive Alternate #1: Signals related to the existing Chlorination and De-chlorination processes will be deleted from 83-CP-1 if this alternate is selected.

2.5.14.2 Control Narrative

For signals that being relocated to the PAC Remote I/O rack in 83-CP-1, functionality will be defined and documented during specified workshop sessions.

2.5.15 Existing DCU-3 (RTU-3)

2.5.15.1 Process Overview

This Emerson Bristol Babcock programmable controller is located in the existing Secondary Digester Building and interfaces to the following signals:

- Boiler
- Sludge Flows
- Sludge Temperatures
- Digester Levels
- Digester Temperatures
- Thickener Feed Tank Flow
- Return Flow to Primary Digesters
- Scrubber
- Secondary Digester Sludge Recirculation Pumps
- Primary Digester Sludge Pumps
- Gas Compressors
- Thickener Rake
- Thickener Pumps
- Hot Water Pumps
- Digester Building Sump Pump
- Various Alarms and Miscellaneous Signals

The wiring for these signals will be moved to new Remote I/O Control Panel 85-CP-1 and the existing controller logic and functionality will be ported to execute in new PAC Control Panel CP-20-1.

Control signals for the Digested Sludge Pumps will be re-assigned to the I/O racks in new PAC Control Panel 20-CP-1.

The following signals are related to decommissioned components and will not be transferred to the new system:

- Grit Removal Equipment (confirm these are obsolete)
- Primary Sediment Tanks (confirm these are obsolete)

Additive Alternate #1: The existing Scrubber will be re-purposed, and its control signals will be allocated to new Remote I/O Control Panel, 50-CP-1 if this alternate is selected.

2.5.15.2 Control Narrative

For signals that being relocated to the PAC Remote I/O rack in 85-CP-1, functionality will be defined and documented during specified workshop sessions.

2.5.16 Additive Alternate #9: Existing DCU-4 (RTU-4)

2.5.16.1 Process Overview

This Emerson Bristol Babcock programmable controller is located in the existing Headworks Electrical Building and interfaces to the following signals:

- Generator 3
- Eslava Creek Influent Flow
- Plant Sewer Pumps
- Screening Equipment
- Primary Clarifiers
- Scum Pumps
- Return Sludge Flow
- Sludge Pumps
- PCEPS Pumps
- Septage Receiving Flows
- Submersible Mixers
- Odor Control Equipment
- Various Alarms and Miscellaneous Signals

If this alternate is selected, the wiring for these signals will be moved to new Remote I/O Control Panel 91-CP-1 and the existing controller logic and functionality will be ported to execute in new PAC Control Panel CP-20-1.

2.5.16.2 Control Narrative

For signals that being relocated to the PAC Remote I/O rack in 91-CP-1, functionality will be defined and documented during specified workshop sessions.

2.5.17 Existing SWAT (Sidestream, PLC-1)

2.5.17.1 Process Overview

This Allen-Bradley PLC-5 programmable controller is located in the existing Final Clarifiers Electrical Building and interfaces to the following signals:

- Sidestream Pumps
- Sidestream Storage Tank
- Storage Supply Valve
- Storage Discharge Valve
- Headworks Supply Valve
- Various Alarms and Miscellaneous Signals

The wiring for these signals will be moved to new Remote I/O Control Panel 83-CP-2 and the existing controller logic and functionality will be ported to execute in new PAC Control Panel 20-CP-1.

The existing OIT (Panelview) will be abandoned. Operators will be able to monitor and control the SWAT process using the VTScada Thin Client terminal located at nearby control panel 83-CP-1.

The following signal is related to decommissioned components and will not be transferred to the new system:

- Headworks Supply Valve (confirm this is obsolete)

2.5.17.2 Control Narrative

For signals that being relocated to the PAC Remote I/O rack in 83-CP-2, functionality will be defined and documented during specified workshop sessions.

C.C. WILLIAMS WWTP DEWATERING AND IMPROVEMENTS PROJECT INSTRUMENT LIST					
Tag	Component Code	Quantity	Instrument Name	Component Options	P&ID Number
85-PE-11-1, -2	P15	2	Pressure Seal, Annular	Line Size: 6-inch See detail 4091-304C.	08-N-6001
85-PI-11-1, -2	P4	2	Pressure Gauge	Range: 0-40 PSI	08-N-6001
20-PE-12-1, -2	P15	2	Pressure Seal, Annular	Line Size: 4-inch See detail 4091-304C.	08-N-6001
20-PI-12-1, -2	P4	2	Pressure Gauge	Range: 0-30 PSI	08-N-6001
20-LE/LIT-10-1	L29	1	Level Element and Transmitter, Ultrasonic	Process Range: 0-19.5 ft Zero Reference: Bottom of Tank See Details 4091-254, 4091-383, & 4091-384	08-N-6001A
20-LE/LIT-10-2	L29	1	Level Element and Transmitter, Ultrasonic	Process Range: 0-19.5 ft Zero Reference: Bottom of Tank See Details 4091-254, 4091-383, & 4091-384	08-N-6001A
20-LE/LIT-50-1, -2	L29	2	Level Element and Transmitter, Ultrasonic	Process Range: 0-9.5 ft Zero Reference: Bottom of Tank Integral Flange: 4" (confirm with tank supplier) See Details 4091-254 & 4091-383	08-N-6006
50-AIT-10-1 (Note 1)	A18	1	Chlorine Leak Detector, Transmitter	Process Range: 0-10 PPM Contacts: Program N.O. for each sensor See Detail 4091-149	08-N-6007
50-AE-10-1, -2, -3 (Note 1)	A18	3	Chlorine Leak Detector, Sensor	Process Range: 0-10 PPM Setpoint: 0.5 PPM See Detail 4091-152AG	08-N-6007
50-AIT-32-1 (Note 1)	A19	1	SO2 Leak Detector, Transmitter/Controller	Process Range: 0-25 PPM Contacts: Program N.O. for each sensor See Detail 4091-149	08-N-6008
50-AE-32-1, -2, -3 (Note 1)	A19	3	SO2 Leak Detector, Sensor	Process Range: 0-25 PPM Setpoint: 5 PPM See Detail 4091-152AG	08-N-6008
20-LE/LIT-71-1	L29	1	Level Element and Transmitter, Ultrasonic	Process Range: 0-20.0 ft Zero Reference: Bottom of Wetwell Hazardous Location Approval Required See Detail 4091-253, 4091-384	08-N-6009

20-LSHH-71-1 20-LSLL-71-1	L8	2	Float Switch, Mercury	LSHH Setpoint: 5.0 FT EL Rising, N.O. LSLL Setpoint: -2.5 FT EL Failing, N.C. See Detail 4091-248AG	08-N-6009
20-PE-70-1, -2	P15	2	Pressure Seal, Annular	Offline, 2-inch See Detail 4091- 304DG	08-N-6009
20-PI-70-1, -2	P4	2	Pressure Gauge	Range: 0-50 PSI	08-N-6009
20-PSH-12-1	P8	1	Pressure Switch	Range: Coordinate with Pump Supplier	08-N-6001

Notes:

1. Provide instruments with prefix of "50" only if Additive Alternate #1 is selected and included in contract.

SUPPLEMENT 3					
PAC AND NETWORK EQUIPMENT LIST					
Code	Description	Qty.	Model	Manufacturer	Comments
	20-CP-1, DEWATERING BUILDING				
Y311	ControlLogix 5580 Controller with 10 MB User Memory, USB Port, 1 gigabit (Gb) Ethernet Port	2	1756-L83E	Allen Bradley	Provide all required ancillary PLC hardware including but not limited to front connectors, etc for a fully functional PLC system
Y312	ControlLogix 120VAC Power Supply (5V @ 13A)	5	1756-PA75	Allen Bradley	Power Supply
Y316	ControlLogix Redundancy Enhanced Module	2	1756-RM2	Allen Bradley	Redundancy Module with cable
Y3141	ControlLogix Ethernet 10-100M Bridge Module	2	1756-EN2T	Allen Bradley	Ethernet Module
Y3142	ControlLogix Ethernet 10-100M Bridge Module (2-Ports)	5	1756-EN2TR	Allen Bradley	Ethernet Module, DLR support
Y3153	ControlLogix 10 Slot Chassis	3	1756-A10	Allen Bradley	I/O Racks
Y3151	ControlLogix 7 Slot Chassis	2	1756-A7	Allen Bradley	Primary and Secondary Racks
	ControlLogix Chassis Slot Filler	A/R	1756-N2	Allen Bradley	ControlLogix 1756 Chassis Empty Slot Cover
Y3131	ControlLogix Discrete Input Module	13	1756-IA16	Allen Bradley	120VAC; 16 point module (20 Pin)
Y3132	ControlLogix Discrete Output Module	3	1756-OA16	Allen Bradley	120VAC; 16 point module (20 Pin)
Y3133	ControlLogix Analog Input Module	2	1756-IF8I	Allen Bradley	8 isolated point module, current, current sourcing and voltage (36 Pin)
Y3134	ControlLogix Analog Output Module	2	1756-OF8I	Allen Bradley	8 isolated point module, current, current sourcing and voltage (36 Pin)
Y040	Uninterruptible Power Supply	1	GXT5 Series	Vertiv	
Y3143	Ethernet/IP (ETAP) Embedded Switch	2	1783-ETAP1F	Allen Bradley	1 Copper, 1 Fiber port, DLR network
Name	Description	Qty.	Model	Manufacturer	Comments
	50-CP-1, CHLORINE/SO2 BUILDING				NOTE 1
Y312	ControlLogix 120VAC Power Supply (5V @ 13A)	1	1756-PA75	Allen Bradley	Power Supply
Y3142	ControlLogix Ethernet 10-100M Bridge Module (2-Ports)	1	1756-EN2TR	Allen Bradley	Ethernet Module, DLR support
Y3154	ControlLogix 13 Slot Chassis	1	1756-A13	Allen Bradley	I/O Racks
	ControlLogix Chassis Slot Filler	A/R	1756-N2	Allen Bradley	ControlLogix 1756 Chassis Empty Slot Cover
Y3131	ControlLogix Discrete Input Module	3	1756-IA16	Allen Bradley	120VAC; 16 point module (20 Pin)
Y3132	ControlLogix Discrete Output Module	1	1756-OA16	Allen Bradley	120VAC; 16 point module (20 Pin)
Y3133	ControlLogix Analog Input Module	3	1756-IF8I	Allen Bradley	8 isolated point module, current, current sourcing and voltage (36 Pin)
Y3134	ControlLogix Analog Output Module	1	1756-OF8I	Allen Bradley	8 isolated point module, current, current sourcing and voltage (36 Pin)
Y040	Uninterruptible Power Supply	1	GXT5 Series	Vertiv	
Y3143	Ethernet/IP (ETAP) Embedded Switch	1	1783-ETAP2F	Allen Bradley	1 Copper, 2 Fiber ports, DLR network
Name	Description	Qty.	Model	Manufacturer	Comments
	82-CP-1, EXISTING BLOWER BUILDING				I/O moved from existing RTU-1
Y321	CompactLogix 5370 L3 Controller, 2 MB Memory	1	1769-L33ER	Allen Bradley	
Y322	CompactLogix 120VAC Power Supply (5V @ 4Amps)	2	1769-PA4	Allen Bradley	
Y3231	CompactLogix Discrete Input Module	3	1769-IQ16	Allen Bradley	24VDC; 16 point module
Y3232	CompactLogix Discrete Output Module	1	1769-OB16	Allen Bradley	24VDC; 16 point module
Y3233	CompactLogix Analog Input Module	4	1769-IF4I	Allen Bradley	4 Channel Analog Current/Voltage Isolated Input Module
Y3234	CompactLogix Analog Output Module	1	1769-OF4CI	Allen Bradley	4 Channel Analog Current Isolated Output Module
	CompactLogix 3.28 Right-To-Right Bus Expansion Cable	1	1769-CRR3	Allen Bradley	
	CompactLogix Right End Cap Terminator	2	1769-ECR	Allen Bradley	
	CompactLogix Left End Cap Terminator	1	1769-ECL	Allen Bradley	
Y040	Uninterruptible Power Supply	1	GXT5 Series	Vertiv	
Y108	Stratix Managed Ethernet Switch	1	Stratix 5700 Series	Allen Bradley	SCADA Field Ethernet Switch
Name	Description	Qty.	Model	Manufacturer	Comments
83-CP-1	EXISTING FINAL CLARIFIERS ELECTRICAL BUILDING				
Y070	HMI Thin Client, Panel-mount	1	OIT-215	Zoher	Industrial computer and touchscreen, 21.5", 12 VDC
Y312	ControlLogix 120VAC Power Supply (5V @ 13A)	2	1756-PA75	Allen Bradley	Power Supply
Y3142	ControlLogix Ethernet 10-100M Bridge Module (2-Ports)	2	1756-EN2TR	Allen Bradley	Ethernet Module, DLR support
Y3155	ControlLogix 17 Slot Chassis	2	1756-A17	Allen Bradley	I/O Racks
	ControlLogix Chassis Slot Filler	A/R	1756-N2	Allen Bradley	ControlLogix 1756 Chassis Empty Slot Cover
Y3131	ControlLogix Discrete Input Module	8	1756-IB16	Allen Bradley	24VDC; 16 point module (20 Pin)
Y3132	ControlLogix Discrete Output Module	3	1756-OB16E	Allen Bradley	24VDC; 16 point module (20 Pin)
Y3133	ControlLogix Analog Input Module	9	1756-IF8I	Allen Bradley	8 isolated point module, current, current sourcing and voltage (36 Pin)
Y3134	ControlLogix Analog Output Module	4	1756-OF8I	Allen Bradley	8 isolated point module, current, current sourcing and voltage (36 Pin)
Y040	Uninterruptible Power Supply	1	GXT5 Series	Vertiv	
Y108	Stratix Managed Ethernet Switch	1	Stratix 5700 Series	Allen Bradley	SCADA Field Ethernet Switch
Y3143	Ethernet/IP (ETAP) Embedded Switch	2	1783-ETAP1F	Allen Bradley	1 Copper, 1 Fiber port, DLR network

SUPPLEMENT 3					
PAC AND NETWORK EQUIPMENT LIST					
Code	Description	Qty.	Model	Manufacturer	Comments
20-CP-1, DEWATERING BUILDING					
Name	Description	Qty.	Model	Manufacturer	Comments
83-CP-2	EXISTING SIDESTREAM (SWAT) PUMP STATION				
Y312	ControlLogix 120VAC Power Supply (5V @ 13A)	2	1756-PA75	Allen Bradley	Power Supply
Y3142	ControlLogix Ethernet 10-100M Bridge Module (2-Ports)	2	1756-EN2TR	Allen Bradley	Ethernet Module, DLR support
Y3153	ControlLogix 10 Slot Chassis	2	1756-A10	Allen Bradley	I/O Racks
	ControlLogix Chassis Slot Filler	A/R	1756-N2	Allen Bradley	ControlLogix 1756 Chassis Empty Slot Cover
Y3131	ControlLogix Discrete Input Module	5	1756-IB16	Allen Bradley	24VDC; 16 point module (20 Pin)
Y3132	ControlLogix Discrete Output Module	3	1756-OB16E	Allen Bradley	24VDC; 16 point module (20 Pin)
Y3133	ControlLogix Analog Input Module	3	1756-IF8I	Allen Bradley	8 isolated point module, current, current sourcing and voltage (36 Pin)
Y3134	ControlLogix Analog Output Module	1	1756-OF8I	Allen Bradley	8 isolated point module, current, current sourcing and voltage (36 Pin)
Y040	Uninterruptible Power Supply	1	GXT5 Series	Vertiv	
Name	Description	Qty.	Model	Manufacturer	Comments
85-CP-1	EXISTING SECONDARY DIGESTER BUILDING				
Y070	HMI Thin Client, Panel-mount	1	OIT-215	Zober	Industrial computer and touchscreen, 21.5", 12 VDC
Y312	ControlLogix 120VAC Power Supply (5V @ 13A)	1	1756-PA75	Allen Bradley	Power Supply
Y3142	ControlLogix Ethernet 10-100M Bridge Module (2-Ports)	1	1756-EN2TR	Allen Bradley	Ethernet Module, DLR support
Y3154	ControlLogix 17 Slot Chassis	1	1756-A17	Allen Bradley	I/O Racks
	ControlLogix Chassis Slot Filler	A/R	1756-N2	Allen Bradley	ControlLogix 1756 Chassis Empty Slot Cover
Y3131	ControlLogix Discrete Input Module	3	1756-IB16	Allen Bradley	24VDC; 16 point module (20 Pin)
Y3132	ControlLogix Discrete Output Module	1	1756-OB16E	Allen Bradley	24VDC; 16 point module (20 Pin)
Y3133	ControlLogix Analog Input Module	5	1756-IF8I	Allen Bradley	8 isolated point module, current, current sourcing and voltage (36 Pin)
Y3134	ControlLogix Analog Output Module	1	1756-OF8I	Allen Bradley	8 isolated point module, current, current sourcing and voltage (36 Pin)
Y040	Uninterruptible Power Supply	1	GXT5 Series	Vertiv	
Y108	Stratix Managed Ethernet Switch	1	Stratix 5700 Series	Allen Bradley	SCADA Field Ethernet Switch
Y3143	Ethernet/IP (ETAP) Embedded Switch	1	1783-ETAP2F	Allen Bradley	1 Copper, 2 Fiber ports, DLR network
Name	Description	Qty.	Model	Manufacturer	Comments
91-CP-1	EXISTING HEADWORKS				NOTE 2
Y070	HMI Thin Client, Panel-mount	1	OIT-215	Zober	Industrial computer and touchscreen, 21.5", 12 VDC
Y312	ControlLogix 120VAC Power Supply (5V @ 13A)	5	1756-PA75	Allen Bradley	Power Supply
Y3142	ControlLogix Ethernet 10-100M Bridge Module (2-Ports)	5	1756-EN2TR	Allen Bradley	Ethernet Module, DLR support
Y3153	ControlLogix 10 Slot Chassis	5	1756-A10	Allen Bradley	I/O Racks
	ControlLogix Chassis Slot Filler	A/R	1756-N2	Allen Bradley	ControlLogix 1756 Chassis Empty Slot Cover
Y3131	ControlLogix Discrete Input Module	21	1756-IB16	Allen Bradley	24VDC; 16 point module (20 Pin)
Y3132	ControlLogix Discrete Output Module	4	1756-OB16E	Allen Bradley	24VDC; 16 point module (20 Pin)
Y3133	ControlLogix Analog Input Module	6	1756-IF8I	Allen Bradley	8 isolated point module, current, current sourcing and voltage (36 Pin)
Y3134	ControlLogix Analog Output Module	5	1756-OF8I	Allen Bradley	8 isolated point module, current, current sourcing and voltage (36 Pin)
	ControlLogix High Speed Count Discrete Input Module	3	1756-HSC	Allen Bradley	2-Channel Counter, 24VDC, up to 1MHz
Y040	Uninterruptible Power Supply	1	GXT5 Series	Vertiv	
Y108	Stratix Managed Ethernet Switch	2	Stratix 5700 Series	Allen Bradley	SCADA Field Ethernet Switch (Provide under base bid).
Y3143	Ethernet/IP (ETAP) Embedded Switch	2	1783-ETAP1F	Allen Bradley	1 Copper, 1 Fiber ports, DLR network
Name	Description	Qty.	Model	Manufacturer	Comments
MCP-1	EXISTING SCREENING TRAIN 1 & 2 PANEL				
Y108	Stratix Managed Ethernet Switch	1	Stratix 5700 Series	Allen Bradley	SCADA Field Ethernet Switch
Name	Description	Qty.	Model	Manufacturer	Comments
MCP-2	EXISTING SCREENING TRAIN 3 & 4 PANEL				
Y108	Stratix Managed Ethernet Switch	1	Stratix 5700 Series	Allen Bradley	SCADA Field Ethernet Switch
Name	Description	Qty.	Model	Manufacturer	Comments
MCP-3	EXISTING GREASE/SEPTAGE RECEIVING PANEL				
Y108	Stratix Managed Ethernet Switch	1	Stratix 5700 Series	Allen Bradley	SCADA Field Ethernet Switch
Name	Description	Qty.	Model	Manufacturer	Comments
LCP-1	EXISTING GRIT REMOVAL TRAIN 1 & 2				
Y108	Stratix Managed Ethernet Switch	1	Stratix 5700 Series	Allen Bradley	SCADA Field Ethernet Switch
Name	Description	Qty.	Model	Manufacturer	Comments
LCP-2	EXISTING GRIT REMOVAL TRAIN 3 & 4				
Y108	Stratix Managed Ethernet Switch	1	Stratix 5700 Series	Allen Bradley	SCADA Field Ethernet Switch

Notes:

1. Provide the equipment listed for 50-CP-1 only if Additive Alternate #1 is selected and included in contract.
2. With exceptions to the Stratix Ethernet switches, provide the equipment listed for 91-CP-1 only if Additive Alternate #9 is selected and included in contract.

20-CP-1 PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
85-HS-11-1A	DIGESTED SLUDGE PUMP #1 IN AUTO (AFD)	DI
85-HS-11-1B	DIGESTED SLUDGE PUMP #1 IN REMOTE (FIELD)	DI
85-RS-11-1	DIGESTED SLUDGE PUMP #1 RUN STATUS	DI
85-XS-11-1	DIGESTED SLUDGE PUMP #1 ALARM	DI
85-TSH-11-1	DIGESTED SLUDGE PUMP #1 HIGH TEMP ALARM	DI
85-HS-11-2A	DIGESTED SLUDGE PUMP #2 IN AUTO (AFD)	DI
85-HS-11-2B	DIGESTED SLUDGE PUMP #2 IN REMOTE (FIELD)	DI
85-RS-11-2	DIGESTED SLUDGE PUMP #2 RUN STATUS	DI
85-XS-11-2	DIGESTED SLUDGE PUMP #2 ALARM	DI
85-TSH-11-2	DIGESTED SLUDGE PUMP #2 HIGH TEMP ALARM	DI
20-HS-14-1	DIGESTED SLUDGE MECHANICAL GRINDER IN REMOTE	DI
20-RS-14-1	DIGESTED SLUDGE MECHANICAL GRINDER RUN STATUS	DI
20-XS-14-1	DIGESTED SLUDGE MECHANICAL GRINDER ALARM	DI
20-RS-12-1	SMITH SLUDGE PUMP #1 RUN STATUS	DI
20-XS-12-1	SMITH SLUDGE PUMP #1 ALARM	DI
20-RS-12-2	SMITH SLUDGE PUMP #2 RUN STATUS	DI
20-XS-12-2	SMITH SLUDGE PUMP #2 ALARM	DI
20-RS-13-1	SMITH SLUDGE MECHANICAL GRINDER RUN STATUS	DI
20-XS-13-1	SMITH SLUDGE MECHANICAL GRINDER ALARM	DI
20-HS-10-1	BIOSOLIDS HOLDING TANK MIXER IN REMOTE	DI
20-JI-10-1	BIOSOLIDS HOLDING TANK MIXER RUN STATUS	DI
20-XS-10-1	BIOSOLIDS HOLDING TANK MIXER ALARM	DI
20-TSH-10-1	BIOSOLIDS HOLDING TANK MIXER HIGH TEMP ALARM	DI
20-HS-10-2	SMITH BIOSOLIDS RECEIVING TANK MIXER IN REMOTE	DI
20-JI-10-2	SMITH BIOSOLIDS RECEIVING TANK MIXER RUN STATUS	DI
20-XS-10-2	SMITH BIOSOLIDS RECEIVING TANK MIXER ALARM	DI
20-TSH-10-2	SMITH BIOSOLIDS RECEIVING TANK MIXER HIGH TEMP ALARM	DI
20-HS-30-1A	CONVEYOR #1 IN REMOTE	DI
20-RS-30-1BF	CONVEYOR #1 RUNNING FORWARD	DI
20-RS-30-1BR	CONVEYOR #1 RUNNING REVERSE	DI
20-XS-30-1A	CONVEYOR #1 ALARM	DI
20-HS-30-1B	CONVEYOR #1 E-STOP	DI
20-HS-30-2A	CONVEYOR #2 IN REMOTE	DI
20-RS-30-2BF	CONVEYOR #2 RUNNING FORWARD	DI
20-RS-30-2BR	CONVEYOR #2 RUNNING REVERSE	DI
20-XS-30-2A	CONVEYOR #2 ALARM	DI
20-HS-30-2B	CONVEYOR #2 E-STOP	DI
20-HS-30-3A	CONVEYOR #3 IN REMOTE	DI
20-RS-30-3BF	CONVEYOR #3 RUNNING FORWARD	DI
20-RS-30-3BR	CONVEYOR #3 RUNNING REVERSE	DI
20-XS-30-3A	CONVEYOR #3 ALARM	DI
20-HS-30-3B	CONVEYOR #3 E-STOP	DI
20-HS-30-4A	CONVEYOR #4 IN REMOTE	DI
20-RS-30-4BF	CONVEYOR #4 RUNNING FORWARD	DI
20-RS-30-4BR	CONVEYOR #4 RUNNING REVERSE	DI
20-XS-30-4A	CONVEYOR #4 ALARM	DI
20-HS-30-4B	CONVEYOR #4 E-STOP	DI
20-HS-30-5A	CONVEYOR #5 IN REMOTE	DI
20-RS-30-5BF	CONVEYOR #5 RUNNING FORWARD	DI
20-RS-30-5BR	CONVEYOR #5 RUNNING REVERSE	DI

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PAC INPUT OUTPUTS LIST
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20-CP-1 PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
20-XS-30-5A	CONVEYOR #5 ALARM	DI
20-HS-30-5B	CONVEYOR #5 E-STOP	DI
20-HS-30-6A	CONVEYOR #6 IN REMOTE	DI
20-RS-30-6BF	CONVEYOR #6 RUNNING FORWARD	DI
20-RS-30-6BR	CONVEYOR #6 RUNNING REVERSE	DI
20-XS-30-6A	CONVEYOR #6 ALARM	DI
20-HS-30-6B	CONVEYOR #6 E-STOP	DI
20-HS-30-7A	CONVEYOR #7 IN REMOTE	DI
20-RS-30-7BF	CONVEYOR #7 RUNNING FORWARD	DI
20-RS-30-7BR	CONVEYOR #7 RUNNING REVERSE	DI
20-XS-30-7A	CONVEYOR #7 ALARM	DI
20-HS-30-7B	CONVEYOR #7 E-STOP	DI
20-HS-30-8A	CONVEYOR #8 IN REMOTE	DI
20-RS-30-8BF	CONVEYOR #8 RUNNING FORWARD	DI
20-RS-30-8BR	CONVEYOR #8 RUNNING REVERSE	DI
20-XS-30-8A	CONVEYOR #8 ALARM	DI
20-HS-30-8B	CONVEYOR #8 E-STOP	DI
20-ZSO-30-5A	SLUDGE CAKE GATE #5A OPEN STATUS	DI
20-ZSC-30-5A	SLUDGE CAKE GATE #5A CLOSED STATUS	DI
20-XS-30-5A	SLUDGE CAKE GATE #5A ALARM	DI
20-ZSO-30-6A	SLUDGE CAKE GATE #6A OPEN STATUS	DI
20-ZSC-30-6A	SLUDGE CAKE GATE #6A CLOSED STATUS	DI
20-XS-30-6A	SLUDGE CAKE GATE #6A ALARM	DI
20-ZSO-30-7A	SLUDGE CAKE GATE #7A OPEN STATUS (TRUCK 1)	DI
20-ZSC-30-7A	SLUDGE CAKE GATE #7A CLOSED STATUS (TRUCK 1)	DI
20-XS-30-7A	SLUDGE CAKE GATE #7A ALARM (TRUCK 1)	DI
20-ZSO-30-7B	SLUDGE CAKE GATE #7B OPEN STATUS (TRUCK 1)	DI
20-ZSC-30-7B	SLUDGE CAKE GATE #7B CLOSED STATUS (TRUCK 1)	DI
20-XS-30-7B	SLUDGE CAKE GATE #7B ALARM (TRUCK 1)	DI
20-ZSO-30-7C	SLUDGE CAKE GATE #7C OPEN STATUS (TRUCK 1)	DI
20-ZSC-30-7C	SLUDGE CAKE GATE #7C CLOSED STATUS (TRUCK 1)	DI
20-XS-30-7C	SLUDGE CAKE GATE #7C ALARM (TRUCK 1)	DI
20-ZSO-30-8A	SLUDGE CAKE GATE #8A OPEN STATUS (TRUCK 2)	DI
20-ZSC-30-8A	SLUDGE CAKE GATE #8A CLOSED STATUS (TRUCK 2)	DI
20-XS-30-8A	SLUDGE CAKE GATE #8A ALARM (TRUCK 2)	DI
20-ZSO-30-8B	SLUDGE CAKE GATE #8B OPEN STATUS (TRUCK 2)	DI
20-ZSC-30-8B	SLUDGE CAKE GATE #8B CLOSED STATUS (TRUCK 2)	DI
20-XS-30-8B	SLUDGE CAKE GATE #8B ALARM (TRUCK 2)	DI
20-ZSO-30-8C	SLUDGE CAKE GATE #8C OPEN STATUS (TRUCK 2)	DI
20-ZSC-30-8C	SLUDGE CAKE GATE #8C CLOSED STATUS (TRUCK 2)	DI
20-XS-30-8C	SLUDGE CAKE GATE #8C ALARM (TRUCK 2)	DI
20-HS-30-10	SLUDGE CAKE GATES ALL IN REMOTE	DI
20-HS-70-1A	PLANT DRAIN PUMP #1 IN AUTO (AFD)	DI
20-HS-70-1B	PLANT DRAIN PUMP #1 IN REMOTE (FIELD)	DI
20-RS-70-1A	PLANT DRAIN PUMP #1 RUN STATUS (AFD)	DI
20-XS-70-1A	PLANT DRAIN PUMP #1 ALARM (AFD)	DI
20-HS-70-1C	PLANT DRAIN PUMP #1 IN BYPASS MODE	DI
20-RS-70-1B	PLANT DRAIN PUMP #1 RUN STATUS (BYPASS)	DI
20-XS-70-1B	PLANT DRAIN PUMP #1 ALARM (BYPASS)	DI
20-XS-70-1C	PLANT DRAIN PUMP #1 BACKUP SPEED ACTIVE	DI

20-CP-1 PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
20-XS-70-1D	PLANT DRAIN PUMP #1 LEAK/MOISTURE ALARM	DI
20-TSH-70-1	PLANT DRAIN PUMP #1 HIGH TEMP ALARM	DI
20-HS-70-2A	PLANT DRAIN PUMP #2 IN AUTO (AFD)	DI
20-HS-70-2B	PLANT DRAIN PUMP #2 IN REMOTE (FIELD)	DI
20-RS-70-2A	PLANT DRAIN PUMP #2 RUN STATUS (AFD)	DI
20-XS-70-2A	PLANT DRAIN PUMP #2 ALARM (AFD)	DI
20-HS-70-2C	PLANT DRAIN PUMP #2 IN BYPASS MODE	DI
20-RS-70-2B	PLANT DRAIN PUMP #2 RUN STATUS (BYPASS)	DI
20-XS-70-2B	PLANT DRAIN PUMP #2 ALARM (BYPASS)	DI
20-XS-70-2C	PLANT DRAIN PUMP #2 BACKUP SPEED ACTIVE	DI
20-XS-70-2D	PLANT DRAIN PUMP #2 LEAK/MOISTURE ALARM	DI
20-TSH-70-2	PLANT DRAIN PUMP #2 HIGH TEMP ALARM	DI
20-LAHH-71-1	PLANT DRAIN PUMP STATION HIGH HIGH LEVEL ALARM	DI
20-LALL-71-1	PLANT DRAIN PUMP STATION LOW LOW LEVEL ALARM	DI
20-HS-51-1	POLYMER MIXING PUMP #1 IN REMOTE	DI
20-RS-51-1	POLYMER MIXING PUMP #1 RUN STATUS	DI
20-XS-51-1	POLYMER MIXING PUMP #1 ALARM	DI
20-HS-51-2	POLYMER MIXING PUMP #2 IN REMOTE	DI
20-RS-51-2	POLYMER MIXING PUMP #2 RUN STATUS	DI
20-XS-51-2	POLYMER MIXING PUMP #2 ALARM	DI
20-FAH-50-1	POLYMER EYEWASH SAFETY SHOWER #1 IN USE ALARM	DI
20-FAH-50-2	POLYMER EYEWASH SAFETY SHOWER #2 IN USE ALARM	DI
20-FAH-50-3	POLYMER EYEWASH SAFETY SHOWER #3 IN USE ALARM	DI
20-FAH-50-4	POLYMER EYEWASH SAFETY SHOWER #4 IN USE ALARM	DI
20-RS-53-1	POLYMER WATER BOOSTER PUMP #1 RUN STATUS	DI
20-XS-53-1	POLYMER WATER BOOSTER PUMP #1 ALARM	DI
20-RS-53-2	POLYMER WATER BOOSTER PUMP #2 RUN STATUS	DI
20-XS-53-2	POLYMER WATER BOOSTER PUMP #2 ALARM	DI
20-XS-HCP-01	VENTILATION SYSTEM FAILURE	DI
20-XS-HCP-02	VENTILATION SYSTEM FAILURE	DI
20-XS-HCP-03	VENTILATION SYSTEM FAILURE	DI
20-XS-FACP-1A	FIRE ALARM PANEL ALARM	DI
20-XS-FACP-1B	FIRE ALARM PANEL SUPERVISORY	DI
20-XS-FACP-1C	FIRE ALARM PANEL TROUBLE	DI
20-JS-1A	PANEL AC POWER FAIL ALARM	DI
20-JS-1B	24 VDC POWER FAIL ALARM	DI
20-XS-UPS-1A	UPS FAIL ALARM	DI
20-XS-UPS-1B	UPS LOW BATTERY ALARM	DI
20-TAH-1	PANEL HIGH TEMPERATURE ALARM	DI
85-RC-11-1	DIGESTED SLUDGE PUMP #1 RUN COMMAND	DO
85-RC-11-2	DIGESTED SLUDGE PUMP #2 RUN COMMAND	DO
20-RC-14-1	BIOSOLIDS MECHANICAL GRINDER RUN COMMAND	DO
20-LAHH-10-2	SMITH BIOSOLIDS RECEIVING TANK HIGH HIGH LEVEL	DO
20-RC-10-1	BIOSOLIDS HOLDING TANK MIXER RUN COMMAND	DO
20-RC-10-2	SMITH BIOSOLIDS RECEIVING TANK MIXER RUN COMMAND	DO
20-RS-30-1F	CONVEYOR #1 RUN FORWARD COMMAND	DO
20-RS-30-2F	CONVEYOR #2 RUN FORWARD COMMAND	DO
20-RS-30-3F	CONVEYOR #3 RUN FORWARD COMMAND	DO
20-RS-30-4F	CONVEYOR #4 RUN FORWARD COMMAND	DO

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20-CP-1 PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
20-RS-30-5F	CONVEYOR #5 RUN FORWARD COMMAND	DO
20-RS-30-6F	CONVEYOR #6 RUN FORWARD COMMAND	DO
20-RS-30-7F	CONVEYOR #7 RUN FORWARD COMMAND	DO
20-RS-30-8F	CONVEYOR #8 RUN FORWARD COMMAND	DO
20-ZCO-30-5A	SLUDGE CAKE GATE #5A OPEN COMMAND	DO
20-ZCC-30-5A	SLUDGE CAKE GATE #5A CLOSE COMMAND	DO
20-ZCO-30-6A	SLUDGE CAKE GATE #6A OPEN COMMAND	DO
20-ZCC-30-6A	SLUDGE CAKE GATE #6A CLOSE COMMAND	DO
20-ZCO-30-7A	SLUDGE CAKE GATE #7A OPEN COMMAND (TRUCK 1)	DO
20-ZCC-30-7A	SLUDGE CAKE GATE #7A CLOSE COMMAND (TRUCK 1)	DO
20-ZCO-30-7B	SLUDGE CAKE GATE #7B OPEN COMMAND (TRUCK 1)	DO
20-ZCC-30-7B	SLUDGE CAKE GATE #7B CLOSE COMMAND (TRUCK 1)	DO
20-ZCO-30-7C	SLUDGE CAKE GATE #7C OPEN COMMAND (TRUCK 1)	DO
20-ZCC-30-7C	SLUDGE CAKE GATE #7C CLOSE COMMAND (TRUCK 1)	DO
20-ZCO-30-8A	SLUDGE CAKE GATE #8A OPEN COMMAND (TRUCK 2)	DO
20-ZCC-30-8A	SLUDGE CAKE GATE #8A CLOSE COMMAND (TRUCK 2)	DO
20-ZCO-30-8B	SLUDGE CAKE GATE #8B OPEN COMMAND (TRUCK 2)	DO
20-ZCC-30-8B	SLUDGE CAKE GATE #8B CLOSE COMMAND (TRUCK 2)	DO
20-ZCO-30-8C	SLUDGE CAKE GATE #8C OPEN COMMAND (TRUCK 2)	DO
20-ZCC-30-8C	SLUDGE CAKE GATE #8C CLOSE COMMAND (TRUCK 2)	DO
20-RC-70-1	PLANT DRAIN PUMP #1 RUN COMMAND	DO
20-RC-70-2	PLANT DRAIN PUMP #2 RUN COMMAND	DO
20-RC-51-1	POLYMER MIXING PUMP #1 RUN COMMAND	DO
20-RC-51-2	POLYMER MIXING PUMP #2 RUN COMMAND	DO
20-LAH-50-1	POLYMER TANK #1 HIGH LEVEL (FULL)	DO
20-LAH-50-2	POLYMER TANK #2 HIGH LEVEL (FULL)	DO
20-LI-10-1	BIOSOLIDS HOLDING TANK LEVEL	AI
20-LI-10-2	SMITH BIOSOLIDS RECEIVING TANK LEVEL	AI
85-SI-11-1	DIGESTED SLUDGE PUMP #1 SPEED INDICATION	AI
85-SI-11-2	DIGESTED SLUDGE PUMP #2 SPEED INDICATION	AI
20-SI-70-1	PLANT DRAIN PUMP #1 SPEED INDICATION	AI
20-SI-70-2	PLANT DRAIN PUMP #2 SPEED INDICATION	AI
20-LI-71-1	PLANT DRAIN PUMP STATION LEVEL	AI
20-PI-53-2	POLYMER WATER BOOSTER PUMP STATION DISCHARGE PRESSURE	AI
20-LI-50-1A	POLYMER STORAGE TANK #1 LEVEL	AI
20-LI-50-2A	POLYMER STORAGE TANK #2 LEVEL	AI
20-LI-10-1	BIOSOLIDS HOLDING TANK LEVEL	AO
20-LI-10-2	SMITH BIOSOLIDS RECEIVING TANK LEVEL	AO
85-SC-11-1	DIGESTED SLUDGE PUMP #1 SPEED COMMAND	AO
85-SC-11-2	DIGESTED SLUDGE PUMP #2 SPEED COMMAND	AO
20-SC-70-1	PLANT DRAIN PUMP #1 SPEED COMMAND	AO
20-SC-70-2	PLANT DRAIN PUMP #2 SPEED COMMAND	AO
20-LI-50-1B	POLYMER STORAGE TANK #1 LEVEL	AO
20-LI-50-2B	POLYMER STORAGE TANK #2 LEVEL	AO

50-CP-1 PAC I/O LIST (ADDITIVE ALTERNATE #1)

INSTRUMENT TAG	DESCRIPTION	TYPE
50-AAH-10-1	CL2 LEAK ALARM	DI
50-XS-10-1	CL2 LEAK DETECTOR FAULT ALARM	DI
50-ZSC-FP-1	CL2 GAS FEED EMERGENCY SHUTOFF PANEL #1 EMERGENCY CLOSE	DI
50-XS-FP-1	CL2 GAS FEED EMERGENCY SHUTOFF PANEL #1 SYSTEM ERROR	DI
50-ZSC-FP-2	CL2 GAS FEED EMERGENCY SHUTOFF PANEL #2 EMERGENCY CLOSE	DI
50-XS-FP-2	CL2 GAS FEED EMERGENCY SHUTOFF PANEL #2 SYSTEM ERROR	DI
50-HS-14-1	CL2 W2 BOOSTER PUMP IN REMOTE	DI
50-RS-14-1	CL2 W2 BOOSTER PUMP RUN STATUS	DI
50-XS-14-1	CL2 W2 BOOSTER PUMP ALARM	DI
50-PAH-15-1	CL2 GAS VACUUM MONITOR #1 HIGH PRESSURE ALARM	DI
50-PAL-15-1	CL2 GAS VACUUM MONITOR #1 LOW PRESSURE ALARM	DI
50-PAH-15-2	CL2 GAS VACUUM MONITOR #2 HIGH PRESSURE ALARM	DI
50-PAL-15-2	CL2 GAS VACUUM MONITOR #2 LOW PRESSURE ALARM	DI
50-AAH-32-1	SO2 LEAK ALARM	DI
50-XS-32-1	SO2 LEAK DETECTOR FAULT ALARM	DI
50-ZSC-FP-3	SO2 GAS FEED EMERGENCY SHUTOFF PANEL #3 EMERGENCY CLOSE	DI
50-XS-FP-3	SO2 GAS FEED EMERGENCY SHUTOFF PANEL #3 SYSTEM ERROR	DI
50-PAH-32-1	SO2 GAS VACUUM MONITOR #1 HIGH PRESSURE ALARM	DI
50-PAL-32-1	SO2 GAS VACUUM MONITOR #1 LOW PRESSURE ALARM	DI
50-PAH-32-2	SO2 GAS VACUUM MONITOR #2 HIGH PRESSURE ALARM	DI
50-PAL-32-2	SO2 GAS VACUUM MONITOR #2 LOW PRESSURE ALARM	DI
50-RS-36-1	SCRUBBER EXHAUST FAN RUN STATUS	DI
50-XS-36-1	SCRUBBER EXHAUST FAN ALARM	DI
50-FAH-50-1	CL2/SO2 SAFETY EYEWASH SHOWER #1 IN USE ALARM	DI
50-FAH-50-2	CL2/SO2 SAFETY EYEWASH SHOWER #2 IN USE ALARM	DI
50-FAH-50-3	CL2/SO2 SAFETY EYEWASH SHOWER #3 IN USE ALARM	DI
50-XS-FACP-1A	CL2/SO2 BUILDING FIRE ALARM TROUBLE	DI
50-XS-FACP-1B	CL2/SO2 BUILDING FIRE ALARM	DI
50-XS-FACP-1C	CL2/SO2 BUILDING FIRE ALARM SUPERVISORY	DI
50-JA-1A	PANEL AC POWER FAIL ALARM	DI
50-JA-1B	24 VDC POWER FAIL ALARM	DI
50-XS-UPS-1A	UPS FAIL ALARM	DI
50-XS-UPS-1B	UPS LOW BATTERY ALARM	DI
50-TAH-1	PANEL HIGH TEMPERATURE ALARM	DI
50-XC-FP-1	CL2 GAS FEED EMERGENCY SHUTOFF PANEL #1 SHUTDOWN COMMAND	DO
50-RC-14-1	CL2 W2 BOOSTER PUMP RUN COMMAND	DO
50-XC-FP-3	SO2 GAS FEED EMERGENCY SHUTOFF PANEL #3 SHUTDOWN COMMAND	DO
50-RC-36-1	SCRUBBER EXHAUST FAN RUN COMMAND	DO
50-XC-FACP-1	CL2/SO2 LEAK ALARM TO FIRE ALARM PANEL 50-FACP-1	DO
50-XC-HCP-01	CL2/SO2 LEAK ALARM TO HVAC PANEL 50-HCP-01	DO
50-XC-FP-4	CL2/SO2 LEAK ALARM TO ALARM PANEL 50-FP-4	DO
50-XC-FP-5	CL2/SO2 LEAK ALARM TO ALARM PANEL 50-FP-5	DO
50-XC-FP-6	CL2 LEAK ALARM TO ALARM PANEL 50-FP-6	DO
50-XC-FP-7	SO2 LEAK ALARM TO ALARM PANEL 50-FP-7	DO
50-WI-11-1	CHLORINE GAS FEED TANK #1/2 WEIGHT	AI
50-WI-11-3	CHLORINE GAS FEED TANK #3/4 WEIGHT	AI
50-WI-11-5	CHLORINE GAS FEED TANK #5/6 WEIGHT	AI

50-CP-1 PAC I/O LIST (ADDITIVE ALTERNATE #1)

INSTRUMENT TAG	DESCRIPTION	TYPE
50-WI-11-7	CHLORINE GAS FEED TANK #7/8 WEIGHT	AI
50-SI-15-1	CHLORINE GAS FEED RATE #1	AI
50-SI-15-2	CHLORINE GAS FEED RATE #2	AI
50-AI-99-10	CHLORINE CONTACT BASIN INFLUENT CHLORINE RESIDUAL	AI
50-AI-99-11	PLANT EFFLUENT CHLORINE RESIDUAL	AI
50-WI-30-1	SO2 FEED TANK #1 WEIGHT	AI
50-WI-30-2	SO2 FEED TANK #2 WEIGHT	AI
50-WI-30-3	SO2 FEED TANK #3 WEIGHT	AI
50-WI-30-4	SO2 FEED TANK #4 WEIGHT	AI
50-SI-32-1	SO2 FEED RATE #1	AI
50-SI-32-2	SO2 FEED RATE #2	AI
50-SC-15-1	CHLORINE GAS FEED #1 PACING COMMAND	AO
50-SC-15-2	CHLORINE GAS FEED #2 PACING COMMAND	AO
50-SC-32-1	SO2 FEED #1 PACING COMMAND	AO
50-SC-32-2	SO2 FEED #2 PACING COMMAND	AO

82-CP-1 (I/O from DCU-1/RTU-1) PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
XA-884	PSA #1 CYCLE FAILURE	DI
XA-885	PSA #1 LOW O2 PURITY	DI
PA-883	PSA #1 HIGH PRESSURE BLOWDOWN	DI
TA-886	PSA #1 INLET HIGH TEMPERATURE	DI
PA-888	PSA #2 CYCLE FAILURE	DI
XA-889	PSA #2 LOW O2 PURITY	DI
PA-890	PSA #2 HIGH PRESSURE BLOWDOWN	DI
TA-891	PSA #2 INLET HIGH TEMPERATURE	DI
QA-881	COMPRESSOR #1 SHUTDOWN	DI
QA-882	COMPRESSOR #2 SHUTDOWN	DI
XA-887	INSTRUMENT AIR FAILURE	DI
XA-004	BLOWER BLDG. (FAP 4) ALARM	DI
XA-005	BLOWER BLDG. (FAP 4) TROUBLE	DI
ZI-693	TRAIN 1 REACTOR BASIN #1 AUTO/MAN POS	DI
ZI-703	TRAIN 2 REACTOR BASIN #2 AUTO/MAN POS	DI
JI-695	TRAIN 1 REACTOR MIXER #1 ON/OFF	DI
JI-696	TRAIN 1 REACTOR MIXER #2 ON/OFF	DI
JI-697	TRAIN 1 REACTOR MIXER #3 ON/OFF	DI
JI-698	TRAIN 1 REACTOR MIXER #4 ON/OFF	DI
JI-704	TRAIN 2 REACTOR MIXER #1 ON/OFF	DI
JI-705	TRAIN 2 REACTOR MIXER #2 ON/OFF	DI
JI-706	TRAIN 2 REACTOR MIXER #3 ON/OFF	DI
JI-707	TRAIN 2 REACTOR MIXER #4 ON/OFF	DI
JI-928	PSA BUILDING GENERATOR ON NORMAL POWER	DI
JI-930	PSA BUILDING GENERATOR ON GENERATOR POWER	DI
JI-791	DILUTION WATER SUMP #1 ON/OFF	DI
JI-792	DILUTION WATER SUMP #2 ON/OFF	DI
JI-809	CHLORINE CONTACT CHAMBER SUB. MIXER ON/OFF	DI
QS-695	TRAIN 1 MIXER #1 ON/OFF CMD	DO
QS-696	TRAIN 1 MIXER #2 ON/OFF CMD	DO
QS-697	TRAIN 1 MIXER #3 ON/OFF CMD	DO
QS-698	TRAIN 1 MIXER #4 ON/OFF CMD	DO
QS-704	TRAIN 2 MIXER #1 ON/OFF CMD	DO
QS-705	TRAIN 2 MIXER #2 ON/OFF CMD	DO
QS-706	TRAIN 2 MIXER #3 ON/OFF CMD	DO
QS-707	TRAIN 2 MIXER #4 ON/OFF CMD	DO
HS-713	EMERGENCY SHUTDOWN ALL TRAINS	DO
AI-885	PSA #1 O2 PURITY	AI
AI-889	PSA #2 O2 PURITY	AI
AT-715	LEL FOR TRAIN 1, CELL 1	AI
AT-716	LEL FOR TRAIN 1, CELL 2	AI
AT-717	LEL FOR TRAIN 2, CELL 1	AI
AT-718	LEL FOR TRAIN 2, CELL 2	AI
FI-692	TRAIN #1 REACTOR BASIN #1 OXYGEN FLOW	AI
FIT-702	TRAIN #2 REACTOR BASIN #2 OXYGEN FLOW	AI
PI-700	TRAIN 1 REACTOR PRESSURE	AI
PI-709	TRAIN 2 REACTOR PRESSURE	AI

82-CP-1 (I/O from DCU-1/RTU-1) PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
FI-688	FLOW OF OXYGEN FROM PSA	AI
JI-929	PSA BUILDING GENERATOR LOAD	AI
ZT-693	TRAIN 1 OXYGEN FLOW CONTROL VALVE	AO
ZT-703	TRAIN 2 OXYGEN FLOW CONTROL VALVE	AO
PY-701	VENT TO ATMOSPHERE	AO

83-CP-1 (Formerly DCU-2/RTU-2) PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
LA-655	SCREEN #1 HIGH LEVEL	DI
JI-656	SCREEN #1 ON/OFF	DI
LA-653	SCREEN #2 HIGH LEVEL	DI
JI-654	SCREEN #2 ON/OFF	DI
JI-660	PISTA GRIT MIXER #1 ON/OFF	DI
JI-663	PISTA GRIT MIXER #2 ON/OFF	DI
JI-661	WEMCO GRIT PUMP #1 ON/OFF	DI
JI-664	WEMCO GRIT PUMP #2 ON/OFF	DI
JI-662	CLASSIFIER #1 ON/OFF	DI
JI-665	CLASSIFIER #2 ON/OFF	DI
JI-685	SPLITTER BOX #1 MIXER ON/OFF	DI
JI-801	DECHLORINATION MIXER #1 ON/OFF (NOTE 1)	DI
JI-802	DECHLORINATION MIXER #2 ON/OFF (NOTE 1)	DI
JI-2000	INT. PUMP STATION P-1A ON/OFF	DI
JI-2001	INT. PUMP STATION P-1B ON/OFF	DI
JI-2002	INT. PUMP STATION P-1C ON/OFF	DI
JI-2003	INT. PUMP STATION P-1D ON/OFF	DI
JI-2004	INT. PUMP STATION P-1E ON/OFF	DI
ZIO-2140	GATE S-2A OPEN	DI
ZIC-2140	GATE S-2A CLOSED	DI
ZIO-2150	GATE S-2B OPEN	DI
ZIC-2150	GATE S-2B CLOSED	DI
XAH-2304	CLARIFIER #1 40% TORQUE ALARM	DI
XAH-2315	CLARIFIER #1 85% TORQUE ALARM/SHUTDOWN	DI
JI-2371	CLARIFIER #1 RAKE MOTOR ON/OFF	DI
XA-2331	CLARIFIER #1 LEVEL DIAGNOSTIC	DI
HS-2351A	CLARIFIER #1 RAS/WAS WEIR LOCAL/REMOTE	DI
JI-2321	CLARIFIER #1 MOTOR ON/OFF	DI
QA-2325	CLARIFIER #1 SCUM PUMP LO OIL ALARM	DI
QI-2321	CLARIFIER #1 SCUM PUMP HOA	DI
XAH-2305	CLARIFIER #2 40% TORQUE ALARM	DI
XAH-2316	CLARIFIER #2 85% TORQUE ALARM/SHUTDOWN	DI
JI-2372	CLARIFIER #2 RAKE MOTOR ON/OFF	DI
XA-2332	CLARIFIER #2 LEVEL DIAGNOSTIC	DI
HS-2352A	CLARIFIER #2 RAS/WAS WEIR LOCAL/REMOTE	DI
JI-2322	CLARIFIER #2 MOTOR ON/OFF	DI
QA-2326	CLARIFIER #2 SCUM PUMP LO OIL ALARM	DI
QI-2322	CLARIFIER #2 SCUM PUMP HOA	DI
XAH-2306	CLARIFIER #3 40% TORQUE ALARM	DI
XAH-2317	CLARIFIER #3 85% TORQUE ALARM/SHUTDOWN	DI
JI-2373	CLARIFIER #3 RAKE MOTOR ON/OFF	DI
XA-2333	CLARIFIER #3 LEVEL DIAGNOSTIC	DI
HS-2353A	CLARIFIER #3 RAS/WAS WEIR LOCAL/REMOTE	DI
JI-2323	CLARIFIER #3 MOTOR ON/OFF	DI
QA-2327	CLARIFIER #3 SCUM PUMP LO OIL ALARM	DI
QS-2323	CLARIFIER #3 SCUM PUMP HOA	DI
XAH-2307	CLARIFIER #4 40% TORQUE ALARM	DI
XAH-2318	CLARIFIER #4 85% TORQUE ALARM/SHUTDOWN	DI
JI-2374	CLARIFIER #4 RAKE MOTOR ON/OFF	DI
XA-2334	CLARIFIER #4 LEVEL DIAGNOSTIC	DI
HS-2354A	CLARIFIER #4 RAS/WAS WEIR LOCAL/REMOTE	DI
JI-2324	CLARIFIER #4 MOTOR ON/OFF	DI
QA-2328	CLARIFIER #4 SCUM PUMP LO OIL ALARM	DI
QI-2324	CLARIFIER #4 SCUM PUMP HOA	DI
PAL-856	LOW CITY WATER PRESSURE	DI

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83-CP-1 (Formerly DCU-2/RTU-2) PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
PAL-854A	SO2 VACUUM LO (NOTE 1)	DI
PAH-854A	SO2 VACUUM HIGH (NOTE 1)	DI
PAL-854B	SO2 VACUUM LO (NOTE 1)	DI
PAH-854B	SO2 VACUUM HIGH (NOTE 1)	DI
QA-855	SO2 SUPPLY LO (NOTE 1)	DI
QA-857	SO2 GAS LEAK (NOTE 1)	DI
QA-867	CL2 GAS LEAK (NOTE 1)	DI
PAL-864A	CL2 VACUUM LO (NOTE 1)	DI
PAL-864B	CL2 VACUUM LO (NOTE 1)	DI
PAH-864A	CL2 VACUUM HIGH (NOTE 1)	DI
PAH-864B	CL2 VACUUM HIGH (NOTE 1)	DI
PAL-860	LOW CITY WATER PRESSURE CHLORINATOR BUILDING (NOTE 1)	DI
QA-862	CL2 HIGH PRESSURE (NOTE 1)	DI
XA-902	INTERSTITIAL LEAK ALARM	DI
LAH-903	GEN #2 DIESEL TANK HIGH WATER LVL ALARM	DI
LAL-901	GEN #2 DIESEL TANK LO FUEL LEVEL ALARM	DI
JI-925	GEN #1 NORMAL POWER ON	DI
JI-927	GEN #1 GENERATOR ON	DI
JI-832	WAS 2 RUN STATUS	DI
QA-832	WAS 2 FAULT	DI
JI-836	WAS 1 RUN STATUS	DI
QA-836	WAS 1 FAULT	DI
ZI-742	REACTOR 2 TRAIN 3 O2 FLOW CONTROL AUTO/MANUAL	DI
JI-744	REACTOR 2 TANK 3 MIXER A-2A ON/OFF	DI
JI-752	REACTOR 2 TRAIN 4 O2 FLOW CONTROL AUTO/MANUAL	DI
JI-753	REACTOR 2 TRAIN 4 MIXER A-2E ON/OFF	DI
JI-754	REACTOR 2 TRAIN 4 MIXER A-2F ON/OFF	DI
JI-755	REACTOR 2 TRAIN 4 MIXER A-2G ON/OFF	DI
JI-756	REACTOR 2 TRAIN 4 MIXER A-2H ON/OFF	DI
83-JA-1A	PANEL AC POWER FAIL ALARM	DI
83-JA-1B	24 VDC POWER FAIL ALARM	DI
83-JA-1C	12 VDC POWER FAIL ALARM	DI
83-XS-UPS-1A	UPS FAIL ALARM	DI
83-XS-UPS-1B	UPS LOW BATTERY ALARM	DI
83-TAH-1	PANEL HIGH TEMPERATURE ALARM	DI
QS-832	WAS PUMP 2 START/STOP	DO
QS-836	WAS PUMP 1 START/STOP	DO
QS-2000	INT. PUMP STATION P-1A START/STOP	DO
QS-2001	INT. PUMP STATION P-1B START/STOP	DO
QS-2002	INT. PUMP STATION P-1C START/STOP	DO
QS-2003	INT. PUMP STATION P-1D START/STOP	DO
QS-2004	INT. PUMP STATION P-1E START/STOP	DO
HS-2321A	CLARIFIER #1 SCUM PUMP ON/OFF CMD	DO
QSO-2325	CLARIFIER #1 RECIRC/DISCHARGE VALVE OPEN	DO
QSC-2325	CLARIFIER #1 RECIRC/DISCHARGE VALVE CLOSED	DO
HS-2322	CLARIFIER #2 SCUM PUMP ON/OFF CMD	DO
QSO-2326	CLARIFIER #2 RECIRC/DISCHARGE VALVE OPEN	DO
QSC-2326	CLARIFIER #2 RECIRC/DISCHARGE VALVE CLOSED	DO
HS-2323A	CLARIFIER #3 SCUM PUMP ON/OFF CMD	DO
QSO-2333	CLARIFIER #3 RECIRC/DISCHARGE VALVE OPEN	DO
QSC-2333	CLARIFIER #3 RECIRC/DISCHARGE VALVE CLOSED	DO
HS-2324	CLARIFIER #4 SCUM PUMP ON/OFF CMD	DO
QSO-2328	CLARIFIER #4 RECIRC/DISCHARGE VALVE OPEN	DO
QSC-2328	CLARIFIER #4 RECIRC/DISCHARGE VALVE CLOSED	DO

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83-CP-1 (Formerly DCU-2/RTU-2) PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
QS-744	REACTOR 2 TANK 3 MIXER A-2A START/STOP	DO
QS-745	REACTOR 2 TANK 3 MIXER A-2B START/STOP	DO
QS-746	REACTOR 2 TANK 3 MIXER A-2C START/STOP	DO
QS-747	REACTOR 2 TANK 3 MIXER A-2D START/STOP	DO
QS-753	REACTOR 2 TANK 4 MIXER A-2E START/STOP	DO
QS-754	REACTOR 2 TANK 4 MIXER A-2F START/STOP	DO
QS-755	REACTOR 2 TANK 4 MIXER A-2G START/STOP	DO
QS-756	REACTOR 2 TANK 4 MIXER A-2H START/STOP	DO
FIT-757	INFLUENT FLOW	AI
FIT-793	PARSHALL FLUME NORMAL EFFLUENT FLOW	AI
FIT-793A	PARSHALL FLUME HIGH EFFLUENT FLOW	AI
AI-810	EFFLUENT PH	AI
AI-803	EFFLUENT DISSOLVED OXYGEN	AI
SI-832	WAS PUMP 2 SPEED IND	AI
FIT-834	WAS FLOW	AI
SI-836	WAS PUMP 1 SPEED IND	AI
LI-2100	INT. PUMP STATION WET WELL LVL	AI
SI-2000	INT. PUMP STATION P-1A SPEED IND	AI
SI-2001	INT. PUMP STATION P-1B SPEED IND	AI
SI-2002	INT. PUMP STATION P-1C SPEED IND	AI
SI-2003	INT. PUMP STATION P-1D SPEED IND	AI
SI-2004	INT. PUMP STATION P-1E SPEED IND	AI
LI-2120	INT. PUMP STATION WET WELL LVL	AI
FI-2130	INT. PUMP STATION OVERFLOW FLOW	AI
AI-2250	INT. PUMP STATION SPLITTER BOX 2 SUSPENDED SOLIDS #1	AI
LI-2331	CLARIFIER #1 INTERFACE LVL	AI
LI-2311	CLARIFIER #1 RAS/WAS LVL	AI
ZI-2351	CLARIFIER #1 POSITION OF RAS/WAS WEIR	AI
LI-2341	CLARIFIER #1 SCUM WELL LEVEL	AI
LI-2332	CLARIFIER #2 INTERFACE LVL	AI
LI-2312	CLARIFIER #2 RAS/WAS LVL	AI
ZI-2352	CLARIFIER #2 POSITION OF RAS/WAS WEIR	AI
LI-2342	CLARIFIER #2 SCUM WELL LVL	AI
LI-2333	CLARIFIER #3 INTERFACE LVL	AI
LI-2313	CLARIFIER #3 RAS/WAS LVL	AI
ZI-2353	CLARIFIER #3 POSITION OF RAS/WAS WIER	AI
LI-2343	CLARIFIER #3 SCUM WELL LEVEL	AI
LI-2334	CLARIFIER #4 INTERFACE LEVEL	AI
LI-2314	CLARIFIER #4 RAS/WAS LVL	AI
ZI-2354	CLARIFIER #4 POSITION OF RAW/WAS WEIR	AI
LI-2344	CLARIFIER #4 SCUM WELL LVL	AI
AI-850	RESIDUAL CL2 PPM (NOTE 1)	AI
WI-868A	SO2 WEIGHT #1 (NOTE 1)	AI
WI-868B	SO2 WEIGHT #2 (NOTE 1)	AI
AI-851	CL2 BEFORE SO2 (NOTE 1)	AI
WI-870A	CL2 SUPPLY WEIGHT #1 (NOTE 1)	AI
WI-870B	CL2 SUPPLY WEIGHT #2 (NOTE 1)	AI
WI-870C	CL2 SUPPLY WEIGHT #3 (NOTE 1)	AI
WI-870D	CL2 SUPPLY WEIGHT #4 (NOTE 1)	AI
LI-901	GEN #2 DIESEL TANK FUEL LEVEL	AI
JT-926	ON GENERATOR POWER LOAD	AI
AIC-748	REACTOR 2 TRAIN 3 DO READING	AI
PIC-749	REACTOR 2 TRAIN 3 PRESSURE	AI
FIT-741	REACTOR 2, TRAIN 3 O2 FLOW	AI

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83-CP-1 (Formerly DCU-2/RTU-2) PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
AIC-757	REACTOR 2 TRAIN 4 DO READING	AI
PI-756	REACTOR 2 TRAIN 4 PRESSURE	AI
FIT-751	REACTOR 2, TRAIN 4 O2 FLOW	AI
AI-766	REACTOR 2, TRAIN 3, CELL 1 LEL	AI
AI-767	REACTOR 2 TRAIN 3 CELL 2 LEL	AI
AI-768	REACTOR 2 TRAIN 4 CELL 1 LEL	AI
AI-769	REACTOR 2 TRAIN 4 CELL 2 LEL	AI
LY-2351	CLARIFIER #1 SLUDGE LEVEL CONTROL	AO
FI-2351	CLARIFIER #1 COMPUTED RAS/WAS FLOW	AO
FI-2352	CLARIFIER #2 SLUDGE LEVEL CONTROL	AO
LY-2352	CLARIFIER #2 COMPUTED RAW/WAS FLOW	AO
FIT-2353	CLARIFIER #3 SLUDGE LEVEL CONTROL	AO
LY-2354	CLARIFIER #3 COMPUTED RAS/WAS FLOW	AO
FI-2354	CLARIFIER #4 SLUDGE LEVEL CONTROL	AO
FIC-650	CLARIFIER #4 COMPUTED RAW/WAS FLOW	AO
SC-2000	INT. PUMP STATION P-1A SPEED SET	AO
SC-2001	INT. PUMP STATION P-1B SPEED SET	AO
SC-2002	INT. PUMP STATION P-1C SPEED SET	AO
SC-2003	INT. PUMP STATION P-1D SPEED SET	AO
SC-2004	INT. PUMP STATION P-1E SPEED SET	AO
ZT-742	REACTOR 2 TRAIN 3 O2 FLOW CONTROL	AO
HC-750	REACTOR 2 VENT CONTROL	AO
ZT-752	REACTOR 2 TRAIN 4 O2 FLOW CONTROL	AO
SC-836	WAS PUMP 1 SPEED SET	AO
SC-832	WAS PUMP 2 SPEED SET	AO
HC-861A	CHLORINATOR VALVE CONTROL (NOTE 1)	AO
HC-861B	CHLORINATOR VALVE CONTROL (NOTE 1)	AO
SC-2004	SULFONATOR CONTROL VALVE (NOTE 1)	AO

NOTE 1: I/O SIGNALS TO BE REMOVED AND SHOWN AS SPARES IF THE NEW CHLORINE & SO2 BUILDING ADDITIVE ALTERNATE #1 IS PROVIDED UNDER THIS CONTRACT.

83-CP-2 (Formerly PLC-1/SWAT) PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
HS-01AA	LIFT STATION PUMP 01A IN HAND	DI
HS-01AB	LIFT STATION PUMP 01A IN AUTO	DI
JI-01A	LIFT STATION PUMP 01A RUNNING	DI
TAH-01AA	LIFT STATION PUMP 01A HIGH BEARING TEMPERATURE	DI
TAH-01AB	LIFT STATION PUMP 01A HIGH MOTOR TEMPERATURE	DI
QA-01A	LIFT STATION PUMP 01A SEAL FAIL	DI
HS-01BA	LIFT STATION PUMP 01B IN HAND	DI
HS-01BB	LIFT STATION PUMP 01B IN AUTO	DI
JI-01B	LIFT STATION PUMP 01B RUNNING	DI
TAH-01BA	LIFT STATION PUMP 01B HIGH BEARING TEMPERATURE	DI
TAH-01BB	LIFT STATION PUMP 01B HIGH MOTOR TEMPERATURE	DI
QA-01B	LIFT STATION PUMP 01B SEAL FAIL	DI
HS-01CA	LIFT STATION PUMP 01C IN HAND	DI
HS-01CB	LIFT STATION PUMP 01C IN AUTO	DI
JI-01C	LIFT STATION PUMP 01C RUNNING	DI
TAH-01CA	LIFT STATION PUMP 01C HIGH BEARING TEMPERATURE	DI
TAH-01CB	LIFT STATION PUMP 01C HIGH MOTOR TEMPERATURE	DI
QA-01C	LIFT STATION PUMP 01C SEAL FAIL	DI
HS-V1A	STORAGE TANK DRAIN (VALVE V1) IN REMOTE	DI
HS-V1B	STORAGE TANK DRAIN (VALVE V1) IN LOCAL	DI
HS-V2A	STORAGE TANK FILL (VALVE V2) IN REMOTE	DI
HS-V2B	STORAGE TANK FILL (VALVE V2) IN LOCAL	DI
HS-V3A	STORAGE TANK LEVEL CONTROL (VALVE V3) IN REMOTE	DI
HS-V3B	STORAGE TANK LEVEL CONTROL (VALVE V3) IN LOCAL	DI
HS-V5AA	STORAGE TANK WASH HEADER (VALVE V5A) IN REMOTE	DI
HS-V5AB	STORAGE TANK WASH HEADER (VALVE V5A) IN LOCAL	DI
HS-V5BA	STORAGE TANK WASH HEADER (VALVE V5B) IN REMOTE	DI
HS-V5BB	STORAGE TANK WASH HEADER (VALVE V5B) IN LOCAL	DI
HS-V5CA	STORAGE TANK WASH HEADER (VALVE 5C) IN REMOTE	DI
HS-V5CB	STORAGE TANK WASH HEADER (VALVE 5C) IN LOCAL	DI
HS-V5DA	STORAGE TANK WASH HEADER (VALVE 5D) IN REMOTE	DI
HS-V5DB	STORAGE TANK WASH HEADER (VALVE 5D) IN LOCAL	DI
HS-V6A	HEADWORKS BYPASS (VALVE V6) IN REMOTE	DI
HS-V6B	HEADWORKS BYPASS (VALVE V6) IN LOCAL	DI
HS-G1A	FLOW SHUTOFF TO JB-B (GATE G1) IN REMOTE	DI
HS-G1B	FLOW SHUTOFF TO JB-B (GATE G1) IN LOCAL	DI
HS-G4A	FLOW SHUTOFF TO LEFT STATION (GATE G4) IN REMOTE	DI
HS-G4B	FLOW SHUTOFF TO LIFT STATION (GATE G4) IN LOCAL	DI
HS-G6A	FLOW DIVERSION TO JB-A (GATE G6) IN REMOTE	DI
HS-02AA	EFFLUENT REUSE PUMP 02A IN HAND	DI
HS-02AB	EFFLUENT REUSE PUMP 02A IN AUTO	DI
JI-02A	EFFLUENT REUSE PUMP 02A RUNNING	DI
HS-02BA	EFFLUENT REUSE PUMP 02B IN HAND	DI
HS-02BB	EFFLUENT REUSE PUMP 02B IN AUTO	DI
JI-02B	EFFLUENT REUSE PUMP 02B RUNNING	DI
LAL-1	LIFT STATION SUMP LEVEL LOW (LSL-1)	DI
LAH-1	LIFT STATION SUMP LEVEL HIGH HIGH (LSH-1)	DI
LAH-2	LIFT STATION SUMP LEVEL HIGH HIGH (LSH-2)	DI
LAH-3	LIFT STATION SUMP LEVEL HIGH HIGH (LSH-3)	DI

83-CP-2 (Formerly PLC-1/SWAT) PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
LAAH-2	LIFT STATION SUMP LEVEL HIGH HIGH HIGH HIGH (LSAH-2)	DI
LAAH-1	SIDE STREAM STORAGE TANK HIGH LEVEL (LSAH-1)	DI
LAH-5	PLANT HEADWORKS HIGH LEVEL (LSH-5)	DI
83-JA-2A	PANEL AC POWER FAIL ALARM	DI
83-JA-2B	24 VDC POWER FAIL ALARM	DI
83-XS-UPS-2A	UPS FAIL ALARM	DI
83-XS-UPS-2B	UPS LOW BATTERY ALARM	DI
83-TAH-2	PANEL HIGH TEMPERATURE ALARM	DI
QS-01A	LIFT STATION PUMP 01A RUN COMMAND	DO
QS-01B	LIFT STATION PUMP 01B RUN COMMAND	DO
QS-01C	LIFT STATION PUMP 01C RUN COMMAND	DO
QS-02A	EFFLUENT REUSE PUMP 02A RUN COMMAND	DO
QS-02B	EFFLUENT REUSE PUMP 02B RUN COMMAND	DO
ZCO-V1	STORAGE TANK DRAIN (VALVE V1) OPEN COMMAND	DO
ZCC-V1	STORAGE TANK DRAIN (VALVE V1) CLOSE COMMAND	DO
ZCO-V2	STORAGE TANK FILL (VALVE V2) OPEN COMMAND	DO
ZCC-V2	STORAGE TANK FILL (VALVE V2) CLOSE COMMAND	DO
ZCO-V3	STORAGE TANK LEVEL CONTROL (VALVE V3) OPEN COMMAND	DO
ZCC-V3	STORAGE TANK LEVEL CONTROL (VALVE V3) CLOSE COMMAND	DO
ZCO-V4	EFFLUENT REUSE RECIRCULATION (VALVE V4) OPEN COMMAND	DO
ZCC-V4	EFFLUENT REUSE RECIRCULATION (VALVE V4) CLOSE COMMAND	DO
ZCO-V5A	STORAGE TANK WASH HEADER (VALVE V5A) OPEN COMMAND	DO
ZCC-V5A	STORAGE TANK WASH HEADER (VALVE V5A) CLOSE COMMAND	DO
ZCO-V5B	STORAGE TANK WASH HEADER (VALVE V5B) OPEN COMMAND	DO
ZCC-V5B	STORAGE TANK WASH HEADER (VALVE V5B) CLOSE COMMAND	DO
ZCO-V5C	STORAGE TANK WASH HEADER (VALVE V5C) OPEN COMMAND	DO
ZCC-V5C	STORAGE TANK WASH HEADER (VALVE V5C) CLOSE COMMAND	DO
ZCO-V5D	STORAGE TANK WASH HEADER (VALVE V5D) OPEN COMMAND	DO
ZCC-V5D	STORAGE TANK WASH HEADER (VALVE V5D) CLOSE COMMAND	DO
ZCO-V6	HEADWORKS BYPASS (VALVE V6) OPEN COMMAND	DO
ZCC-V6	HEADWORKS BYPASS (VALVE V6) CLOSE COMMAND	DO
ZCO-G1	FLOW SHUTOFF TO JB-B (GATE G1) OPEN COMMAND	DO
ZCC-G1	FLOW SHUTOFF TO JB-B (GATE G1) CLOSE COMMAND	DO
ZCO-G4	FLOW SHUTOFF TO LIFT STATION (GATE G4) OPEN COMMAND	DO
ZCC-G4	FLOW SHUTOFF TO LIFT STATION (GATE G4) CLOSE COMMAND	DO
ZCO-G6	FLOW DIVERSION TO JB-A (GATE G6) OPEN COMMAND	DO
ZCC-G6	FLOW DIVERSION TO JB-A (GATE G6) CLOSE COMMAND	DO
ZT-V1	STORAGE TANK DRAIN (VALVE V1) POSITION	AI
ZT-V2	STORAGE TANK DRAIN (VALVE V2) POSITION	AI
ZT-V3	STORAGE TANK LEVEL CONTROL (VALVE V3) POSITION	AI
ZT-V4	EFFLUENT REUSE RECIRCULATION (VALVE V4) POSITION	AI
ZI-V6	HEADWORKS BYPASS (VALVE V6) POSITION	AI
ZT-G1	FLOW SHUTOFF TO JB-B (GATE G1) POSITION	AI
ZT-G4	FLOW SHUTOFF TO LIFT STATION (GATE G4) POSITION	AI
ZT-G6	FLOW DIVERSION TO JB-A (GATE G6) POSITION	AI
IT-01A	STORAGE TANK PUMP 01A AMPS	AI
IT-01B	STORAGE TANK PUMP 01B AMPS	AI

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83-CP-2 (Formerly PLC-1/SWAT) PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
IT-01C	STORAGE TANK PUMP 01C AMPS	AI
IT-02A	EFFLUENT REUSE PUMP 02A AMPS	AI
IT-02B	EFFLUENT REUSE PUMP 02B AMPS	AI
PT-1	EFFLUENT REUSE RECIRCULATION PRESSURE	AI
LT-1	SIDE STREAM STORAGE TANK LEVEL	AI
LT-2	LIFT STATION LEVEL	AI
LT-3	PLANT HEADWORKS LEVEL	AI

85-CP-1 (Formerly DCU-3/RTU-3) PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
JI-666	PREAERATION CLASSIFIER ON/OFF	DI
JI-667	TRAVELING DEGRITTER ON/OFF	DI
JI-668	GRIT PUMP ON/OFF	DI
JI-693	SCRUBBER ON (NOTE 1)	DI
JA-693	SCRUBBER ALARM ON (NOTE 1)	DI
JI-681A	PRIMARY SEDIMENT TANK (NORTH) SCUM WIPER ON/OFF IND	DI
JI-681B	PRIMARY SEDIMENT TANK (NORTH) SCUM WIPER ON/OFF IND	DI
JI-681C	PRIMARY SEDIMENT TANK (SOUTH) SCUM WIPER ON/OFF IND	DI
JI-681D	PRIMARY SEDIMENT TANK (SOUTH) SCUM WIPER ON/OFF IND	DI
XA-841	ELECTRIC BOILER FAULT ALARM	DI
XI-842	ELECTRIC BOILER ON/OFF STATUS	DI
JI-920	RETURN PUMP P-202 RUN STATUS	DI
JI-955	M-105 GRINDER RUN STATUS	DI
JI-956	M-106 GRINDER RUN STATUS	DI
85-JA-1A	PANEL AC POWER FAIL ALARM	DI
85-JA-1B	24 VDC POWER FAIL ALARM	DI
85-JA-1C	12 VDC POWER FAIL ALARM	DI
85-XS-UPS-1A	UPS FAIL ALARM	DI
85-XS-UPS-1B	UPS LOW BATTERY ALARM	DI
85-TAH-1	PANEL HIGH TEMPERATURE ALARM	DI
	GAS COMPRESSOR #1 (M-101) IN REMOTE	DI
	GAS COMPRESSOR #1 (M-101) RUN STATUS	DI
	GAS COMPRESSOR #1 (M-101) ALARM	DI
	GAS COMPRESSOR M-101 FIELD MANUAL MODE	DI
	GAS COMPRESSOR M-101 FIELD AUTO MODE	DI
	GAS COMPRESSOR M-101 SEAL WATER FLOW SWITCH	DI
	GAS COMPRESSOR M-101 HIGH PRESSURE SWITCH	DI
	GAS COMPRESSOR #2 (M-102) IN REMOTE	DI
	GAS COMPRESSOR #2 (M-102) RUN STATUS	DI
	GAS COMPRESSOR #2 (M-102) ALARM	DI
	GAS COMPRESSOR M-102 FIELD MANUAL MODE	DI
	GAS COMPRESSOR M-102 FIELD AUTO MODE	DI
	GAS COMPRESSOR M-102 SEAL WATER FLOW SWITCH	DI
	GAS COMPRESSOR M-102 HIGH PRESSURE SWITCH	DI
	GAS COMPRESSOR #3 (M-103) IN REMOTE	DI
	GAS COMPRESSOR #3 (M-103) RUN STATUS	DI
	GAS COMPRESSOR #3 (M-103) ALARM	DI
	GAS COMPRESSOR M-103 FIELD MANUAL MODE	DI
	GAS COMPRESSOR M-103 FIELD AUTO MODE	DI
	GAS COMPRESSOR M-103 SEAL WATER FLOW SWITCH	DI
	GAS COMPRESSOR M-103 HIGH PRESSURE SWITCH	DI
	GAS COMPRESSOR #4 (M-104) IN REMOTE	DI
	GAS COMPRESSOR #4 (M-104) RUN STATUS	DI
	GAS COMPRESSOR #4 (M-104) ALARM	DI
	GAS COMPRESSOR M-104 FIELD MANUAL MODE	DI
	GAS COMPRESSOR M-104 FIELD AUTO MODE	DI
	GAS COMPRESSOR M-104 SEAL WATER FLOW SWITCH	DI
	GAS COMPRESSOR M-104 HIGH PRESSURE SWITCH	DI
	SECONDARY DIGESTER SLUDGE RECIRC PUMP #1 RUN STATUS	DI

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INSTRUMENT TAG	DESCRIPTION	TYPE
	SECONDARY DIGESTER SLUDGE RECIRC PUMP #1 ALARM	DI
	SECONDARY DIGESTER SLUDGE RECIRC PUMP #2 RUN STATUS	DI
	SECONDARY DIGESTER SLUDGE RECIRC PUMP #2 ALARM	DI
	SECONDARY DIGESTER SLUDGE RECIRC PUMP #3 RUN STATUS	DI
	SECONDARY DIGESTER SLUDGE RECIRC PUMP #3 ALARM	DI
	SECONDARY DIGESTER BLDG SUMP PUMP RUN STATUS	DI
	SECONDARY DIGESTER BLDG SUMP PUMP ALARM	DI
	PRIMARY DIGESTER SLUDGE PUMP #1 RUN STATUS	DI
	PRIMARY DIGESTER SLUDGE PUMP #1 ALARM	DI
	PRIMARY DIGESTER SLUDGE PUMP #2 RUN STATUS	DI
	PRIMARY DIGESTER SLUDGE PUMP #2 ALARM	DI
	PRIMARY DIGESTER SLUDGE PUMP #3 RUN STATUS	DI
	PRIMARY DIGESTER SLUDGE PUMP #3 ALARM	DI
	PRIMARY DIGESTER HOT WATER PUMP #1 RUN STATUS	DI
	PRIMARY DIGESTER HOT WATER PUMP #1 ALARM	DI
	PRIMARY DIGESTER HOT WATER PUMP #2 RUN STATUS	DI
	PRIMARY DIGESTER HOT WATER PUMP #2 ALARM	DI
	THICKENER PUMP #1 RUN STATUS	DI
	THICKENER PUMP #1 ALARM	DI
	THICKENER PUMP #2 RUN STATUS	DI
	THICKENER PUMP #2 VFD FAULT	DI
	THICKENER RAKE RUN STATUS	DI
	THICKENER RAKE VFD FAULT	DI
	GAS COMPRESSOR #1 (M-101) RUN COMMAND	DO
	GAS COMPRESSOR #2 (M-102) RUN COMMAND	DO
	GAS COMPRESSOR #3 (M-103) RUN COMMAND	DO
	GAS COMPRESSOR #4 (M-104) RUN COMMAND	DO
	GAS COMPRESSOR M-101 SEAL WATER ON COMMAND	DO
	GAS COMPRESSOR M-102 SEAL WATER ON COMMAND	DO
	GAS COMPRESSOR M-103 SEAL WATER ON COMMAND	DO
	GAS COMPRESSOR M-104 SEAL WATER ON COMMAND	DO
FI-820	SLUDGE FLOW TO DIGESTER	AI
TI-824	SLUDGE TEMP BEFORE #1 HEAT EXCHANGER	AI
TI-825	SLUDGE TEMP BEFORE #2 HEAT EXCHANGER	AI
TI-827	SLUDGE TEMP AFTER #2 HEAT EXCHANGER	AI
TI-828	SLUDGE TEMP AFTER #1 HEAT EXCHANGER	AI
LI-502	LEVEL INDICATOR EAST DIGESTER #1	AI
LI-509	LEVEL INDICATOR EAST DIGESTER #2	AI
FI-957	THICKENER FEED TANK FLOW	AI
FI-921	RETURN FLOW TO PRIMARY DIGESTER	AI
TI-501	EAST SECONDARY DIGESTER #1 BASE TEMP	AI
TI-502	EAST SECONDARY DIGESTER #1 UPPER TEMP	AI
LI-504	EAST SECONDARY DIGESTER #1 LEVEL	AI
TI-507	EAST SECONDARY DIGESTER #2 BASE TEMP	AI
TI-509	EAST SECONDARY DIGESTER #2 UPPER TEMP	AI
LI-510	EAST SECONDARY DIGESTER #2 LEVEL	AI
TI-513	PRIMARY DIGESTER #1 BASE TEMP	AI

85-CP-1 (Formerly DCU-3/RTU-3) PAC I/O LIST

INSTRUMENT TAG	DESCRIPTION	TYPE
TI-515	PRIMARY DIGESTER #1 UPPER TEMP	AI
PI-519	PRIMARY DIGESTER #1 PRESSURE	AI
TI-520	PRIMARY DIGESTER #2 BASE TEMP	AI
TI-522	PRIMARY DIGESTER #2 UPPER TEMP	AI
PI-524	PRIMARY DIGESTER #2 PRESSURE	AI
PI-586	METHANE HEADER PRESSURE	AI
TI-527	PRIMARY DIGESTER #3 BASE TEMP	AI
TI-529	PRIMARY DIGESTER #3 UPPER TEMP	AI
PI-531	PRIMARY DIGESTER #3 PRESSURE	AI
FIT-600A	DIGESTED SLUDGE FLOW (RELOCATED TRANSMITTER)	AI

NOTE 1: I/O SIGNALS TO BE REMOVED AND SHOWN AS SPARES IF THE NEW CHLORINE & SO2 BUILDING
ADDITIVE ALTERNATE #1 IS PROVIDED UNDER THIS CONTRACT.

91-CP-1 (Formerly DCU-4/RTU-4) PAC I/O LIST (ADDITIVE ALTERNATE #9)

INSTRUMENT TAG	DESCRIPTION	TYPE
YI-4000	GENERATOR RUNNING	DI
QA-4001	GENERATOR FAULT	DI
YI-4002	ATS GENERATOR RUN INDICATION	DI
QI-4003	ATS HOA IN AUTO	DI
QI-4004	ATS UTILITY POWER AVAILABLE	DI
QA-4005	ATS COMMON ALARM	DI
QA-4006	PHASE POWER FAULT	DI
QA-4008	GENERATOR DIESEL TANK LOW FLOAT	DI
QA-4009	VIRGINIA STREET SAMPLER ALARM	DI
QA-4010A	ESLAVA CREEK SAMPLER ALARM	DI
LAH-4011	ESLAVA CREEK HEAD MONITOR BOX #2 HIGH FLOAT	DI
LAH-4012	VIRGINIA STREET HEAD MONITOR BOX #1 HIGH FLOAT	DI
LAL-4308A	PRIMARY CLARIFIER #1 LOW OIL	DI
LAL-4304A	PRIMARY CLARIFIER #2 LOW OIL	DI
LAL-4408A	PRIMARY CLARIFIER #3 LOW OIL	DI
LAL-4404A	PRIMARY CLARIFIER #4 LOW OIL	DI
JI-4040	ODOR CONTROL #1 RUNNING	DI
QA-4040	ODOR CONTROL #1 FAULT	DI
HIS-4038A	SUBMERSIBLE MIXER #1 HOA IN AUTO	DI
MAH-4038A	SUBMERSIBLE MIXER #1 HIGH MOISTURE	DI
TAH-4038A	SUBMERSIBLE MIXER #1 HIGH TEMP	DI
YI-4038A	SUBMERSIBLE MIXER #1 RUNNING	DI
QA-4039A	SUBMERSIBLE MIXER #1 GENERAL FAULT	DI
HSA-4049	SUBMERSIBLE MIXER #1 E-STOP ACTIVATED	DI
HSI-4144A	SUBMERSIBLE MIXER #2 HOA IN AUTO	DI
MAH-4144A	SUBMERSIBLE MIXER #2 HIGH MOISTURE	DI
TAH-4144A	SUBMERSIBLE MIXER #2 HIGH TEMP	DI
YI-4144A	SUBMERSIBLE MIXER #2 RUNNING	DI
QA-4145A	SUBMERSIBLE MIXER #2 FAULT	DI
HSA-4171	SUBMERSIBLE MIXER #2 E-STOP ACTIVATED	DI
HSI-4525A	PCEPS PUMP #1 RVSS HOA IN /AUTO (FUTURE)	DI
YI-4525B	PCEPS PUMP #1 RVSS RUNNING (FUTURE)	DI
QA-4526A	PCEPS PUMP #1 RVSS FAULT (FUTURE)	DI
HSI-4527	PCEPS PUMP #2 RVSS HOA IN AUTO	DI
YI-4527B	PCEPS PUMP #2 RVSS RUNNING	DI
QA-4527A	PCEPS PUMP #2 RVSS FAULT	DI
HSI-4539A	PCEPS PUMP #3 RVSS HOA IN AUTO	DI
YI-4539B	PCEPS PUMP #3 RVSS RUNNING	DI
QA-4539A	PCEPS PUMP #3 RVSS FAULT	DI
HSI-4514A	PCEPS PUMP #4 RVSS HOA IN AUTO	DI
YI-4514B	PCEPS PUMP #4 RVSS RUNNING	DI
QA-4515A	PCEPS PUMP #4 RVSS FAULT	DI
HSI-4509A	PCEPS PUMP #5 RVSS HOA IN AUTO	DI
YI-4509B	PCEPS PUMP #5 RVSS RUNNING	DI
QA-4510A	PCEPS PUMP #5 RVSS FAULT	DI
HSI-4504A	PCEPS PUMP #6 RVSS HOA IN AUTO (FUTURE)	DI
YI-4504B	PCEPS PUMP #6 RVSS RUNNING (FUTURE)	DI
QA-4505A	PCEPS PUMP #6 RVSS FAULT (FUTURE)	DI
HSI-4306A	PRIMARY CLARIFIER #1 LOCAL HOA IN AUTO	DI

91-CP-1 (Formerly DCU-4/RTU-4) PAC I/O LIST (ADDITIVE ALTERNATE #9)		
INSTRUMENT TAG	DESCRIPTION	TYPE
HSI-4307A	PRIMARY CLARIFIER #1 HOA IN AUTO	DI
XAH-4307	PRIMARY CLARIFIER #1 HIGH TORQUE	DI
XAHH-4307	PRIMARY CLARIFIER #1 HI-HI TORQUE	DI
YI-4307B	PRIMARY CLARIFIER #1 RUNNING	DI
QA-4308A	PRIMARY CLARIFIER #1 GENERAL FAULT	DI
LAH-4310	PRIMARY CLARIFIER #1 DISCHARGE BOX HIGH FLOAT	DI
HSI-4301A	PRIMARY CLARIFIER #2 LOCAL HOA IN AUTO	DI
HSI-4302A	PRIMARY CLARIFIER #2 HOA IN AUTO	DI
XAH-4302	PRIMARY CLARIFIER #2 HIGH TORQUE	DI
XAHH-4302	PRIMARY CLARIFIER #2 HI-HI TORQUE	DI
YI-4302B	PRIMARY CLARIFIER #2 RUNNING	DI
QA-4304A	PRIMARY CLARIFIER #2 GENERAL FAULT	DI
LAH-4320	PRIMARY CLARIFIER #2 DISCHARGE BOX HIGH FLOAT	DI
HSI-4406A	PRIMARY CLARIFIER #3 LOCAL HOA IN AUTO	DI
HSI-4407A	PRIMARY CLARIFIER #3 HOA IN AUTO	DI
XAH-4407	PRIMARY CLARIFIER #3 HIGH TORQUE	DI
XAHH-4407	PRIMARY CLARIFIER #3 HI-HI TORQUE	DI
YI-4407B	PRIMARY CLARIFIER #3 RUNNING	DI
QA-4408A	PRIMARY CLARIFIER #3 GENERAL FAULT	DI
LAH-4410	PRIMARY CLARIFIER #3 DISCHARGE BOX HIGH FLOAT	DI
HSI-4401A	PRIMARY CLARIFIER #4 LOCAL HOA IN AUTO	DI
HSI-4402A	PRIMARY CLARIFIER #4 HOA IN AUTO	DI
XAH-4402	PRIMARY CLARIFIER #4 HIGH TORQUE	DI
XAHH-4402	PRIMARY CLARIFIER #4 HI-HI TORQUE	DI
YI-4402B	PRIMARY CLARIFIER #4 RUNNING	DI
QA-4404A	PRIMARY CLARIFIER #4 GENERAL FAULT	DI
LAH-4420	PRIMARY CLARIFIER #4 DISCHARGE BOX HIGH FLOAT	DI
HSI-4314A	SCUM PUMP #1 HOA IN AUTO	DI
YI-4314B	SCUM PUMP #1 RUNNING	DI
HSI-4317A	SCUM PUMP #1 LOCAL HOA IN AUTO	DI
HSI-4414A	SCUM PUMP #2 HOA IN AUTO	DI
YI-4414B	SCUM PUMP #2 RUNNING	DI
HSI-4417A	SCUM PUMP #2 LOCAL HOA IN AUTO	DI
QA-4316	SCUM PUMP #1 GENERAL FAULT	DI
QA-4416	SCUM PUMP #2 GENERAL FAULT	DI
QA-4324A	SLUDGE PUMP #1 GENERAL FAULT	DI
YI-4323B	SLUDGE PUMP #1 RUNNING	DI
ZA-4323A	SLUDGE PUMP #1 NO FLOW	DI
HSA-4341	SLUDGE PUMP #1 E-STOP ACTIVATED	DI
HSI-4342A	SLUDGE PUMP #1 LOCAL HOA IN AUTO	DI
HSI-4343A	SLUDGE PUMP #2 LOCAL HOA IN AUTO	DI
HSA-4345	SLUDGE PUMP #2 E-STOP ACTIVATED	DI
QA-4329A	SLUDGE PUMP #2 GENERAL FAULT	DI
YI-4328A	SLUDGE PUMP #2 RUNNING	DI
ZA-4328A	SLUDGE PUMP #2 NO FLOW	DI
HSI-4344A	SLUDGE PUMP #3 LOCAL HOA IN AUTO	DI
QA-4333A	SLUDGE PUMP #3 GENERAL FAULT	DI
YI-4332A	SLUDGE PUMP #3 RUNNING	DI
ZA-4332A	SLUDGE PUMP #3 NO FLOW	DI

91-CP-1 (Formerly DCU-4/RTU-4) PAC I/O LIST (ADDITIVE ALTERNATE #9)

INSTRUMENT TAG	DESCRIPTION	TYPE
HSA-4346	SLUDGE PUMP #3 E-STOP ACTIVATED	DI
HSI-4442A	SLUDGE PUMP #4 LOCAL HOA IN AUTO	DI
HSA-4441	SLUDGE PUMP #4 E-STOP ACTIVATED	DI
QA-4424A	SLUDGE PUMP #4 GENERAL FAULT	DI
YI-4423B	SLUDGE PUMP #4 RUNNING	DI
ZA-4423A	SLUDGE PUMP #4 NO FLOW	DI
HSI-4443A	SLUDGE PUMP #5 LOCAL HOA IN AUTO	DI
HSA-4445	SLUDGE PUMP #5 E-STOP ACTIVATED	DI
QA-4429A	SLUDGE PUMP #5 GENERAL FAULT	DI
YI-4428B	SLUDGE PUMP #5 RUNNING	DI
ZA-4428A	SLUDGE PUMP #5 NO FLOW	DI
HSA-4446	SLUDGE PUMP #6 E-STOP ACTIVATED	DI
HSI-4444	SLUDGE PUMP #6 LOCAL HOA IN AUTO	DI
QA-4433A	SLUDGE PUMP #6 GENERAL FAULT	DI
YI-4432B	SLUDGE PUMP #6 RUNNING	DI
ZA-4432A	SLUDGE PUMP #6 NO FLOW (FUTURE)	DI
MA-4323A	SLUDGE PUMP #1 OIL SEAL FAIL	DI
MA-4328A	SLUDGE PUMP #2 OIL SEAL FAIL	DI
MA-4332A	SLUDGE PUMP #3 OIL SEAL FAIL	DI
MA-4423A	SLUDGE PUMP #4 OIL SEAL FAIL	DI
MA-4428A	SLUDGE PUMP #5 OIL SEAL FAIL	DI
MA-4332A	SLUDGE PUMP #6 OIL SEAL FAIL	DI
HSI-4523A	PCEPS PUMP #1 IN BYPASS CONTROL (FUTURE)	DI
HSI-4524A	PCEPS PUMP #1 VFD HOA IN AUTO (FUTURE)	DI
YI-4524B	PCEPS PUMP #1 VFD RUNNING (FUTURE)	DI
FAL-4524A	PCEPS PUMP #1 LOW SEAL (FUTURE)	DI
ZA-4524A	PCEPS PUMP #1 NO FLOW (FUTURE)	DI
QA-4525A	PCEPS PUMP #1 VFD GENERAL FAULT (FUTURE)	DI
HSI-4526A	PCEPS PUMP #1 LOCAL HOA IN AUTO (FUTURE)	DI
HSI-4562A	PCEPS PUMP #1 MANUAL OVERRIDE	DI
HSI-4528A	PCEPS PUMP #2 LOCAL HOA IN AUTO	DI
HSI-4529A	PCEPS PUMP #2 IN BYPASS CONTROL	DI
HSI-4530A	PCEPS PUMP #2 VFD HOA IN AUTO	DI
YI-4530B	PCEPS PUMP #2 VFD RUNNING	DI
ZA-4530A	PCEPS PUMP #2 NO FLOW	DI
QA-4531A	PCEPS PUMP #2 VFD GENERAL FAULT	DI
HSI-4564A	PCEPS PUMP #2 MANUAL OVERRIDE	DI
FAL-4530A	PCEPS PUMP #2 LOW SEAL	DI
HSI-4535A	PCEPS PUMP #3 LOCAL HOA IN AUTO	DI
HSI-4536A	PCEPS PUMP #3 IN BYPASS CONTROL	DI
HSI-4537A	PCEPS PUMP #3 VFD HOA IN AUTO	DI
YI-4537B	PCEPS PUMP #3 VFD RUNNING	DI
FAL-4537A	PCEPS PUMP #3 LOW SEAL	DI
ZA-4537A	PCEPS PUMP #3 NO FLOW	DI
QA-4541A	PCEPS PUMP #3 VFD GENERAL FAULT	DI
HSI-4568A	PCEPS PUMP #3 MANUAL OVERRIDE	DI
HSI-4511A	PCEPS PUMP #4 LOCAL HOA IN AUTO	DI
HSI-4512A	PCEPS PUMP #4 IN BYPASS CONTROL	DI
HSI-4513A	PCEPS PUMP #4 VFD HOA IN AUTO	DI

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PAC INPUT OUTPUTS LIST
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91-CP-1 (Formerly DCU-4/RTU-4) PAC I/O LIST (ADDITIVE ALTERNATE #9)

INSTRUMENT TAG	DESCRIPTION	TYPE
YI-4513B	PCEPS PUMP #4 VFD RUNNING	DI
ZA-4513B	PCEPS PUMP #4 NO FLOW	DI
QA-4514A	PCEPS PUMP #4 GENERAL FAULT	DI
HSI-4559A	PCEPS PUMP #4 MANUAL OVERRIDE	DI
FAL-4513A	PCEPS PUMP #4 LOW SEAL	DI
HSI-4507A	PCEPS PUMP #5 IN BYPASS CONTROL	DI
HSI-4508A	PCEPS PUMP #5 VFD HOA IN AUTO	DI
YI-4508B	PCEPS PUMP #5 VFD RUNNING	DI
ZA-4508	PCEPS PUMP #5 NO FLOW	DI
QA-4509A	PCEPS PUMP #5 VFD GENERAL FAULT	DI
HSI-4522A	PCEPS PUMP #5 LOCAL HOA IN AUTO	DI
FAL-4508	PCEPS PUMP #5 LOW SEAL	DI
HSI-4555A	PCEPS PUMP #5 MANUAL OVERRIDE	DI
HSI-4500A	PCEPS PUMP #6 VFD HOA IN AUTO (FUTURE)	DI
HSI-4501A	PCEPS PUMP #6 IN BYPASS CONTROL (FUTURE)	DI
HSI-4502A	PCEPS PUMP #6 LOCAL HOA IN AUTO (FUTURE)	DI
YI-4502B	PCEPS PUMP #6 VFD RUNNING (FUTURE)	DI
ZA-4502A	PCEPS PUMP #6 NO FLOW (FUTURE)	DI
QA-4504A	PCEPS PUMP #6 VFD GENERAL FAULT (FUTURE)	DI
FAL-4502A	PCEPS PUMP #6 LOW SEAL	DI
HSI-4552A	PCEPS PUMP #6 MANUAL OVERRIDE (FUTURE)	DI
VI-4524A	PCEPS PUMP #1 VIBRATION HIGH (FUTURE)	DI
VI-4530A	PCEPS PUMP #2 VIBRATION HIGH	DI
VI-4537A	PCEPS PUMP #3 VIBRATION HIGH	DI
VI-4513A	PCEPS PUMP #4 VIBRATION HIGH	DI
VI-4508A	PCEPS PUMP #5 VIBRATION HIGH	DI
VI-4502A	PCEPS PUMP #6 VIBRATION HIGH (FUTURE)	DI
HSA-4534	PCEPS PUMP #1 E-STOP ACTIVATED (FUTURE)	DI
HSA-4540	PCEPS PUMP #2 E-STOP ACTIVATED	DI
HSA-4547	PCEPS PUMP #3 E-STOP ACTIVATED	DI
HSA-4510	PCEPS PUMP #4 E-STOP ACTIVATED	DI
HSA-4518	PCEPS PUMP #5 E-STOP ACTIVATED	DI
HSA-4512	PCEPS PUMP #6 E-STOP ACTIVATED	DI
LAL-4517	PCEPS WEST WET WELL LOW LEVEL FLOAT	DI
LI-4518A	PCEPS WEST WET WELL LEAD PUMP START FLOAT	DI
LI-4519A	PCEPS WEST WET WELL LEAD-LAG PUMP STOP FLOAT	DI
LI-4520A	PCEPS WEST WET WELL LAG PUMP START FLOAT	DI
LAL-4543	PCEPS EAST WET WELL LOW LEVEL FLOAT	DI
LI-4544A	PCEPS EAST WET WELL LEAD PUMP START FLOAT	DI
LI-4545A	PCEPS EAST WET WELL LEAD -LAG PUMP STOP FLOAT	DI
LI-4546A	PCEPS EAST WET WELL LAG PUMP START FLOAT	DI
LAH-4547	PCEPS WEST WET WELL HIGH FLOAT	DI
LAH-4550	PCEPS EAST WET WELL HIGH FLOAT	DI
MAH-4600	PLANT SEWER PUMP #1 HIGH MOISTURE	DI
TAH-4600	PLANT SEWER PUMP #1 HIGH TEMP	DI
YI-4600A	PLANT SEWER PUMP #1 RUNNING	DI
HSI-4602A	PLANT SEWER PUMP #1 LOCAL HOA IN AUTO	DI
QA-4603A	PLANT SEWER PUMP #1 GENERAL FAULT	DI
HSI-4605A	PLANT SEWER PUMP #2 LOCAL HOA IN AUTO	DI

91-CP-1 (Formerly DCU-4/RTU-4) PAC I/O LIST (ADDITIVE ALTERNATE #9)		
INSTRUMENT TAG	DESCRIPTION	TYPE
HSA-4606	PLANT SEWER PUMP #2 E-STOP ACTIVATED	DI
MAH-4606A	PLANT SEWER PUMP #2 HIGH MOISTURE	DI
TAH-4606A	PLANT SEWER PUMP #2 HIGH TEMP	DI
YI-4606A	PLANT SEWER PUMP #2 RUNNING	DI
QA-4622A	PLANT SEWER PUMP #2 GENERAL FAULT	DI
LAL-4608A	PLANT SEWER PUMP STATION LOW FLOAT	DI
LAH-4609A	PLANT SEWER PUMP STATION HIGH FLOAT	DI
HSI-4610A	FLOW DIVERSION 24" MPV HOA IN AUTO	DI
ZIA-4610	FLOW DIVERSION 24" MPV OPEN POSITION	DI
HSI-4708	SEPTAGE PRESSURE HIGH TORQUE	DI
HYL-4624	48-INCH VALVE OPEN OUTPUT RESET	DI
HIS-4701	SEPTAGE PUMP MOTOR HOA SWITCH IN AUTO	DI
YI-4701	SEPTAGE PUMP MOTOR INDICATION	DI
QY-4702	SEPTAGE PUMP MOTOR RUN FAILURE	DI
	EFFLUENT VALVE OPEN STATUS	DI
HSI-4708	SEPTAGE PRESSURE HOA IN AUTO	DI
YI-4708	SEPTAGE PRESSURE RUN INDICATION	DI
QY4709	SEPTAGE PRESSURE RUN FAILURE	DI
SCP1-LO-OIL-LVL	SCUM PUMP #1 LOW OIL FLOAT	DI
SCP1-MTR-HI-TEMP	SCUM PUMP #1 MOTOR HIGH TEMP	DI
SCP2-LO-OIL-LVL	SCUM PUMP #2 LOW OIL FLOAT	DI
SCP2-MTR-HI-TEMP	SCUM PUMP #2 MOTOR HIGH TEMP	DI
HSA-4305	PRIMARY CLARIFIER #1 E-STOP ACTIVATED	DI
HSA-4300	PRIMARY CLARIFIER #2 E-STOP ACTIVATED	DI
HSA-4405	PRIMARY CLARIFIER #3 E-STOP ACTIVATED	DI
HSA-4400	PRIMARY CLARIFIER #4 E-STOP ACTIVATED	DI
HSA-4318	SCUM PUMP #1 E-STOP ACTIVATED	DI
HSA-4418	SCUM PUMP #2 E-STOP ACTIVATED	DI
HAS-4700	SEPTAGE PUMP MOTOR E-STOP ACTIVATED	DI
HSA-4601	PLANT SEWER PUMP #1 E-STOP ACTIVATED	DI
LAY-4550	PCEPS EAST BASIN FLOAT CONTROL ACTIVE	DI
LAY-4547	PCEPS WEST BASIN FLOAT CONTROL ACTIVE	DI
QIC-4620	48-INCH VALVE NITROGEN OPEN PRESS INDICATION	DI
CT-4323	SLUDGE PUMP #1 REVOLUTION IND	DI
CT-4328	SLUDGE PUMP #2 REVOLUTION IND	DI
CT-4332	SLUDGE PUMP #3 REVOLUTION IND	DI
CT-4423	SLUDGE PUMP #4 REVOLUTION IND	DI
CT-4428	SLUDGE PUMP #5 REVOLUTION IND	DI
CT-4432	SLUDGE PUMP #6 REVOLUTION IND	DI
91-JA-1A	PANEL AC POWER FAIL ALARM	DI
91-JA-1B	24 VDC POWER FAIL ALARM	DI
91-JA-1C	12 VDC POWER FAIL ALARM	DI
91-XS-UPS-1A	UPS FAIL ALARM	DI
91-XS-UPS-1B	UPS LOW BATTERY ALARM	DI
91-TAH-1	PANEL HIGH TEMPERATURE ALARM	DI
HS-4524A	PCEPS PUMP #1 VFD CALL TO START (FUTURE)	DO
HS-4530A	PCEPS PUMP #2 VFD CALL TO START	DO
HS-4537A	PCEPS PUMP #3 VFD CALL TO START	DO

91-CP-1 (Formerly DCU-4/RTU-4) PAC I/O LIST (ADDITIVE ALTERNATE #9)		
INSTRUMENT TAG	DESCRIPTION	TYPE
HS-4513A	PCEPS PUMP #4 VFD CALL TO START	DO
HS-4508A	PCEPS PUMP #5 VFD CALL TO START	DO
HS-4502A	PCEPS PUMP #6 VFD CALL TO START (FUTURE)	DO
HS-4525A	PCEPS PUMP #1 RVSS CALL TO START (FUTURE)	DO
HS-4527A	PCEPS PUMP #2 RVSS CALL TO START	DO
HS-4539A	PCEPS PUMP #3 RVSS CALL TO START	DO
HS-4514A	PCEPS PUMP #4 RVSS CALL TO START	DO
HS-4509A	PCEPS PUMP #5 RVSS CALL TO START	DO
HS-4504A	PCEPS PUMP #6 RVSS CALL TO START (FUTURE)	DO
HS-4701A	SEPTAGE PUMP MOTOR AUTO START	DO
HS-4602A	PLANT SEWER PUMP #1 CALL TO START	DO
	PLANT SEWER PUMP #2 CALL TO START	DO
HS-4038A	SUBMERSIBLE MIXER #1 CALL TO START	DO
HS-4144A	SUBMERSIBLE MIXER #2 CALL TO START	DO
HS-4323A	SLUDGE PUMP #1 CALL TO START	DO
HS-4328A	SLUDGE PUMP #2 CALL TO START	DO
HS-4332A	SLUDGE PUMP #3 CALL TO START	DO
HS-4423A	SLUDGE PUMP #4 CALL TO START	DO
HS-4428A	SLUDGE PUMP #5 CALL TO START	DO
HS-4432A	SLUDGE PUMP #6 CALL TO START	DO
HS-4307A	PRIMARY CLARIFIER #1 CALL TO START	DO
HS-4302A	PRIMARY CLARIFIER #2 CALL TO START	DO
HS-4407A	PRIMARY CLARIFIER #3 CALL TO START	DO
HSI-4402A	PRIMARY CLARIFIER #4 CALL TO START	DO
HS-4314A	SCUM PUMP #1 CALL TO START	DO
HS-4414A	SCUM PUMP #2 CALL TO START	DO
HS-4708A	SEPTAGE PRESS AUTO START	DO
LI-4007	GENERATOR DIESEL TANK LEVEL	AI
FI-4010	ESLAVA CREEK INFLUENT FLOW	AI
SI-4600	PLANT SEWER PUMP #1 SPEED	AI
SI-4606	PLANT SEWER PUMP #2 SPEED	AI
LI-4309A	PRIMARY CLARIFIER #1 DISCHARGE BOX LEVEL	AI
LI-4319	PRIMARY CLARIFIER #2 DISCHARGE BOX LEVEL	AI
LI-4409A	PRIMARY CLARIFIER #3 DISCHARGE BOX LEVEL	AI
LI-4419	PRIMARY CLARIFIER #4 DISCHARGE BOX LEVEL	AI
FI-4325	SLUDGE RETURN FLOW	AI
SI-4323	SLUDGE PUMP #1 SPEED IND	AI
SI-4328	SLUDGE PUMP #2 SPEED IND	AI
SI-4332	SLUDGE PUMP #3 SPEED IND	AI
SI-4423A	SLUDGE PUMP #4 SPEED IND	AI
SI-4428A	SLUDGE PUMP #5 SPEED IND	AI
SI-4432A	SLUDGE PUMP #6 SPEED IND	AI
LI-4311A	SCUM COLLECTION BOX #1 LEVEL	AI
LI-4411A	SCUM COLLECTION BOX #2 LEVEL	AI
LIT-4307	PRIMARY CLARIFIER #1 SLUDGE BLANKET	AI
LIT-4302	PRIMARY CLARIFIER #2 SLUDGE BLANKET	AI
	PRIMARY CLARIFIER #3 SLUDGE BLANKET LEVEL	AI
	PRIMARY CLARIFIER #4 SLUDGE BLANKET LEVEL	AI

91-CP-1 (Formerly DCU-4/RTU-4) PAC I/O LIST (ADDITIVE ALTERNATE #9)

INSTRUMENT TAG	DESCRIPTION	TYPE
SI-4524	PCEPS PUMP #1 VFD SPEED	AI
SI-4530	PCEPS PUMP #2 VFD SPEED	AI
SI-4537	PCEPS PUMP #3 VFD SPEED	AI
SI-4513	PCEPS PUMP #4 VFD SPEED	AI
SI-4508	PCEPS PUMP #5 VFD SPEED	AI
SI-4502	PCEPS PUMP #6 VFD SPEED	AI
LI-4607	PLANT SEWER PUMP STATION LEVEL	AI
FI-4706	SEPTAGE RECEIVING FLOW	AI
FI-4707	SEPTAGE RECEIVING GREASE FLOW	AI
ZI-4610	FLOW DIVERSION 24" MPV POSITION	AI
FIC-4009	VIRGINIA STREET SAMPLER INFLUENT FLOW PACING	AO
SIC-4323	SLUDGE PUMP #1 SPEED COMMAND	AO
SIC-4328	SLUDGE PUMP #2 SPEED COMMAND	AO
SIC-4332	SLUDGE PUMP #3 SPEED COMMAND	AO
FIC-4439	SLUDGE PUMP #4 SPEED COMMAND	AO
FIC-4437	SLUDGE PUMP #5 SPEED COMMAND	AO
FIC-4434	SLUDGE PUMP #6 SPEED COMMAND	AO
SIC-4600	PLANT SEWER PUMP #1 SPEED COMMAND	AO
SIC-4606	PLANT SEWER PUMP #2 SPEED COMMAND	AO
FIC-4503	PCEPS PUMP #1 VFD SPEED COMMAND	AO
FIC-4532	PCEPS PUMP #2 VFD SPEED COMMAND	AO
FIC-4538	PCEPS PUMP #3 VFD SPEED COMMAND	AO
FIC-4516	PCEPS PUMP #4 VFD SPEED COMMAND	AO
FIC-4548	PCEPS PUMP #5 VFD SPEED COMMAND	AO
FIC-4506	PCEPS PUMP #6 VFD SPEED COMMAND	AO
FIC-4010	ESLAVA CREEK SAMPLER INFLUENT FLOW	AO
FIC-4503	PCEPS PUMP #1 VFD SPEED COMMAND	AO
FIC-4532	PCEPS PUMP #2 VFD SPEED COMMAND	AO
FIC-4538	PCEPS PUMP #3 VFD SPEED COMMAND	AO
FIC-4516	PCEPS PUMP #4 VFD SPEED COMMAND	AO
FIC-4548	PCEPS PUMP #5 VFD SPEED COMMAND	AO
FIC-4610	FLOW DIVERSION 24" MPV POS. COMMAND	AO

CONTROL PANEL SCHEDULE				
PANEL TAG #	PANEL DESCRIPTION	NEMA Rating	APPROXIMATE SIZE (H x W x D)	COMMENTS
20-CP-1	Dewatering Building Electrical Room PAC Panel	12	72" x 72" x 24"	Painted gray steel enclosure; Free-standing, 2-door, front access.
50-CP-1	Chlorine/SO2 Building RIO Panel	12	72" x 36" x 24"	Painted gray steel enclosure, Free-standing, single door, front access (Note 1)
82-CP-1	Blower Building PAC Panel	4X	72" x 24" x 24"	316 stainless. steel enclosure, Free-standing, single door, front access; Air Conditioner.
83-CP-1	Final Clarifiers Electrical Building RIO Panel	12	84" x 48"x 24"	Painted gray steel enclosure; Free-standing, 2-door, front access; HMI View Client
83-CP-2	Sidestream (SWAT) Pump Station RIO Panel			Back panel replacement. Remove existing touchscreen and cover hole with steel plate; match existing enclosure color.
85-CP-1	Secondary Digester Building RIO Panel	4X	72" x 36" x 24"	316 stainless steel Enclosure;Free-standing, single door, front access; HMI View Client
91-CP-1	Headworks RIO Panel			Back panel replacement. HMI View Client. (Note 2)

CONTROL PANEL SCHEDULE				
PANEL TAG #	PANEL DESCRIPTION	NEMA Rating	APPROXIMATE SIZE (H x W x D)	COMMENTS
20-LCP-49-1	Truck Fill Panel	4X	24" x 24" x 12"	316 stainless steel Enclosure; Rack stanchion mount, single door, front access; Sun shield over level displays
20-LCP-30-10	Conveyor Gate Control Panel	4X	24" x 24" x 8"	316 stainless steel Enclosure; Wall mount, single door, front access
20-LCP-12-1	Smith Sludge Pump Station Panel	4X	24"x 24"x12"	316 stainless steel enclosure; single door, front access; Sun shield over level display
50-FP-4	Chlorine & SO2 Building CL2/SO2 Alarm Panel	4X	12" x 12" x 8"	316 stainless steel enclosure; single door, front access, wall mount (Note 1)
50-FP-5	Chlorine & SO2 Building CL2/SO2 Leak Alarm Panel	4X	12" x 12" x 8"	316 stainless steel enclosure; single door, front access, wall mount (Note 1)
50-FP-6	Chlorine & SO2 Building CL2 Storage Room Leak Alarm Panel	4X	12" x 12" x 8"	316 stainless steel enclosure; single door, front access, wall mount (Note 1)
50-FP-7	Chlorine & SO2 Building SO2 Storage Room Leak Alarm Panel	4X	12" x 12" x 8"	316 stainless steel enclosure; single door, front access, wall mount (Note 1)
20-FOPP-01	Administration Building SCADA Fiber Optic Patch Panel	3S	11"x13.5"x5.5"	Wall-mount in Dewatering Building 1st Floor Electrical Room
20-FOPP-02	Administration Building Security Fiber Optic Patch Panel	3S	11"x13.5"x5.5"	Wall-mount in Dewatering Building 1st Floor Electrical Room

CONTROL PANEL SCHEDULE				
PANEL TAG #	PANEL DESCRIPTION	NEMA Rating	APPROXIMATE SIZE (H x W x D)	COMMENTS
20-FOPP-03	Administration Building MAWSS Business Network Fiber Optic Patch Panel	3S	11"x13.5"x5.5"	Wall-mount in Dewatering Building 1st Floor Electrical Room
91-FOPP-01	Headworks Electrical Building SCADA Fiber Optic Patch Panel	3S	11"x13.5"x5.5"	Wall-mount in Headworks Electrical Room
94-FOPP-01	Maintenance Building SCADA Fiber Optic Patch Panel	3S	16"x20"x6"	Wall-mount in Maintenance Building for use by MAWSS IT. Enclosure shall be model ICH-06P.
FOPP-02	Pole No. 1 Security Fiber Optic Patch Panel	4X	12.5"x10.5"x6.25"	Pole mount on opposite side of Security Panel.
FOPP-03	Maintenance Building Security Fiber Optic Patch Panel	12	7.5"x16.1"x4.5"	Wall-mount adjacent to Security Panel.
FOPP-04	Headworks MCC Building Security Fiber Optic Patch Panel	12	7.5"x16.1"x4.5"	Wall-mount adjacent to Security Panel.
FOPP-05	Pole No. 2 Security Fiber Optic Patch Panel	4X	12.5"x10.5"x6.25"	Pole mount on opposite side of Security Panel.
FOPP-06	Pole No. 3 Security Fiber Optic Patch Panel	4X	12.5"x10.5"x6.25"	Pole mount on opposite side of Security Panel.
FOPP-07	Pole No. 4 Security Fiber Optic Patch Panel	4X	12.5"x10.5"x6.25"	Pole mount on opposite side of Security Panel.
FOPP-08	Pole No. 5 Security Fiber Optic Patch Panel	4X	12.5"x10.5"x6.25"	Pole mount on opposite side of Security Panel.
FOPP-10	Pole No. 7 Security Fiber Optic Patch Panel	4X	12.5"x10.5"x6.25"	Pole mount on opposite side of Security Panel.
FOPP-11	Pole No. 8 Security Fiber Optic Patch Panel	4X	12.5"x10.5"x6.25"	Pole mount on opposite side of Security Panel.
FOPP-12	Generator/Electrical Building Security Fiber Optic Patch Panel	12	7.5"x16.1"x4.5"	Wall-mount adjacent to Security Panel.

CONTROL PANEL SCHEDULE				
PANEL TAG #	PANEL DESCRIPTION	NEMA Rating	APPROXIMATE SIZE (H x W x D)	COMMENTS
FOPP-13	Pole No. 9 Security Fiber Optic Patch Panel	4X	12.5"x10.5"x6.25"	Pole mount on opposite side of Security Panel.
FOPP-14	Chlorine/SO2 Building Security Fiber Optic Patch Panel	12	7.5"x16.1"x4.5"	Wall-mount adjacent to Security Panel. (Note 1)
FOPP-15	Pole No. 10 Security Fiber Optic Patch Panel	4X	12.5"x10.5"x6.25"	Pole mount on opposite side of Security Panel. (Note 1)
FOPP-16	Pole No. 11 Security Fiber Optic Patch Panel	4X	12.5"x10.5"x6.25"	Pole mount on opposite side of Security Panel.
FOPP-17	Pole No. 12 Security Fiber Optic Patch Panel	4X	12.5"x10.5"x6.25"	Pole mount on opposite side of Security Panel.
FOPP-18	Blower Building Security Fiber Optic Patch Panel	12	7.5"x16.1"x4.5"	Wall-mount adjacent to Security Panel.

Notes:

1. Provide only if Additive Alternate #1 is selected and included in contract.
2. Provide only if Additive Alternate #9 is selected and included in contract.
3. FOPP-01, -09 tag numbers are not used.

Control System Interfaces

February 2020

Mobile Area Water & Sewer System (MAWSS)



Document History and Status

Revision	Date	Author	Reason for Change
0	2/26/2020	Nick Freeman/Jacobs	

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Acronyms and Abbreviations

A/M	Auto/Manual
ATS	automatic transfer switch
HMI	human-machine interface
kV	kilovolt
kW	kilowatt
LOR	Local-Off-Remote
MAWSS	Mobile Area Water & Sewer System
PAC	programmable automation controller
RMS	root mean square
SCADA	supervisory control and data acquisition
VFD	variable-frequency drive

Control System Interfaces

1.1 General

This document provides general process control philosophy. Descriptive control narratives for selected process control areas will be provided as part of a future task. In general:

- All logic functions, where practical, will be performed in the programmable automation controller (PAC) and not in the human-machine interface (HMI).
- Equipment in local control will not have PAC logic associated with it.
- Equipment in Remote/Manual control will not have logic interlocks from the PAC or HMI unless otherwise noted.
- Equipment with only local controls and no status feedback will not be displayed on the HMI.

1.2 Control Hierarchy

Two primary levels of operational control exist for all equipment and systems: Local and Remote. In general, a Local-Off-Remote field switch will be provided at each piece of equipment and a software Manual-Auto switch will be provided for selected equipment.

To ensure compatibility and consistency of designs, the following definitions will be used for both hardwired control stations and software control station control switch nameplates:

- LOCAL - Control is performed local to the device.
- REMOTE - Control is performed remote from local equipment. Control is performed by the PAC.

1.2.1 Field Local-Off-Remote Switch (LOR)

- LOCAL - This is a manual hand switch position. In LOCAL there is LOCAL-MANUAL mode where the final control element or device will change state to "Run" or "On" or LOCAL-AUTO where automatic control of the system is done locally (such as automatically backwashing a screen based on the differential level in the channel).
- OFF - This is a manual hand switch position. When this position is selected, the final control element or device will change state to "Off."
- REMOTE (manual hand switch) - This is a manual hand switch position that is wired as an input to the PAC. When this position is selected, the final control element or device is controlled by the main plant PAC system.

1.2.2 HMI Software Auto/Manual Switch (A/M)

- AUTO (software switch) - This is a software-provided hand switch position. This software switch is only active when the hardware hand switch has already been selected to the REMOTE position. When the hardware switch is in REMOTE and the software switch is in AUTO, the main plant PAC will automatically control the output functions.
- MANUAL (software switch) - This is a software-provided hand switch position. This software switch is only active when the hardware hand switch has already been placed in the REMOTE position. When the hardware switch is in REMOTE and the software switch is in MANUAL, the output will be manually controlled by the operator to either the ON output state or the OFF output state.
- ON (software switch) - This is a software-provided hand switch position. This software switch is only active when the Field switch is in REMOTE and the software switch is in MANUAL. When the ON switch is selected, the output from the PAC to the device will be energized.
- OFF (software switch) - This is a software-provided hand switch position. This software switch is only active when the field switch is in REMOTE and the software switch is in MANUAL. When the OFF switch is selected, the output from the PAC to the device will be de-energized.

1.3 Hardwired Control and Interlocks

1.3.1 Equipment Protection and Safety

For new equipment or for cases where existing equipment is being retrofitted, the contractor will review the existing electrical interlocks and modify, if required, to provide hardwired interlocks for personnel safety, electrical protection, and compliance with applicable codes. Hardwired interlock(s) will be wired directly into the individual equipment controller or starter, and not rely on the plant control system. It is intended that all other process-related interlocks be provided in the main plant PAC. There will be no duplication of hardwired interlocks in the PAC.

1.3.2 Local Manual Control

All new equipment will be provided with local manual control that overrides the plant control system interlocks in the PAC, but maintains the hardwired interlocks. It is intended this is used primarily for maintenance functions and not for normal operation of the process; however, local control may be used in emergency operations.

1.3.3 Automatic Control

It is intended that all automatic control and equipment sequencing be accomplished through the plant PACs. It is intended that all equipment sequencing for motor restart after a power outage be programmed into the PAC. Hardwired time delay relays in individual starters are not required, except as individually specified or required based on safety or equipment protection.

1.4 Redundancy and Reliability

In general, new instrumentation and control system components will be designed so that no single component failure can result in disruption of normal operation for more than 4 hours, or a loss of remote monitoring/control capability for more than 4 hours. The 4-hour criterion includes time for the City of Mobile to receive notification of the failure via telemetry, dispatch an appropriate maintenance technician, and, if necessary, obtain spare parts from inventory and replace defective components causing the failure, or make adjustments necessary to restore normal operation. In particular, new PAC rack, components, layout, and recommended spare parts will support these criteria.

For important systems and/or processes, redundant PACs shall be provided. Also, for plant critical operations (such as high-service pump pressure control), redundant instrumentation shall be provided.

1.5 Monitoring and Control of Pumps/Motors

1.5.1 Constant-Speed Motors/Pumps/General Equipment

Table 1 lists the PAC actions associated with constant-speed motors or pumps and other constant-speed general equipment.

Table 1. Interface Requirements for Constant Speed Motors/Pumps/General Equipment

Item	Type	PAC Action
Run Command	Hardwired Discrete Output from PAC	When the equipment is in REMOTE and not running, the equipment will be given a Start Command.
Running Status	Hardwired Discrete Input to PAC	Monitor the status of the motor starter.
Remote Status	Hardwired Discrete Input to PAC	Monitor the position of the device handswitch is in the REMOTE position. When the device is not in REMOTE, the PAC has no control of the device.
Fault Alarm	Hardwired Discrete Input to PAC	Monitor the fault status of the starter and, if in REMOTE and being commanded to run, remove the run command.
Discrete Alarm(s) (Interlock)	Hardwired Discrete Input to PAC	Monitor and alarm interlocks that shut down the equipment

Table 1. Interface Requirements for Constant Speed Motors/Pumps/General Equipment

Item	Type	PAC Action
Fail Reset (refer to Note 1)	Software Reset in PAC	When the equipment fails because of an alarm condition (Fail to Start or Fail to Stop), the Fail Reset must be used to clear the alarm and re-enable the equipment for use. Each device will have an independent Fail Reset. Certain other shutdown alarms will be latched in the PAC if it is possible that the alarm can self-clear prior to generating an alarm in the HMI. These alarms will also require the Fail Reset to clear the alarm.

Notes:

1. Remote reset to equipment starters is not standard. Discuss exceptions with MAWSS.

1.5.2 Variable-Speed Motors/Pumps/General Equipment

Variable-speed drives will be connected to the plant control system via hardwired signals and via Ethernet/IP. For Ethernet/IP connections inside of the building, the connection shall be via copper (category 6 cable). For network connections that extend outside of the building, the connection shall be via fiberoptic (multimode 50/125 micrometers).

Table 2 lists PAC actions associated with variable-speed motors or pumps and other variable-speed general equipment.

Table 2. Interface Requirements for Variable-Speed Motors/Pumps/General Equipment

Item	Type	PAC Action
Run Command	Discrete output from PAC	When the equipment is in Remote and not running, the equipment will be given a Start command.
Running Status	Discrete Input to PAC	Monitor the status of the motor starter.
Remote Status	Discrete Input to PAC	Monitor the position of the device handswitch is in the REMOTE position. When the device is not in REMOTE, the PAC has no control of the device.
Fault Alarm	Discrete input to PAC	Monitor the fault status of the variable-frequency drive (VFD) and, if in remote and being commanded to run, remove the run command.
Speed Feedback	Analog Input to PAC	Monitor the speed of the pump (0–100%).
Speed Command	Analog Output to PAC	Command the speed of the pump (0–100%).
Current	Software Read by PAC	Monitor the current drawn by the VFD and generate a high high current alarm (as needed based on the size of the pump).
Motor or Pump Vibration (if available)	Software Read by PAC	Monitor the vibration and generate high high alarms.
Motor Stator Temp 1, 2, 3	Software Read by PAC	Monitor the motor stator temperature and generate high high temperature alarms.
Discrete Alarm(s) (Interlock)	Software Read by PAC or Hardwired Discrete Input to PAC (Note 1)	Monitor and alarm interlocks that shut down the equipment.
Fail Reset	Software Reset in PAC or Software Write from PAC (Note 2)	When the equipment fails because of an alarm condition (Fail to Start or Fail to Stop), the Fail Reset must be used to clear the alarm and re-enable the equipment for use. Each device will have an independent Fail Reset. Certain other shutdown alarms will be latched in the PAC if it is possible that the alarm can self-clear prior to generating an alarm in the HMI. These alarms will also require the Fail Reset to clear the alarm.

Notes:

1. Any alarm(s) that shut down the VFDs that are not available over Ethernet/IP shall be hardwired discrete inputs to the Plant Control System.

2. Remote reset to VFDs for critical equipment is not standard. Discuss possible exceptions with MAWSS.

For VFDs that cannot be connected to the Ethernet/IP network, speed control and speed feedback shall be via analog (4-20 milliampere) signals and discrete monitoring and control shall be via discrete signals.

1.6 Monitoring and Control of Valve Actuators

1.6.1 Open/Close Type Motorized Valves Interface

Table 3 lists PAC actions associated with motorized valves interface that are the open/close type.

Table 3. Interface Requirements for Open/Close Type Motorized Valves Interface

Item	Type	PAC Action
Open Command	Hardwired Discrete Output from PAC	Issue a maintained Open command until the open limit is reached. On absence of Open command, the valve will close.
Close Command	Hardwired Discrete Output from PAC	Issue and hold a Close command until the closed limit is reached. On absence of Close command, the valve will stop and become Failed.
Opened Status	Hardwired Discrete Input to PAC	Monitor the position of the valve open limit switch.
Closed Status	Hardwired Discrete Input to PAC	Monitor the position of the valve close limit switch.
Torque Alarm	Hardwired Discrete Input to PAC	Monitor and alarm valve torque alarm.
Remote Status	Hardwired Discrete Input to PAC	Monitor the position of the device handswitch in the REMOTE position. When the device is not in REMOTE, the PAC has no control of the device.

1.6.2 Modulating Type Motorized Valves Interface

Table 4 lists PAC actions associated with motorized valve interface that are the modulating type.

Table 4. Interface Requirements for Modulating Type Motorized Valve Interface

Item	Type	PAC Action
Position Command	Hardwired Analog Output from PAC	Issue a maintained analog output command 0–100%.
Position Feedback	Hardwired Analog Input to PAC	Monitor the position of the valve.
Remote Status	Hardwired Discrete Input to PAC	Monitor the position of the device handswitch in the REMOTE position. When the device is not in REMOTE, the PAC has no control of the device.

1.7 Monitoring of Ancillary Equipment

The PAC will monitor alarms from all ancillary systems, such as fire alarms systems, leak detection systems, and others.

Auxiliary, isolated, 120-VAC or 24-VDC, and 5-amp contacts will be provided from these systems for interface to the plant control system PAC system.

1.8 Monitoring of Electrical Systems

Specific monitoring of electrical power signals will be addressed on a project-by-project basis in each scope of work.

In general, for new designs where electronic power monitoring equipment is provided, the PAC will provide direct communication to the power system electronic power monitoring device via Ethernet/IP. All software and interface hardware to allow communication between the PAC and the power system

monitoring device will be provided, as required. As a minimum, the following functions are required to be monitored through the PAC from each power monitoring device:

- Root mean square (RMS) value of individual phase currents (3)
- RMS value of individual three phase voltage, L-L (3)
- Power factor
- Kilowatt (kW)/kilovolt (kV) ampere meters
- kW-hour meter

For new design cases where a power monitoring electronic device is not selected in the design, provide hardwired signal monitoring for voltage, kW, and amperage.

For new designs with emergency generators and automatic transfer switch (ATS), provide the following:

- Emergency generator voltage
- Emergency generator amperage
- Emergency generator kW
- Emergency generator power factor
- Diesel tank level
- ATS utility power available
- ATS in utility position
- ATS generator power available
- ATS in generator position

1.9 Interface Requirements with Security Systems

Specific monitoring of security system signals will be addressed on a project-by-project basis in each scope of work.

In general, monitoring and control of security systems will be via self-contained systems separate from the supervisory control and data acquisition (SCADA) system over a separate network interface than the SCADA system because of cybersecurity concerns and bandwidth concerns with cameras.

Security control, such as gate control and arm/disarm control, may be considered for remote sites where remote operations may want gate control to provide access for external vendors and to arm/disarm the site so that there are not nuisance security alarms while maintenance workers are onsite.

1.10 Interface with Equipment Package Control Systems

1.10.1 Packaged Systems without PACs

For equipment package systems without PACs, data exchange between the plant control system and the equipment package system will be via hardwired signals.

Specific monitoring and control of package system signals should be addressed on a project-by-project basis in each scope of work.

Table 5 provides general interface requirements for package systems without PACs.

Table 5. Interface Requirements for Equipment Package Control Systems Without PACs

MAWSS Control System Interfaces

Item	Type	PAC Action
For Systems where the Plant Control System cannot control the System: Local-Automatic Status	Hardwired Discrete Input to PAC	Monitor the Local-Automatic (versus Local-Manual) status of the system.
For Systems where the Plant Control System can control the System: Remote Status (system or per piece of equipment)	Hardwired Discrete Input to PAC	Monitor the remote status of the system or individual equipment.
Running Status (system or per piece of equipment)	Hardwired Discrete Input to PAC	Monitor the running status of the system or individual equipment.
Fault Status (system or per piece of equipment)	Hardwired Discrete Input to PAC	Monitor the fault status of the system or individual equipment.
For Systems where the Plant Control System can control the System: Run command (system or per piece of equipment)	Hardwired Discrete Output from PAC	When the system or individual equipment is in REMOTE and not running, the equipment will be given a Start command.
Fault Reset	Hardwired Discrete Output to PAC	Provide in cases where a remote reset is required.
Discrete Input (s)	Hardwired Discrete(s) Input to PAC	Monitor additional status signals as needed to provide additional system information such as opened status, closed status.
Discrete Output (s)	Hardwired Discrete(s) Output to PAC	Provide in cases where additional discrete control is required. Examples include Open command and Close command.
Analog Input (s)	Hardwired Analog Input(s) to PAC	Monitor additional analog status signals to provide additional information, such as speed feedback or position feedback.
Analog Output (s)	Hardwired Analog(s) Output to PAC	Provide in cases where additional analog control is required. Examples include speed command and position command.

1.10.2 Packaged Systems with PACs

For equipment package systems with PACs, data exchange between the plant control system and the equipment package system will either be via hardwired signals or Ethernet/IP network connection. Determination of a hardwired interface or Ethernet/IP network interface will be based on size of the package system, location of the package system, and the amount of data to be exchanged. In the case where an Ethernet/IP network connection is used, all control signals and associated feedback signals shall be hardwired.

Specific monitoring and control of package system signals will be addressed on a project-by-project basis in each scope of work.

As a minimum, the data in the Table 5 shall be exchanged.

SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This section gives general requirements for instrumentation and control components. The following subsections expand on requirements of this section:
 - 1. Section 40 91 00, Supplement 1, SCADA Hardware Standard Specifications.
 - 2. Section 40 94 13, Supplement 2, OT Network Component Specifications.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Hardware Standards Update Submittal. Provide updates to the MAWSS Hardware Standards document in Microsoft Word format with tracked changes. Include all modifications/additions made during the submittal review/approval process, through RFIs, or via field changes.

PART 2 PRODUCTS

2.01 GENERAL

- A. Article Mechanical Systems Components covers requirements of mechanical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

- B. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.
- C. All other Part 2 articles cover components that are referenced by Instrument Lists or Data Sheets in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.
- D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 MECHANICAL SYSTEMS COMPONENTS

- A. Flow Element, Rotameter, Purge:
 - 1. For air or water service, unless otherwise noted.
 - 2. Materials: Glass tube, fiberglass body, stainless steel float, nylon ball check valve.
 - 3. Direct-Reading Scale Length: 2-1/2 inches, minimum.
 - 4. Scale Ranges: 0 scfh to 2.5 scfh for air service or 0 gph to 10 gph for water service.
 - 5. Integral inlet needle valves.
 - 6. Integral differential pressure regulators:
 - a. For water service.
 - b. For air service for level ranges greater than 10 feet of water.
 - 7. Rotameters for water service.
 - 8. Manufacturers and Products:
 - a. Fischer & Porter; Series 10A3130.
 - b. Brooks; Series DS-1350.
- B. Manifold, Three-Valve Equalizing:
 - 1. Type: For isolation and equalization of differential pressure transducers.
 - 2. Materials: Stainless steel.
 - 3. Manufacturers and Products:
 - a. Anderson, Greenwood and Co.; Type M1.
 - b. Evans.

C. Pressure Gauge: For other than process variable measurement.

1. Dial Size: Nominal 2-inch dial size.
2. Accuracy: 2 percent of span.
3. Scale Range: Such that normal operating pressure lies between 50 percent and 80 percent of scale range.
4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
5. Manufacturers and Products:
 - a. Ashcroft Utility; Gauge Series 1000.
 - b. Marsh; Standard Gauge Series.
 - c. Ametek U.S.; Gauge Series P500.
 - d. Acculite; Series 2000.

D. Valve, Needle:

1. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
2. Size: 0.020-inch orifice.
3. Manufacturers and Products:
 - a. Whitey; Model 21RF2.
 - b. Hoke; 3700 Series.

E. ON/OFF Valves:

1. Type: Ball valve.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
 - a. Whitey; Series 41 through Series 43.
 - b. Hoke; Flomite 7100 Series.

F. Regulating Valves:

1. Type: Needle valves, with regulating stems and screwed bonnets.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
 - a. Whitey; Catalog No. RF or No. RS.
 - b. Hoke; 3100 through 3300 Series.

G. Valve, Three-Way:

1. Type: Ball valve.
2. Materials: Brass or stainless steel with nylon handle as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
 - a. Whitey; Series 41 through Series 43.
 - b. Hoke; Selecto-Mite Series.

H. Valve, Four-Way:

1. Type: Four-way, two-position ball valve.
2. Materials:
 - a. Body and Stem: Type 316 stainless steel.
 - b. Handle: Black nylon.
 - c. Packing Gland: Teflon.
3. Ball and stem bed, one-piece assembly.
4. Machined handle stops and directional nameplates.
5. Manufacturers and Products:
 - a. Whitey; Series 457.
 - b. Hoke; Multi-Mite Series.

I. Solenoid Valve, Two-Way:

1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
2. Materials:
 - a. Body: Brass or stainless-steel globe valves as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
 - b. Valve Seat: Buna-N.
3. Size: Normally closed or opened, as noted.
4. Coil: 115V ac, unless noted otherwise.
5. Solenoid Enclosure: NEMA 4.
6. Manufacturer and Product: ASCO; Red Hat Series 8260.

J. Pressure Regulator, Air:

1. Provide air at reduced pressures, as shown, constant to within plus or minus 10 percent for flows from 0 scfh to 300 scfh with 100 psi supply pressure.
2. Setscrew for outlet pressure adjustment.

3. Integral filter and relief valve.
4. Manufacturers and Products:
 - a. Masoneilan; Series 77-4.
 - b. Fisher; Series 67FR.

K. Pressure Regulator, Water:

1. Materials:
 - a. Body: Bronze.
 - b. Spring Case: Cast iron.
 - c. Seat Rings: Brass.
 - d. Valve Disk and Holder: Buna-N and bronze.
 - e. Diaphragm: Buna-N diaphragm.
2. Sizing: For maximum of 7 psi offset pressure.
3. Manufacturers and Products:
 - a. Fisher; Controls Type 95H or 95L.
 - b. Masoneilan; Series 17.

L. Test Tap:

1. Manufacturers and Products:
 - a. Imperial-Eastman; quick-disconnect couplings No. 292-P and caps No. 259-P.
 - b. Crawford Fitting Co.; Swagelok quick-connects Series QC4 and caps QC4-DC.
 - c. Parker; CPI Series precision quick couplings.

M. Copper Tubing and Fittings:

1. Type K hard copper, ASTM B88, with commercially pure wrought copper solder joint fittings. Make joints with 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
2. Alternatively, Type K, soft temper copper tubing, ASTM B88, with brass compression type fittings may be used where shown on Drawings.
3. Manufacturers:
 - a. Parker-Hannifin.
 - b. Swagelok tube fittings.

N. Plastic Tubing and Fittings:

1. Tubing:
 - a. Polyethylene capable of withstanding 190 psig at 175 degrees F.
 - b. Manufacturers and Products:
 - 1) Dekoron; Type P.
 - 2) Imperial Eastman; Poly-Flo black instrument tubing.

- 2. Fittings:
 - a. Type: Brass compression.
 - b. Manufacturers and Products:
 - 1) Imperial Eastman; Poly-Flo tube fittings.
 - 2) Dekoron; E-Z fittings.
- O. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on Drawings.
- P. Stainless Steel Fittings:
 - 1. Compression Type:
 - a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, flareless.
 - b. Manufacturers and Products:
 - 1) Parker Flodar; BA Series.
 - 2) Swagelok tube fittings.
 - 3) Parker CPI tube fittings; Parker A-LOK dual ferrule tube fittings.
 - 2. Socket Weld Type:
 - a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, 3,000 psi maximum working pressure, safety factor 4:1.
 - b. Manufacturers:
 - 1) Cajon.
 - 2) Swagelok.
 - 3) Parker WELDLOK.
- Q. Air Set: Consists of a shutoff valve, pressure regulator, discharge pressure gauge, and interconnecting tubing.
- R. Purge Set:
 - 1. Parts: Purge rotameter flow element, pressure regulator, pressure gauge, test tap, shutoff valve, spool valve, and interconnecting tubing as shown on Drawings and as required in this section.
 - 2. Pressure Gauge Scale Range: 150 percent of the process variable.
 - 3. Mounting:
 - a. Within consoles, panels, or a separate enclosure as shown.
 - b. For separate enclosure mounted purge sets, refer to paragraphs Nonfreestanding Panel Construction and Factory Finishing for enclosure requirements.

S. Tubing Raceways:

1. Cable tray systems complete with tees, elbows, reducers, and covers.
2. Size in accordance with manufacturer's recommendations for intended service.
3. Materials: Galvanized steel or aluminum brass as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
4. Manufacturers:
 - a. Globetray.
 - b. Cope.

T. Air Supply Sets:

1. Parts: Integrally Mounted:
 - a. Pressure Controls: Automatic START/STOP, factory set at 30 psig to 50 psig.
 - b. Valves: Manual drain, manual shutoff, pressure relief, and check valve.
 - c. Pressure gauge.
 - d. Inlet filter muffler.
 - e. Power: 120V ac.
 - f. Compressor: Oilless, single cylinder, rated for at least 1 scfm at 50 psig.
 - g. Manufacturers and Products:
 - 1) ITT Pneumotive; GH Series.
 - 2) Gast.
2. Simplex Air Supply Sets:
 - a. Air Receiver: 2 gallons.
 - b. Compressors: One.
3. Duplex Air Supply Sets:
 - a. Air Receiver: 20 gallons.
 - b. Compressors: Two.
 - c. Automatic Failover Control: Factory set at 20 psig.

2.03 ELECTRICAL COMPONENTS

A. Terminal Blocks for Enclosures:

1. General:
 - a. Connection Type: Screw compression clamp.
 - b. Compression Clamp:
 - 1) Complies with DIN-VDE 0611.

- 2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
 - 3) Guides strands of wire into terminal.
 - c. Screws: Hardened steel, captive, and self-locking.
 - d. Current Bar: Copper or treated brass.
 - e. Insulation:
 - 1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
 - 2) Two funneled shaped inputs to facilitate wire entry.
 - f. Mounting:
 - 1) Standard DIN rail.
 - 2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - 3) End Stops: Minimum of one at each end of rail.
 - g. Wire Preparation: Stripping only permitted.
 - h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
 - i. Marking System:
 - 1) Terminal number shown on both sides of terminal block.
 - 2) Allow use of preprinted and field marked tags.
 - 3) Terminal strip numbers shown on end stops.
 - 4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
 - 5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
2. Terminal Block, General Purpose:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 30 amp.
 - c. Wire Size: 24 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Gray body.
 - f. Spacing: 0.25 inch, maximum.
 - g. Test Sockets: One screw test socket 0.079-inch diameter.
 - h. Manufacturer and Product: Entrelec; Type M4/6.T.
3. Terminal Block, Ground:
 - a. Wire Size: 24 AWG to 10 AWG.
 - b. Rated Wire Size: 10 AWG.
 - c. Color: Green and yellow body.
 - d. Spacing: 0.25 inch, maximum.
 - e. Grounding: Electrically grounded to mounting rail.
 - f. Manufacturer and Product: Entrelec; Type M4/6.P.

4. Terminal Block, Blade Disconnect Switch:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 10 amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Gray body, orange switch.
 - f. Spacing: 0.25 inch, maximum.
 - g. Manufacturer and Product: Entrelec; Type M4/6.SNT.
5. Terminal Block Diode:
 - a. Rated Voltage: 24V dc.
 - b. Rated Current: 30 ma.
 - c. Wire Size: 16 AWG.
 - d. Manufacturer and Product: Phoenix Contact ST-IN.
6. Terminal Block, Fused, 24V dc:
 - a. Rated Voltage: 600V dc.
 - b. Rated Current: 25 amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Gray body.
 - f. Fuse: 0.25 inch by 1.25 inches.
 - g. Indication: LED diode 24V dc.
 - h. Spacing: 0.512 inch, maximum.
 - i. Manufacturer and Product: Entrelec; Type ML10/13.SFD.
7. Terminal Block, Fused, 120V ac:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 25 amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Gray body.
 - f. Fuse: 0.25 inch by 1.25 inches.
 - g. Indication: Neon lamp, 110V ac.
 - h. Leakage Current: 1.8 mA, maximum.
 - i. Spacing: 0.512 inch, maximum.
 - j. Manufacturer and Product: Entrelec; Type ML10/13.SFL.
8. Terminal Block, Fused, 120V ac, High Current:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 35 amps.
 - c. Wire Size: 18 AWG to 8 AWG.
 - d. Rated Wire Size: 8 AWG.
 - e. Color: Gray.
 - f. Fuse: 13/32 inch by 1.5 inches.
 - g. Spacing: 0.95 inch, maximum.
9. Manufacturer and Product: Entrelec; Type MB10/24.SF.

B. Relays:

1. General:
 - a. Relay Mounting: Plug-in type socket.
 - b. Relay Enclosure: Furnish dust cover.
 - c. Socket Type: Screw terminal interface with wiring.
 - d. Socket Mounting: Rail.
 - e. Provide holddown clips.
2. Signal Switching Relay:
 - a. Type: Dry circuit.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 5 amps at 28V dc or 120V ac.
 - d. Contact Material: Gold or silver.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 0.9 watt (dc), 1.2VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Seal Type: Hermetically sealed case.
 - k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA.
3. Control Circuit Switching Relay, Nonlatching:
 - a. Type: Compact general purpose plug-in.
 - b. Contact Arrangement: 3 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 120V ac, and 6.6A at 240V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Push-to-test button.
 - k. Manufacturer and Product: Potter and Brumfield; Series KUP.
4. Control Circuit Switching Relay, Latching:
 - a. Type: Dual coil mechanical latching relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 120V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
 - g. Expected Mechanical Life: 500,000 operations.
 - h. Expected Electrical Life at Rated Load: 50,000 operations.
 - i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.

5. Control Circuit Switching Relay, Time Delay:
 - a. Type: Adjustable time delay relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 30V dc or 277V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
 - g. Repeatability: Plus or minus 2 percent.
 - h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
 - i. Time Delay Setpoint: As noted or shown.
 - j. Mode of Operation: As noted or shown.
 - k. Adjustment Type: Integral potentiometer with knob external to dust cover.
 - l. Manufacturer and Products: Potter and Brumfield; Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges.

C. Surge Suppressors:

1. General:
 - a. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
 - b. Response: 5 nanoseconds maximum.
 - c. Recovery: Automatic.
 - d. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
 - e. Enclosure Mounted: Encapsulated inflame retardant epoxy.
2. Suppressors on 120V ac Power Supply Connections:
 - a. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
 - b. First-Stage Clamping Voltage: 350 volts or less.
 - c. Second-Stage Clamping Voltage: 210 volts or less.
 - d. Power Supplies for Continuous Operation:
 - 1) Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
 - 2) All Other Applications: Minimum 30 amps at 130V ac.
3. Suppressors on Analog Signal Lines:
 - a. Test Waveform: Linear 8-microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.

- b. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
 - 1) dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
 - 2) dc Clamping Voltage Tolerance: Plus or minus 10 percent.
 - 3) Maximum Loop Resistance: 18 ohms per conductor.
- 4. Manufacturers and Products:
 - a. Type SS1. 120V ac Lines: Emerson Edco HSP-121 or Phoenix Contact 2907918.
 - b. Type SS2. Analog Signals Lines: Emerson Edco PC-642 or Phoenix Contact 2838228 (plug) with 2839224 (base).
 - c. Type SS3. Field Mounted at Two-Wire Instruments:
 - 1) Encapsulated in stainless steel pipe nipples.
 - 2) Emerson Edco SS64 series or Phoenix Contact PipeTrab series.
 - d. Type SS4. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
 - 1) Enclosure:
 - a) NEMA 4X with door. Type 316 stainless steel if noted.
 - b) Maximum Size: 12 inches by 12 inches by 8 inches deep.
 - 2) Emerson Edco; SLAC series or Phoenix Contact BoxTrab series.

D. Power Supplies:

- 1. Furnish as required to power instruments requiring external dc power, including two-wire transmitters and dc relays. Provide dual power supplies with diode auctioneered outputs for all PAC and RIO panels and other control panels if noted.
- 2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
- 3. Provide output over voltage and over current protective devices to:
 - a. Protect instruments from damage due to power supply failure.
 - b. Protect power supply from damage due to external failure.
- 4. Enclosures: NEMA 1.
- 5. Mount such that dissipated heat does not adversely affect other components.
- 6. Fuses: For each dc supply line to each individual two-wire transmitter.
 - a. Type: Indicating.
 - b. Mount so fuses can be easily seen and replaced.

E. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
 - a. Manufacturer and Product: MTL, Inc.; Series MTL 5000 or approved equal.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
 - a. Manufacturer and Product: MTL, Inc.; Series MTL 5000 or approved equal.

2.04 I&C COMPONENTS

A. A18 Chlorine Leak Detector:

1. General:
 - a. Function: Continuously monitor ambient air for chlorine gas.
 - b. Sensor Type: Electrochemical gas diffusion.
 - c. Parts: Sensor/transmitter(s); receiver/controller, automatic test generator (if noted), calibration kit, and ancillaries.
2. Performance:
 - a. Range: 0 ppm to 10 ppm, unless otherwise noted.
 - b. Temperature, Operating: 0 degrees F to 105 degrees F.
 - c. Humidity, Operating: 0 percent to 99 percent relative humidity, noncondensing.
3. Sensor (or Integral Sensor/Transmitter):
 - a. Number of Sensor(s): Three, unless otherwise noted.
 - b. Gas Monitored: Chlorine gas.
 - c. Sensor Type: Electrochemical gas diffusion.
 - d. Mounting: Wall.
4. Controller:
 - a. Number of Channels/Receivers: Minimum of three, unless otherwise noted.
 - b. LCD or LED Display.
 - c. Audible Alarm: Integral weatherproof horn with Silence pushbutton, 95 dB.
 - d. Beacon strobe light: Integral top mount, color red.
 - e. Enclosure:
 - 1) Rating: NEMA 4X.
 - 2) Mounting: Wall.
5. Power:
 - a. Controller: 85-255V ac, 50/60 Hz, unless otherwise noted.
 - b. Backup Battery:
 - 1) Required.
 - 2) 12V dc, 4-amp hour battery to maintain operation up to 12 hours to a single point unit.

- c. Signal Interfaces, Controller:
 - 1) Analog Output:
 - a) If noted.
 - b) 4 mA to 20 mA dc analog output capable of driving 600 ohms at 24V dc; one per channel.
 - 2) Discrete outputs.
 - a) SPDT relays rated for 230V ac at 5 amps resistive.
 - b) Three alarm relays, plus one common fault.
 - c) Relays shall be programmed as fail-safe.
- 6. Cables: Provide cabling of required length between sensor/transmitter and controller.
- 7. Ancillaries:
 - a. Automatic Test Gas Generator:
 - 1) If noted.
 - 2) Assembly includes a chlorine generator for automatic daily test of sensor.
 - b. Calibration Kit: Complete with accessories, including regulator and zero and span cylinders of chlorine gas.
 - c. Device to allow personnel to nonintrusively calibrate and adjust transmitter.
- 8. Manufacturers and Products:
 - a. MSA; Trigard Gas Sensor(s) and Monitor.
 - b. Sensidyne, Inc.; Sensalert Plus Universal Transmitter and Controller.

B. A19 Sulfur Dioxide Leak Detector:

- 1. General:
 - a. Function: Continuously monitor ambient air for sulfur dioxide gas.
 - b. Sensor Type: Electrochemical gas diffusion.
 - c. Parts: Sensor/transmitter(s); receiver/controller, automatic test generator (if noted), calibration kit, and ancillaries.
- 2. Performance:
 - a. Range: 0 ppm to 25 ppm, unless otherwise noted.
 - b. Temperature, Operating: 0 degrees F to 105 degrees F.
 - c. Humidity, Operating: 0 percent to 99 percent relative humidity, noncondensing.
- 3. Sensor (or Integral Sensor/Transmitter):
 - a. Number of Sensor(s): Three, unless otherwise noted.
 - b. Gas Monitored: Sulfur dioxide gas.
 - c. Sensor Type: Electrochemical gas diffusion.
 - d. Mounting: Wall.

4. Controller:
 - a. Number of Channels/Receivers: Minimum of three, unless otherwise noted.
 - b. LCD or LED Display.
 - c. Audible Alarm: Integral weatherproof horn, 95 dB.
 - d. Beacon strobe light: Integral top mount, color red.
 - e. Enclosure:
 - 1) Rating: NEMA 4X.
 - 2) Mounting: Wall.
5. Power:
 - a. Controller: 85-255V ac, 50/60 Hz, unless otherwise noted.
 - b. Backup Battery:
 - 1) Required.
 - 2) 12V dc, 4-amp hour battery to maintain operation up to 12 hours to a single point unit.
 - c. Signal Interfaces, Controller:
 - 1) Analog Output:
 - a) If noted.
 - b) 4 mA to 20 mA dc analog output capable of driving 600 ohms at 24V dc; one per channel.
 - 2) Discrete outputs.
 - a) SPDT relays rated for 230V ac at 5 amps resistive.
 - b) Three per channel, plus one common fault.
 - c) Relays shall be programmed as fail-safe.
6. Cables: Provide cabling of required length between sensor/transmitter and controller.
7. Ancillaries:
 - a. Automatic Test Gas Generator:
 - 1) If noted.
 - 2) Assembly includes a chlorine generator for automatic daily test of sensor.
 - b. Calibration Kit: Complete with accessories, including regulator and zero and span cylinders of sulfur dioxide gas.
 - c. Device to allow personnel to nonintrusively calibrate and adjust transmitter.
8. Manufacturers and Products:
 - a. MSA; Trigard Gas Sensor(s) and Monitor.
Sensidyne, Inc.; Sensalert Plus Universal Transmitter and Controller.

C. L8 Level Switch, Float, Mercury:

1. General:
 - a. Function: Actuate contact at preset liquid level.
 - b. Type: Direct-acting float with enclosed mercury switch and integral cable.
2. Service (Liquid): Wastewater, unless otherwise noted.
3. Performance:
 - a. Setpoint: As noted.
 - b. Differential: 2.5 inches, maximum.
 - c. Temperature: 0 degree F to 160 degrees F.
4. Features:
 - a. Entire Assembly: Watertight and impact-resistant.
 - b. Float Material and Size:
 - 1) Polypropylene body; 4.5-inch diameter and 6-inch length.
 - c. Cable:
 - 1) Combination support and signal.
 - 2) Length: 60 feet.
 - 3) PVC cable jacket.
 - d. Mounting: Pipe, unless otherwise noted.
 - 1) Pipe Mounting:
 - a) Cable clamp, suitable for connection to 1-inch pipe.
 - b) Pipe-to-wall bracket, suitable for connection to 1-inch pipe.
 - 2) Suspended Mounting (internal weights): If noted.
 - a) Wall mounting bracket, unless otherwise noted.
 - 3) Anchor Mounting Kit: If noted.
 - a) Compatible with pipe-mounted floats.
 - b) 15-pound vinyl-coated cast iron anchor.
 - c) 1/8-inch, Type 316 stainless steel vinyl-coated wire rope.
 - d) Stainless steel cable clips.
5. Signal Interface:
 - a. Switch Type: Mercury tilt.
 - b. Switch Contacts:
 - 1) Isolated, rated 4.5A continuous at 120V ac.
 - 2) Form C contact (one NO, one NC), unless otherwise noted.
6. Accessories: As noted.
7. Manufacturers and Products:
 - a. Anchor Scientific; Roto-Float, Type S, 3 Wire.

D. L29 Level Element and Transmitter, Ultrasonic:

1. General:
 - a. Function: Continuous level measurement.
 - b. Type: Ultrasonic, non-contacting.
 - c. Parts: Element, transmitter, interconnecting cable, and accessories as noted.
2. Service:
 - a. Application: Refer to Instrument List at the end of this section.
 - b. Operating Temperature Range:
 - 1) Element: Minus Minus 4 degrees F to plus 149 degrees F.
 - 2) Transmitter: Minus 4 degrees F to 120 degrees F.
3. Performance:
 - a. Process Range: As noted.
 - b. Zero Reference: As noted.
 - c. Accuracy: Plus or minus 0.25 percent of maximum range or 6 mm, whichever is greater.
 - d. Resolution: 0.1 percent of range or 2 mm, whichever if greater.
 - e. Blanking Distance: Sensor dependent, 1-foot up to 50-foot range.
 - f. Hazardous Location Approval: Required where noted.
4. Element:
 - a. Quantity: One, unless otherwise noted.
 - b. IP 68, fully submersible.
 - c. Housing: PVDF.
 - d. Integral Flange: If noted.
 - e. Face Housing: PTFE.
 - f. Process Connection:
 - 1) 1-inch, NPT, unless otherwise noted.
 - 2) Top Mounted.
 - g. Element Beam Angle: 10 degrees or less.
 - h. Integral temperature compensation.
5. Transmitter/Controller:
 - a. Display: 6-digits plus 12-character text, bargraph, and remote communicator identifier and program/run/test mode indicators.
 - b. Enclosure: Polycarbonate, IP65 wall mount, unless otherwise noted.
 - c. Power Supply: 120V ac, 50/60 Hz.
 - d. Isolated Analog Output: 4 to 20 mA dc for load impedance of 0 to 750 ohms.
 - e. Discrete Outputs: Three form C rated at 5A at 240V ac. Assignable as noted.
 - f. External Temperature Sensor: If noted.
 - g. Programming: By integral keypad for on-board programming via passcode.

6. Interconnecting Cable: Weatherproof, UV protected, length as required, and type as recommended by manufacturer.
7. Accessories:
 - a. Mounting Bracket: If and as noted.
 - b. USB cable.
 - c. Submergence Shield: If noted.
 - d. Aiming Kit: If noted.
8. Manufacturer and Product:
 - a. Siemens LUT420 Transmitter with XRS-5 Sensor;
 - b. Pulsar Ultra 4 Transmitter with dB Transducer.

E. M26 Hand Switch and Light, Corrosion, Round:

1. General:
 - a. Function: Select, initiate, and display discrete control functions.
 - b. Type: Heavy-duty, corrosion-resistant, industrial.
2. General Features:
 - a. Mounting: 30.5 mm single round hole. Panel thickness 1/16 inch to 1/4 inch.
 - b. Legend Plate: Standard size, square style laminate with white field and black markings, unless otherwise noted. Markings as shown, or as implied by P&IDs.
 - c. Configuration: Light, pushbutton, or switch as noted or shown.
3. Light Features:
 - a. Lights: 6V ac lamps and integral transformer for operation for operation from 120V ac, unless otherwise noted.
 - 1) Furnish LED lamps.
 - b. Lens Color: Color as specified, noted, or shown.
 - c. Push-to-test, unless otherwise noted.
 - d. Additional: As noted.
4. Pushbutton Features:
 - a. Operator: Single pushbutton, flush, unless otherwise noted.
 - b. Color: Black, unless otherwise noted.
 - c. Boot: None, unless otherwise noted.
 - d. Contact Arrangement: As required or shown.
 - e. Additional: As noted.
5. Selector Switch Features:
 - a. Operator: Knob, unless otherwise noted.
 - b. Color: Black, unless otherwise noted.
 - c. Boot: None, unless otherwise noted.
 - d. Positions: As required or shown.
 - e. Return: Manual, unless otherwise noted.
 - f. Contact Arrangement: As required or shown.
 - g. Additional: As noted.

6. Signal Interface:
 - a. Contact Block:
 - 1) Type: Standard, unless otherwise noted.
 - 2) Materials: Silver amalgam, unless otherwise noted.
 - 3) Rating: 10 amps continuous at 120V ac, unless otherwise noted.
 - 4) Sequence: Break-before-make, unless otherwise noted or shown.
 - 5) Arrangement: Normally open or normally closed as shown, or to perform the functions noted.
 7. NEMA Rating: NEMA 4, watertight, dust-tight, and NEMA 4X, corrosion-resistant.
 8. Manufacturers and Products:
 - a. Allen-Bradley; Bulletin 800H.
 - b. Square D Co.; Class 9001, Type SK.
 - c. Eaton Corp.; Cutler-Hammer, Type E34.
- F. M30 Horn, Indoor/Outdoor:
1. General:
 - a. Function: Audible alarm. Produces sound by electro-mechanical vibration of a diaphragm.
 2. Performance:
 - a. Temperature, Operating: Minus 65 degrees F to 150 degrees F.
 - b. Sound Output Level: 100 dB nominal at 10 feet (110 dB at 1 meter).
 3. Features:
 - a. Dimensions: 4-3/8 inches in height and width, and 2.5 inches in depth, for horn and enclosure.
 - b. Body: Die-cast zinc.
 - c. Diaphragm: Stainless steel.
 - d. Projector: None, unless otherwise noted.
 - e. Listings: UL, cUL listed, FM, CSA approved.
 4. Enclosure:
 - a. Type: Cast aluminum with neoprene-gasketed NEMA 4X housing.
 - b. Mounting: Surface mount.
 5. Power: 120V ac, 50/60-Hz, unless otherwise noted.
 6. Manufacturer: Federal Signal Corp.; Model 350WB.
- G. M31 Warning Light, Indoor/Outdoor:
1. General:
 - a. Function: Visual alarm.
 - b. Type: Rotating reflector or flashing bulb.
 - c. Parts: Light and spare bulbs.

2. Performance:
 - a. Temperature, Operating: Minus 35 degrees F to 190 degrees F.
 - b. Flash Rate: Nominally 90 per minute.
3. Features:
 - a. Dome: Polycarbonate.
 - b. Dome Color: Amber, unless otherwise noted.
 - c. Lamp Life: 200 hours.
 - d. Lamp: Incandescent/25 watts.
4. Enclosure:
 - a. Type: IP65 (NEMA 4X).
 - b. Mounting: 1/2-inch pipe, unless otherwise noted.
 - c. Listing: UL listed, CSA certified.
5. Power: 120V ac, 50/60-Hz.
6. Spare Bulbs: Provide two for each light.
7. Manufacturers: Federal Signal; Model 225.

H. P4 Pressure Gauge:

1. General:
 - a. Function: Local pressure indication.
 - b. Type: Bourdon tube element.
2. Performance:
 - a. Scale Range: As noted.
 - b. Accuracy: Plus or minus 0.50 percent of full scale.
3. Features:
 - a. Dial: 4-1/2-inch diameter.
 - b. Pointer Vibration Reduction: Required, unless otherwise noted.
Use the following method.
 - 1) Liquid filled gauge front, unless otherwise noted.
 - a) Glycerin fill, unless otherwise noted.
 - c. Case Material: Black thermoplastic, unless otherwise noted.
 - d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components): Stainless steel, unless otherwise noted.
 - e. Pointer: Adjustable by removing ring and window.
 - f. Window: Glass or acrylic, unless otherwise noted.
 - g. Threaded reinforced polypropylene front ring.
 - h. Case Type: Solid front with blow-out back.
4. Process Connection:
 - a. Mounting: Lower stem, unless otherwise noted.
 - b. Size: 1/2-inch MNPT, unless otherwise noted.

5. Accessories:
 - a. Throttling Device: Required, unless otherwise noted.
 - 1) Type suitable for the intended service.
 - 2) Install in gauge socket bore.
6. Manufacturers and Products:
 - a. Ashcroft; Duragauge Model 1259/Model, 1279/Model, 1279 PLUS!

I. P6 Pressure Seal, Diaphragm:

1. General:
 - a. Function: Isolate sensing element from process fluid.
 - b. Type:
 - 1) Diaphragm.
 - 2) Fluid filled between diaphragm and sensing element.
2. Service:
 - a. Pressure: Same as associated sensor.
 - b. Temperature Range: If noted.
3. Performance:
 - a. Pressure:
 - 1) For threaded process connections, at least 2,500 psig at 100 degrees F.
 - 2) Glycerin Fill: Suitable only for pressure (not vacuum applications).
 - b. Temperature:
 - 1) Dependent upon fill fluid.
 - a) Glycerin (food grade): Zero to 400 degrees F.
 - b) Silicone: Minus 40 degrees F to plus 600 degrees F.
 - c) Silicone (food grade): Zero to 375 degrees F.
 - d) Halocarbon: Minus 70 degrees F to 300 degrees F.
4. Features:
 - a. Materials:
 - 1) Diaphragm Material: Type 316 stainless steel, unless otherwise noted.
 - 2) Diaphragm Material: Type 316 stainless steel, unless otherwise noted.
 - 3) Top Housing: Steel, unless otherwise noted.
 - b. Diaphragm: Welded to upper housing, unless otherwise noted.
 - c. Filling screw in upper housing.
 - d. Fill Fluid:
 - 1) As recommended by manufacturer for application.
 - 2) As noted.
 - 3) Or approved equal.
 - 4) Factory assembled and filled.

- e. Flushing Connection: 1/4-inch NPT in lower housing.
 - f. Diaphragm Seal Displacement: 0.1 cubic inch, nominal.
 - 5. Connections:
 - a. Instrument: 1/2-inch female NPT, unless otherwise noted or shown.
 - b. Process: 1/2-inch female NPT, unless otherwise noted or shown.
 - 6. Manufacturers:
 - a. Ashcroft; Type 201.
 - b. Ametek; Mansfield and Green Division; Type SG.
 - c. WIKA; Type L990.10.
- J. P7 Pressure Switch, Adjustable Dead Band:
- 1. General:
 - a. Function: Monitor pressure, activate switch at setpoint, and deactivate switch at reset point.
 - b. Type:
 - 1) Piston-actuated.
 - 2) Both setpoint and deadband (the differential between setpoint and reset point) adjustable.
 - 2. Performance:
 - a. Setpoint:
 - 1) As noted.
 - 2) Repeatability: Plus or minus 1 percent of range.
 - b. Reset Point: As noted.
 - c. Range: The noted setpoint shall fall between 20 percent and 80 percent of the range.
 - d. Deadband: Adjustable within nominally 25 percent and 85 percent of range.
 - e. Overpressure Proof Pressure:
 - 1) Pressure psi Ranges: At least 400 percent of rated maximum static pressure.
 - 2) Pressure Inches of Water Ranges: 20 psig.
 - 3) Compound Range: 250 psig.
 - 4) Vacuum Range: 250 psig.
 - f. Operating Temperature Range:
 - 1) Dependent on actuator seal materials.
 - 2) For Buna-N seal, 0 degree F to 150 degrees F.
 - 3. Features:
 - a. Actuator Seal: Buna-N, unless otherwise noted.
 - b. Adjustable deadband.
 - c. Mounting: Surface, unless otherwise noted.

4. Process Connection:
 - a. 1/2-inch NPT female connections, unless otherwise noted.
 - b. Materials:
 - 1) Pressure psi Ranges: Type 316 stainless steel, unless otherwise noted.
 - 2) Pressure Inches of Water Ranges: Epoxy coated carbon steel, unless otherwise noted.
5. Enclosure: NEMA 4X, unless otherwise noted.
6. Signal Interface:
 - a. Contact Type:
 - 1) SPDT.
 - 2) Rated for 10 amps minimum at 120V ac.
 - b. Hermetically Sealed Switch: If noted.
7. Manufacturers and Products:
 - a. Ashcroft; L or P Series.
 - b. United Electric; J6 Series.
 - c. If NEMA 7, explosion-proof enclosure specified; Ashcroft; P Series only.

K. P8 Pressure Switch, Fixed Deadband:

1. General:
 - a. Function: Monitor pressure.
 - b. Type: Diaphragm actuated switch.
2. Performance:
 - a. Setpoint:
 - 1) As noted.
 - 2) Repeatability: Plus or minus 1 percent.
 - b. Range: Noted setpoint shall fall between 20 percent and 80 percent of range.
 - c. Overpressure Proof Pressure: At least 400 percent of rated maximum static pressure.
 - d. Operating Temperature Range:
 - 1) Dependent on actuator seal materials.
 - 2) For Buna-N seal, 0 degree F to 150 degrees F.
3. Features:
 - a. Actuator Seal: Buna-N, unless otherwise noted.
 - b. Differential (deadband): Fixed.
 - c. Reset: Automatic, unless otherwise noted.
 - d. Mounting: Surface, unless otherwise noted.
4. Process Connection:
 - a. 1/4-inch NPT female connections, unless otherwise noted.
 - b. Materials: Nickel-plated brass, unless otherwise noted.

5. Enclosure: NEMA 4X.
6. Signal Interface:
 - a. Contact Type:
 - 1) SPDT, unless otherwise noted.
 - 2) Rated for 10 amps minimum at 120V ac.
 - b. Hermetically Sealed Switch: If noted.
7. Manufacturers and Products:
 - a. Ashcroft; Type 400, B Series.
 - b. United Electric; 400 Series.

L. P9 Pressure Transmitter:

1. General:
 - a. Function: Measure pressure and transmit signal proportional to pressure.
 - b. Type:
 - 1) Electronic variable capacitance or silicon strain gauge.
 - 2) Two-wire transmitter; "smart electronics".
 - c. Parts: Transmitter and accessories.
2. Performance:
 - a. Range: As noted.
 - 1) Select transmitter's factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL but does not exceed it.
 - b. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
 - c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
 - d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
 - e. Humidity: 0 to 100 percent relative humidity.
 - f. Hazardous Location Certifications: If and as noted.
3. Features:
 - a. Type: Gauge pressure, unless otherwise noted.
 - b. Adjustable damping.
 - c. LCD indicator, unless otherwise noted.
 - 1) Display in either percent or engineering units, field configurable.
 - d. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
 - 1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
 - e. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.

- f. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
 - g. Fill Fluid: Silicone, unless otherwise noted.
 - 4. Process Connections:
 - a. Line Size: 1/2 inch.
 - b. Connection Type: FNPT.
 - c. Diaphragm Seal:
 - 1) Required.
 - 2) Direct Mount.
 - 3) Material shall be suitable for Digested Secondary Sludge application.
 - 5. Signal Interface:
 - a. 4mA to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
 - 1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
 - 6. Enclosure:
 - a. Type: NEMA 4X.
 - b. Materials: Coated aluminum, unless otherwise noted.
 - c. Mounting bracket, unless otherwise noted.
 - 1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
 - 7. Accessories:
 - a. Two-valve (isolate and vent) Stainless Steel Manifold: If noted.
 - 8. Manufacturers and Products:
 - a. Gauge Pressure Units:
 - 1) Emerson Rosemount; Model 2051.
 - 2) Endress+Hauser; Model PMP71.
 - M. P15 Pressure Seal, Annular:
 - 1. General:
 - a. Function:
 - 1) Sense pressure in a process line and transfer to pressure monitoring device.
 - 2) Protect attached pressure monitoring device from sludge or slurry.
 - b. Type: Annular fluid-filled device that senses pressure through flexible sleeve around full pipe circumference.
 - 2. Performance:
 - a. Operating Conditions: Suitable for line pressures up to pipe flange rating.

3. Features:
 - a. Construction:
 - 1) In-line, 8 Inches and Smaller: Full-faced thru-bolted with outside diameter same as mating flanges, unless otherwise noted.
 - 2) In-line, 10 Inches and Larger: Wafer style.
 - 3) Offline: Threaded, unless otherwise noted.
 - b. Materials:
 - 1) Body: Carbon steel, unless otherwise noted.
 - 2) Flanges (where applicable): Carbon steel, unless otherwise noted.
 - 3) Flexible Sleeve: Natural Gum Rubber or Buna-N, as recommended by manufacturer for gritty, abrasive sludge application.
 - 4) Fill Fluid: Ethylene glycol/water or propylene glycol, unless otherwise noted.
 - c. Factory Filled System:
 - 1) Filled and assembled with pressure monitoring device(s).
 - 2) Coordinate attached pressure monitoring device(s) with system integrator. Seal vendor's standard pressure monitoring device(s) only acceptable if it meets specification of the related pressure monitoring device.
4. Process Connections:
 - a. Mounting: In-line or offline, as noted or shown.
 - b. Pipe Size:
 - 1) In-line: As noted or shown.
 - 2) Offline: 2 inches, unless otherwise noted.
 - c. Connections:
 - 1) In-line, Full-faced through-bolted: ASME B16.5, 150-pound flanges.
 - 2) In-line, Wafer style: Compatible with Classes 150/300 flange drilling.
 - 3) Offline: Female NPT Threaded, unless otherwise noted.
5. Manufacturers and Products:
 - a. Red Valve Company; Series 40, Series 42/742, Series 48.
 - b. Ashcroft, Series 81.

N. S27 Indicator, Digital Panel:

1. General:
 - a. Function: Digital indication of analog signal.
 - b. Type: 3.5-digit LED display.
2. Performance:
 - a. Accuracy: Plus or minus 0.05 percent of full scale plus or minus one count.
 - b. Display Update Rate: 2.5 second minimum.

- c. Operating Temperature Range: 0 degree C to 60 degrees C.
 - d. Relative Humidity: 0 percent to 90 percent noncondensing.
 - 3. Features:
 - a. Display:
 - 1) LED.
 - 2) At least 3.5-digits.
 - 3) 0.56-inch height.
 - b. Overrange indication.
 - c. Input Impedance: 100 ohms maximum.
 - 4. Enclosure:
 - a. 1/8 DIN, high impact plastic.
 - b. Nominal Maximum Dimensions: 2.5 inches high by 4.7 inches wide by 4 inches deep.
 - c. Nominal Cutout Dimensions: 1.8 inches high by 3.6 inches wide.
 - d. Suitable for panel mounting.
 - e. Maintains NEMA 4X Panel Rating: If noted.
 - 1) Furnish accessories as required.
 - 5. Power: 115V ac, unless otherwise noted.
 - 6. Signal Interfaces:
 - a. Process Inputs:
 - 1) Field Selectable: 4 mA to 20 mA, 1 volt to 5 volts.
 - b. Relays:
 - 1) Quantity as noted.
 - 2) Programmable.
 - c. Loop Power Supply: If noted.
 - 1) 24V dc, at least 25 mA.
 - 7. Manufacturer and Products:
 - a. Newport Electronics, Santa Ana, CA; Model 202A-P.
 - b. Precision Digital, Natick, MA; Model Trident Model PD765.
- O. T10, Temperature Transmitter:
- 1. General:
 - a. Function: Measure indoor room temperature.
 - b. Type: Resistance type sensor with integral analog transmitter.
 - 2. Signal Interface:
 - a. 4mA to 20 mA dc output.
 - 3. Manufacturer and Model:
 - a. Wika, Model TR-60B with T19.10 transmitter and IP65 field case.
 - b. Siemens Series 1000; Model 536-753.

P. Y40 Uninterruptible Power Supply (UPS) System:

1. General:
 - a. Function: Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.
 - b. Major Parts: Inverter, battery charger, sealed battery.
2. Performance:
 - a. Capacity: 1,000 VA minimum; size to meet runtime requirements.
 - b. Input Power:
 - 1) 120V ac single-phase, 60-Hz, unless otherwise noted.
 - 2) Connections: Manufacturer's standard, unless otherwise noted.
 - c. Output Power:
 - 1) 120V ac single-phase, 60-Hz, unless otherwise noted.
 - 2) Connections: Manufacturer's standard, unless otherwise noted.
 - d. On-line Efficiency: 91 percent minimum, unless otherwise noted.
 - e. Backup Runtime:
 - 1) Full Load: 10 minutes minimum, unless otherwise noted.
 - 2) Half Load: 20 minutes minimum, unless otherwise noted.
 - f. Continuous no-break power with no measurable transfer time.
 - g. Sine-Wave Output Voltage Total Harmonic Distortion (THD): Plus or minus 5 percent or less.
 - h. Input Voltage Range: 60 – 150V ac.
 - i. Output Voltage Regulation: Plus or minus 1 percent nominal.
 - j. Operating Temperature: 0 degree to 40 degrees C (32 degrees to 104 degrees F).
 - k. Operating Relative Humidity: 5 percent to 95 percent without condensation.
 - l. Lightning and Surge Protection:
 - 1) UPS shall conform to ANSI C62.41, Category B.
 - 2) MOV ratings shall be 190V, 80 Joules minimum connected L-N.
3. Features:
 - a. Bypass Switches: As noted.
 - b. Enclosure:
 - 1) Tower, unless otherwise noted.
 - 2) If rack-mount noted, unit to be suitable for mounting in a 19-inch rack.
4. Manufacturers and Products:
 - a. Vertiv, Liebert GXT5 series.
 - b. Approved equal.

PART 3 EXECUTION

3.01 SUPPLEMENTS

- A. Supplement listed below, follows “End of Section,” is part of this Specification.
 - 1. MAWSS SCADA Hardware Standard Specifications.

END OF SECTION

Standard Hardware Specifications

Y311, ControlLogix (CLX) Programmable Automation Controller (PAC) Central Processing Unit (CPU)

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial Release

1) General:

- a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
- b) Function: Multiloop analog and discrete control.

2) Service:

- a) Operating Shock: 30 g peak acceleration for 11 ms duration.
- b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
- c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).

3) PAC CPU Processor:

- a) Features:
 - i) Multiple processors can share common input data.
 - ii) Pre-emptive multitasking operating system.
 - iii) Advanced instruction set including file handling, sequencer, diagnostic, shift register, program control, ASCII, function blocks, and motion control instructions.
 - iv) Scheduled I/O data transfers.
 - v) 128,000 I/O max digital; 4,000 analog I/O max.
 - vi) Supports both Local I/O and Universal remote I/O.
- b) Communication:
 - i) EtherNet/IP.
 - ii) ControlNet.
 - iii) DeviceNet.
 - iv) DH+.
 - v) Remote I/O.
 - vi) SynchLink.

- vii) Third party process and device networks.
- c) Built-in Ports: 1 USB; 1 Embedded Ethernet (10/100/1000 Mbps)
- d) Memory:
 - i) User Memory: 3 MB, 5 MB, 10 MB, 20 MB, or 40 MB, based on specific application requirements.
 - ii) I/O Memory: 0.98 MB.
 - iii) Nonvolatile Memory Storage: 2 GB (1784-SD2).
- e) Controller Redundancy: Full support.
- f) Programming Languages:
 - i) Relay ladder (LD).
 - ii) Structured text (ST).
 - iii) Function Block Diagram (FBD).
 - iv) Sequential Function Chart (SFC).
- g) Power Dissipation: 6.2 W.
- h) Thermal Dissipation: 21.2 BTU/hr.
- i) Slot Width: 1 Slot.
- 4) Programming Software:
 - a) Processor, CIM, and I/O Modules:
 - i) Ladder diagram and function block diagram.
 - ii) Includes RSLinx Classic, FactoryTalk Linx, Logix Emulate, RSNetworkx.
 - iii) Supports the Following Processors: CompactLogix, ControlLogix.
 - iv) Product: Studio 5000 Logix Designer Professional
 - v) Quantity: As noted in Specifications.
- 5) Product and Manufacturer: Allen-Bradley ControlLogix 5580 Controller manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y312, ControlLogix (CLX) 1756 Power Supply Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial Release

- 1) General:
 - a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Provide power to the PAC Backplane to support PAC modules.
- 2) Service:
 - a) Operating Shock: 30 g peak acceleration for 11 ms duration.
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) Power Supply Module:
 - a) Input Voltage Range: 85V to 265V AC.
 - b) Input Voltage, Nominal: 120V/240V AC.
 - c) Input Frequency Range: 47 to 63 Hz.
 - d) Input Power, Max: 100 VA/100 W.
 - e) Output Power, Max: 75 W.
 - f) Inrush Current: 20 A.
 - g) Thermal Dissipation: 17.39 BTU/hr.
 - h) Module Location: Left side of 1756 chassis.
- 4) Product and Manufacturer: Allen-Bradley ControlLogix 1756-PA75 manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3131, ControlLogix (CLX) 1756 Discrete Input (DC) Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/20	Jacobs (C Bates / G Gray)	Initial Release

- 1) General:
 - a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Discrete Input.
- 2) Service:
 - a) Operating Shock: 30 g peak acceleration for 11 ms duration.
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) I/O Module:
 - a) Inputs:
 - i) Individually isolated 24V DC.
 - ii) 16 points (8 points/group).
 - b) Voltage:
 - i) 12/24V DC Sink.
 - ii) Range: 10-31.2V DC.
 - iii) Nominal Voltage: 24V DC.
 - c) Current:
 - i) Current Draw:
 - (1) At 24V: 2 mA.
 - (2) At 5.1V: 100 mA.
 - d) Power: Total Backplane Power: 0.56 W.
 - e) Thermal Dissipation: 17.39 BTU/hr.
 - f) Slot Width: 1 Slot.
- 4) Wiring: Provide a Removable Terminal Block (RTB) or 1492 Interface Module (IFM) for each module, based on specific application requirements.

- 5) Product and Manufacturer: Allen-Bradley 1756-IB16 manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3132, ControlLogix (CLX) 1756 Discrete Output (DC) Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial release.

- 1) General:
 - a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Discrete Output.
- 2) Service:
 - a) Operating Shock: 30 g peak acceleration for 11 ms duration.
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) I/O Module:
 - a) Outputs: 16 points electronically fused (8 points/group).
 - b) Voltage:
 - i) 12/24V DC Sink.
 - ii) Range: 10-31.2V DC.
 - iii) Nominal Voltage: 24V DC.
 - c) Current:
 - i) Current Draw:
 - (1) At 24V: 2 mA.
 - (2) At 5.1V: 250 mA.
 - d) Power: Total Backplane Power: 1.32 W.
 - e) Thermal Dissipation: 13.98 BTU/hr.
 - f) Slot Width: 1 Slot.
- 4) Wiring: Provide a Removable Terminal Block (RTB) or 1492 Interface Module (IFM) for each module, based on specific application requirements.
- 5) Product and Manufacturer: Allen-Bradley 1756-OB16E manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3133, ControlLogix (CLX) 1756 Analog Input Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial release.

1) General:

- a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
- b) Function: Analog Input.

2) Service:

- a) Operating Shock: 30 g peak acceleration for 11 ms duration.
- b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
- c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).

3) I/O Module:

- a) Inputs:
 - i) Individually isolated voltage/current.
 - ii) 8 Isolated Channels – Any combination of Voltage or Current mode.
- b) Voltage and Current:
 - i) Backplane:
 - (1) 5.1V DC 200 mA.
 - (2) 24V DC 400 mA.
 - ii) Input Voltage:
 - (1) -10V to +10V.
 - (2) 0V to 10V.
 - (3) 0V to 5V.
 - iii) Input Current: 0 mA to 20 mA.
 - iv) Output Current: 0 mA to 20 mA.
- c) Input Ranges:
 - i) -10 to +10V.

- ii) 0 to 10V.
 - iii) 0 to 5V.
 - iv) 0 to 20 mA.
 - d) Resolution: 24 bit.
 - e) Power:
 - i) Total Backplane Power:
 - (1) Voltage/Non-sourcing Current Mode: 4.6 W.
 - (2) Sourcing Current Mode: 10.6 W.
 - f) Thermal Dissipation
 - i) Voltage Mode: 15.7 BTU/hr.
 - ii) Non-sourcing Current Mode: 17.4 BTU/hr.
 - iii) Sourcing Current Mode: 24.9 BTU/hr.
 - g) Data Format: IEEE 32-bit floating point.
 - h) Slot Width: 1 Slot.
- 4) Wiring: Provide a Removable Terminal Block (RTB) or 1492 Interface Module (IFM) for each module, based on specific application requirements.
- 5) Product and Manufacturer: Allen-Bradley 1756-IF8I manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3134, ControlLogix (CLX) 1756 Analog Output Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial release.

1) General:

- a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
- b) Function: Analog Output.

2) Service:

- a) Operating Shock: 30 g peak acceleration for 11 ms duration.
- b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
- c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).

3) I/O Module:

- a) Outputs: 8 Isolated Channels – Any combination of Voltage or Current mode.
- b) Input Ranges:
 - i) 10 to +10V.
 - ii) 0 to 10V.
 - iii) 0 to 5V.
 - iv) 0 to 20 mA.
- c) Resolution: 16 bit.
- d) Power:
 - i) Total Backplane Power:
 - (1) Voltage Mode: 6.3 W.
 - (2) Current Mode:
 - (a) With 250 ohm loads: 6.3 W.
 - (b) With 5000 ohm loads: 7.6 W.
 - (c) With 750 ohm loads: 9.2 W.
 - (d) With 1000 ohm loads: 10.2 W.

- e) Thermal Dissipation:
 - i) Voltage Mode: 18.4 BTU/hr.
 - ii) Current Mode:
 - (1) With 250 ohm loads: 18.4 BTU/hr.
 - (2) With 5000 ohm loads: 19.8 BTU/hr.
 - (3) With 750 ohm loads: 22.2 BTU/hr.
 - (4) With 1000 ohm loads: 22.9 BTU/hr.
- f) Output Impedance: 46 ohms.
- g) Data Format: IEEE 32-bit floating point.
- h) Slot Width: 1 Slot.
- 4) Wiring: Provide a Removable Terminal Block (RTB) or 1492 Interface Module (IFM) for each module, based on specific application requirements.
- 5) Product and Manufacturer: Allen-Bradley 1756-OF8I manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3141, ControlLogix (CLX) 1756 Ethernet/IP Communication Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial release.

- 1) General:
 - a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Connect PAC to Ethernet network.
- 2) Service:
 - a) Operating Shock: 30 g peak acceleration for 11 ms duration.
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) Ethernet/IP Communication Module:
 - a) Communication Rate: 100 Mbps.
 - b) Single-port, Copper RJ45 or Multimode Fiber, LC Connector, based on specific application requirements.
 - c) Logix Communication Connections: 256.
 - d) TCP/IP Communication Connections: 128.
 - e) Power Dissipation: 6.2 W.
 - f) Thermal Dissipation: 21.28 BTU/hr.
 - g) Quantity: One, unless otherwise noted.
 - h) Slot Width: 1 Slot.
- 4) Product and Manufacturer: Allen-Bradley ControlLogix 1756-EN2T or 1756-EN2F manufactured by Rockwell Automation (Milwaukee, Wisconsin), based on specific application requirements.

Standard Hardware Specifications

Y3142, ControlLogix (CLX) 1756 Ethernet/IP Device Level Ring (DLR) Communication Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial Release.

1) General:

- a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
- b) Function: Connect PAC to Device Level Ring (DLR).

2) Service:

- a) Operating Shock: 30 g peak acceleration for 11 ms duration.
- b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
- c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).

3) Ethernet/IP DLR Communication Module:

- a) Communication Rate: 100 Mbps.
- b) Double-port, Copper RJ45.
- c) Logix Communication Connections: 256.
- d) TCP/IP Communication Connections: 128.
- e) Power Dissipation: 6.2 W.
- f) Thermal Dissipation: 17.4 BTU/hr.
- g) Quantity: One, unless otherwise noted.
- h) Slot Width: 1 Slot.

4) Product and Manufacturer: Allen-Bradley ControlLogix 1756-EN2TR manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3143, 1783 ETAP Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial Release

- 1) General:
 - a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Connect devices to an Ethernet ring.
- 2) Service:
 - a) Operating Shock: 30 g peak acceleration for 11 ms duration.
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) ETAP: Tap Type, 3 Copper Ports (RJ45), 2 Copper Ports (RJ45), 1 Fiber Port (MM LC Connector), or 1 Copper Port (RJ45)/2 Fiber Ports (MM LC Connector), based on specific application requirements.
- 4) Product and Manufacturer: Allen-Bradley ControlLogix 1783-ETAP, 1783-ETAP1F, or 1783-ETAP2F manufactured by Rockwell Automation (Milwaukee, Wisconsin), based on specific application requirements.

Standard Hardware Specifications

Y3151, Chassis 1756, 4-Slot

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial Release

- 1) General:
 - a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Provide backplane housing for all chassis mounted PAC modules.
- 2) Service:
 - a) Operating Shock: 30 g peak acceleration for 11 ms duration.
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: -13 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) Chassis:
 - a) Slots:
 - i) 4.
 - ii) Provide slot filler for each unused slot.
 - iii) Provide all required interconnect cables.
 - b) Minimum Panel Size: 20 inches by 20 inches by 8 inches.
 - c) Mounting Method: Horizontal.
 - d) Power Dissipation: 4 W.
- 4) Product and Manufacturer: Allen-Bradley ControlLogix 1756-A4 manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3152, Chassis 1756, 7-Slot

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial Release

- 1) General:
 - a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Provide backplane housing for all chassis mounted PAC modules.
- 2) Service:
 - a) Operating Shock: 30 g peak acceleration for 11 ms duration.
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: -13 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) Chassis:
 - a) Slots:
 - i) 7.
 - ii) Provide slot filler for each unused slot.
 - iii) Provide all required interconnect cables.
 - b) Minimum Panel Size: 20 inches by 24 inches by 8 inches.
 - c) Mounting Method: Horizontal.
 - d) Power Dissipation: 4.5 W.
- 4) Product and Manufacturer: Allen-Bradley ControlLogix 1756-A7 manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3153, Chassis 1756, 10-Slot

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial Release

- 1) General:
 - a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Provide backplane housing for all chassis mounted PAC modules.
- 2) Service:
 - a) Operating Shock: 30 g peak acceleration for 11 ms duration.
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: -13 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) Chassis:
 - a) Slots:
 - i) 10.
 - ii) Provide slot filler for each unused slot.
 - iii) Provide all required interconnect cables.
 - b) Minimum Panel Size: 20 inches by 30 inches by 8 inches.
 - c) Mounting Method: Horizontal.
 - d) Power Dissipation: 5 W.
- 4) Product and Manufacturer: Allen-Bradley ControlLogix 1756-A10 manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3154, Chassis 1756, 13-Slot

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial Release

- 1) General:
 - a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Provide backplane housing for all chassis mounted PAC modules.
- 2) Service:
 - a) Operating Shock: 30 g peak acceleration for 11 ms duration.
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: -13 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) Chassis:
 - a) Slots:
 - i) 13.
 - ii) Provide slot filler for each unused slot.
 - iii) Provide all required interconnect cables.
 - b) Minimum Panel Size: 24 inches by 30 inches by 8 inches.
 - c) Mounting Method: Horizontal.
 - d) Power Dissipation: 5.4 W.
- 4) Product and Manufacturer: Allen-Bradley ControlLogix 1756-A13 manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3155, Chassis 1756, 17-Slot

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial Release

- 1) General:
 - a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Provide backplane housing for all chassis mounted PAC modules.
- 2) Service:
 - a) Operating Shock: 30 g peak acceleration for 11 ms duration.
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: -13 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) Chassis:
 - a) Slots:
 - i) 17.
 - ii) Provide slot filler for each unused slot.
 - iii) Provide all required interconnect cables.
 - b) Minimum Panel Size: 30 inches by 36 inches by 8 inches.
 - c) Mounting Method: Horizontal.
 - d) Power Dissipation: 6 W.
- 4) Product and Manufacturer: Allen-Bradley ControlLogix 1756-A17 manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y316, ControlLogix (CLX) 1756 Ethernet/IP Communication Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial release.

- 1) General:
 - a) This component specification is part of the ControlLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Connect PAC controllers to provide a redundant PAC system.
- 2) Service:
 - a) Operating Shock: 30 g peak acceleration for 11 ms duration.
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) Redundancy Module:
 - a) Power Dissipation: 6 W.
 - b) Thermal Dissipation: 21 BTU/hr.
 - c) Slot Width: 1 Slot.
- 4) Connector Cable: 1m, 3m, or 10m, based on specific application requirements.
- 5) Product and Manufacturer: Allen-Bradley ControlLogix 1756-RM2 manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y321, CompactLogix (CPX) Programmable Automation Controller (PAC) Central Processing Unit (CPU)

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial release.

1) General:

- a) This component specification is part of the CompactLogix PAC Small to Medium Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
- b) Function: Multiloop analog and discrete control.

2) Service:

- a) Operating Shock: 30 g peak acceleration for 11 ms duration.
- b) Vibration: 5 g maximum peak acceleration between 10 to 500 Hz.
- c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).

3) PAC CPU Processor:

- a) Features:
 - i) Multiple processors can share common input data.
 - ii) Pre-emptive multitasking operating system.
 - iii) Advanced instruction set including file handling, sequencer, diagnostic, shift register, program control, ASCII, function blocks, and motion control instructions.
 - iv) Scheduled I/O data transfers.
 - v) 128,000 I/O max in any mix (4,000 analog I/O max).
 - vi) Supports both Local I/O and Universal remote I/O.
- b) Communication Ports:
 - i) 1 EtherNet/IP.
 - ii) 1 RS-232 serial port.
- c) Module Expansion Capacity: 16 1769 modules or 30 1769 modules, based on specific application requirements.
- d) User Memory: 750 KB or 1.5 KB, based on specific application requirements.
- e) Controller Redundancy: Not support.

- f) Programming Languages:
 - i) Relay ladder.
 - ii) Structured text.
 - iii) Function Block Diagram.
 - iv) Sequential Function Chart (SFC).
- g) Power Dissipation: 5.5 W.
- h) Slot Width: 1 Slot.
- 4) Accessories:
 - a) Provide End Caps as required:
 - i) Left: 1769-ECL.
 - ii) Right: 1769-ECR.
- 5) Programming Software:
 - a) Processor, CIM, and I/O Modules:
 - i) Ladder diagram and function block diagram.
 - ii) Includes RSNetWorx for ControlNet, RSNetWorx for DeviceNet, and RSLinx Professional.
 - iii) Supports the Following Processors: CompactLogix, FlexLogix, ControlLogix, DriveLogix, SoftLogix 5800.
 - iv) Product: RSLogix 5000 Professional.
 - v) Quantity: As required by Specifications.
- 6) Product and Manufacturer: Allen-Bradley CompactLogix L3x Controller manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y322, CompactLogix (CPX) 1769 Power Supply Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial release.

- 1) General:
 - a) This component specification is part of the CompactLogix PAC Medium to Large Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Provide power to the PAC modules.
- 2) Service:
 - a) Operating Shock: 30 g peak acceleration for 11 ms duration.
 - b) Vibration: 5g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) Power Supply Module:
 - a) Input Voltage Range: 85V to 265V AC or 170V to 265V, switch selectable.
 - b) Input Voltage, Nominal: 120V/220V AC.
 - c) Power Consumption: 200 VA at 120V AC/240 VA at 240V AC.
 - d) Power Dissipation: 18 W at 140 degrees F.
 - e) Inrush Current: 25 A at 132V AC.
- 4) Product and Manufacturer: Allen-Bradley ControlLogix 1769-PA4 manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3231, CompactLogix (CPX) 1769 Discrete Input (DC) Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial release

- 1) General:
 - a) This component specification is part of the CompactLogix PAC Small to Medium Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Discrete Input.
- 2) Service:
 - a) Operating Shock: 30 g panel mount/20 g DIN rail mount.
 - b) Vibration: 5 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) I/O Module:
 - a) Inputs: 16 points (8 points/group).
 - b) Voltage:
 - i) 24V DC Sink/Source.
 - ii) Range: 10-30V DC.
 - c) Current:
 - i) Current Draw: At 5.1V: 115 mA.
 - ii) Inrush Current, Max: 250 mA.
 - d) Input Impedance: 3 kOhm.
 - e) Heat Dissipation: 3.55 W.
 - f) Slot Width: 1 Slot.
- 4) Product and Manufacturer: Allen-Bradley 1769-IQ16 manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3232, CompactLogix (CPX) 1769 Discrete Output (DC) Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial release.

- 1) General:
 - a) This component specification is part of the CompactLogix PAC Small to Medium Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Discrete Output.
- 2) Service:
 - a) Operating Shock: 30 g panel mount/20 g DIN rail mount.
 - b) Vibration: 5 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) I/O Module:
 - a) Outputs: 16 points (16 points/group).
 - b) Voltage:
 - i) 24V DC Source.
 - ii) Range: 20.4-26.4V DC.
 - c) Current:
 - i) Current Draw: At 5.1V: 200 mA.
 - ii) Surge Current: 2.0 A for 10 ms.
 - d) Input Impedance: 3 kOhm.
 - e) Heat Dissipation: 2.11 W.
 - f) Slot Width: 1 Slot.
- 4) Product and Manufacturer: Allen-Bradley 1769-OB16 manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3233, CompactLogix (CPX) 1769 Analog Input Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial release.

- 1) General:
 - a) This component specification is part of the CompactLogix PAC Small to Medium Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Analog Input.
- 2) Service:
 - a) Operating Shock: 30 g panel mount/20 g DIN rail mount.
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) I/O Module:
 - a) Inputs:
 - i) Individually isolated voltage/current.
 - ii) 4 Isolated differential.
 - b) Input Ranges:
 - i) -10 to +10V.
 - ii) 0 to 10V.
 - iii) 0 to 5V.
 - iv) 1 to 5V.
 - v) 0 to 20 mA.
 - vi) 4 to 20 mA.
 - c) Resolution: 16 bit (unipolar)/15 bit plus sign (bipolar).
 - d) Heat Dissipation: 3 W.
 - e) Slot Width: 1 Slot.
- 4) Product and Manufacturer: Allen-Bradley 1769-IF4I manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y3234, CompactLogix (CPX) 1769 Analog Output Module

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial Release.

- 1) General:
 - a) This component specification is part of the CompactLogix PAC Small to Medium Systems specification series. It is intended to be combined with other component specifications from this series to provide a complete PAC system specification.
 - b) Function: Analog Output.
- 2) Service:
 - a) Operating Shock: 30 g panel mount/20 g DIN rail mount .
 - b) Vibration: 2 g maximum peak acceleration between 10 to 500 Hz.
 - c) Environmental:
 - i) Operating Temperature: 32 to 140 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).
- 3) I/O Module:
 - a) Outputs: 4 individually isolated.
 - b) Output Ranges:
 - i) 0 to 20 mA.
 - ii) 4 to 20 mA.
 - c) Resolution: 16 bits unipolar.
 - d) Current Draw: 145 mA at 5V / 120 mA at 24V.
 - e) Heat Dissipation: 2.68 W.
 - f) Resistive Load:
 - i) Current: 0 to 500 ohms
 - g) Inductive Load:
 - i) 0.1 mH
 - h) Slot Width: 1 Slot.
- 4) Product and Manufacturer: Allen-Bradley 1769-OF4CI manufactured by Rockwell Automation (Milwaukee, Wisconsin).

Standard Hardware Specifications

Y331, Programmable Automation Controller (PAC) System Operator Interface Unit (OIU)

Document History and Status

Revision	Date	Author	Reason for Change
0	7/29/2020	Jacobs (C Bates / G Gray)	Initial Release

1) General:

- a) This component specification is part of the ControlLogix and CompactLogix PAC specification series. It is intended to be combined with other component specifications from a series to provide a complete PAC system specification.
 - i) Function: Allows operator to monitor and control at PAC level.

2) Service:

- a) Operating Shock: 15 g peak acceleration for 11 ms duration.
- b) Vibration: 2 g maximum peak acceleration between 57 to 500 Hz.
- c) Environmental:
 - i) Operating Temperature: 32 to 131 degrees F.
 - ii) Relative Humidity: 5 to 95 percent (without condensation).

3) Operator Interface Unit:

a) Features:

- i) Installation: Front mount.
- ii) Display Type: Color TFT LCD.
- iii) Display Resolution: 800 by 600 XGA, 18-bit color graphics.
- iv) Aspect Ratio: 4:3.
- v) Nominal Display Size: 10 inch (minimum).
- vi) Touch Panel Type: Analog resistive.
- vii) Memory: 512 MB RAM and 1 GB nonvolatile.
- viii) Secure Digital (SD) Slot: One, with 2GB SD card.
- ix) USB Ports: Two USB 2.0 (Type A) high speed host ports and one USB 2.0 (Type B) high speed device port.
- x) Ethernet Port: One 10/100Base-T, Auto MDI/MDI-X Ethernet port that supports linear or star network topologies.
- xi) Operating Software: Windows CE (includes FTP, VNC client server, ActiveX controls, PDF reader, 3rd-party device support).

b) Accessories:

- i) Configuration Software and Ancillaries:
 - (1) FactoryTalk View Studio for Machine Edition (Version 8.10 or later).
 - (2) Full documentation.
 - (3) Download cable.
 - (4) 24V dc power supply and cords.
- 4) Product and Manufacturer: Allen-Bradley PanelView Plus 7. (Catalog Number 2711P-T10C21D8S) manufactured by Rockwell Automation (Milwaukee, Wisconsin).

SECTION 40 94 13
OPERATIONAL TECHNOLOGY COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This section gives general requirements for operational technology components (OTC). The following OTC subsections or supplements expand on requirements of this section:
 - 1. Section 40 95 80, Fiber Optic Communication System.
 - 2. Section 40 96 00, Applications Software.
 - 3. Section 40 96 02, Networking Software.
- B. Provide all hardware and software for a completely functioning system meeting the specified requirements.
- C. Configure all hardware and software as shown and specified.
- D. Major Work Items (include but are not limited to): Engineering, furnishing (procuring), installing, programming, configuring, calibrating, adjusting, testing, documenting, starting up, and Owner training for complete and fully functional OTC of the Industrial Control System (ICS). OTC major work includes (but is not limited to) the following: Virtual infrastructure (physical servers, virtual SAN, hypervisors, virtual machines); Backup software and infrastructure (NAS, disaster recovery backups); Alarm notification infrastructure; Network infrastructure and segregation (firewalls, switches, transceivers, physical media; VLANs, subnets, DMZs, network logging and monitoring); Client infrastructure (thick clients, video wall monitors); Remote access infrastructure and DMZ infrastructure.
 - 1. Refer to Project Drawings for an overview of the OTC, and connections. Coordinate software requirements with Section 40 96 00, Application Software.
 - 2. OTC Hardware: Provide all OTC hardware as shown on the Block Diagrams and specified this section. Provide all necessary appurtenances such as cables, drivers, and peripherals for a fully operational ICS.
 - a. Major hardware items include: Rack mounted Servers, network switches, firewalls, routers, transceivers, workstations, video wall components, thin clients, zero clients, network attached storage, mounting hardware, monitors, large screen monitors and Printers.

- b. Minor hardware items needed for a fully operational OTC are not identified nor specified in this document. All Minor hardware items are to be provided for a complete and fully functional OTC as part of this scope.
 - c. All Major and Minor hardware components shall be included.
 - 3. Application Software: Refer to Section 40 96 00, Application Software for additional requirements. Provide application software as specified for specific components, as specified in this section, and as required for a fully operational system. Major software items to be included with Hardware components listed in this section include standard software such as operating systems and office packages.
 - 4. Upgrades to existing facility panels and hardware as indicated in Contract Documents and as required to incorporate complete instrumentation and control system interface. Upgrades include, but are not limited to: power wiring, network cabling, fiber cabling and terminations, adding or removing hardware and cabling at an existing panel, and altering network configuration of existing system.
 - 5. Programming all OTC components.
 - 6. Provision of all fiber optic cabling on the Project unless otherwise noted.
 - 7. Provide all configurations for both hardware and software for proper operation of the ICS and for successful implementation of the Process Control Software.
 - 8. Participate in System Configuration workshops with Owner and Owners representative to discuss and document preferred configuration details for hardware and software.
- E. Coordinate IP addressing of all hardware components with component suppliers, network service providers, the Owner, and the Owners representative, and as shown on the Drawings.
- F. Provide enough capacity and modularity in the OTC for future expansion.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section and other OTC subsections:
- 1. International Conference on Energy Conversion and Application (ICECA).
 - 2. National Electrical Code (NEC).
 - 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. IOTC 1, Industrial Control and Systems General Requirements.

4. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Water Treatment and Collection Facilities.
5. Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels.
6. International Society of Automation (ISA):
7. ISA 99, Industrial Automation and Control Systems Security.
8. National Institute of Standards (NIST):
9. NIST Special Publications 800 Series.
10. NIST SP 800-82, Guide to Industrial Control Systems Security.
11. International Standards Organization (ISO):
12. Open Systems Interconnection.
13. Institute of Electrical and Electronics Engineers (IEEE):
14. IEEE 802.3, Carrier Sense Multiple Access with Collision Detection (CSMA/CD) (Ethernet).
15. IEEE 802.3z, Gigabit/s Operation.
16. IEEE 802.3ae, 10 Gigabit/s Operation.
17. IEEE 802.3af, DTE Power via MDI.
18. IEEE 802.1p, Traffic Classification/Prioritization.
19. IEEE 802.1q, Virtual LANs.
20. IEEE 802.1x, Comprehensive security framework.
21. IEEE C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
22. Building Industry Consulting Service International (BICSI):
23. Telecommunications Distribution Methods Manual (TDMM).
24. ANSI/TIA/EIA (Telecommunications Pathways and Spaces).
25. International Telecommunications Union (ITU).
26. Electronic Industries Association (EIA).
27. American National Standards Institute (ANSI):
28. ANSI/IEEE C37.90.1, Surge withstand capability.
29. ANSI/IEE C37.90.2, Tolerance of radiated electromagnetic frequency interference.
30. American National Standards Institute/Electronics Industrial Association (ANSI/EIA): ANSI/EIA RS 310 D Rack Mounting Standards for 19-Inch Racks.
31. ANSI TIA/EIA 606-B Cable Labeling Standards.
32. TIA: Telecommunications Industry Association.

1.03 DEFINITIONS

A. Abbreviations:

1. HMI: Human-Machine Interface.
2. HVAC: Heating, Ventilating, and Air Conditioning.
3. I&C: Instrumentation and Control.
4. ICS: Industrial Control System.

5. I/O: Input and Output.
6. NAS: Network Attached Storage.
7. O&M: Operation and Maintenance.
8. OIU: Operator Interface Unit.
9. OT: Operational Technology.
10. OTC Operational Technology Components.
11. P2V: Physical (Machine) To Virtual (Machine) Conversion.
12. PAM: Privileged Access Management.
13. PC: Personal Computer.
14. PAC: Programmable Automation Controller.
15. SCADA: Supervisory Control and Data Acquisition.

B. Enclosure: Control panel, console, cabinet, rack or instrument housing.

C. Instructor Day: Eight hours of actual instruction time.

1.04 SUBMITTALS

A. General:

1. Submit proposed Submittal breakdown consisting of sequencing and packaging of information in accordance with Progress Schedule.
2. Partial Submittals not in accordance with Progress Schedule will not be accepted.
3. Submittal Format:
 - a. Electronic Copies: Required, unless otherwise noted for specific items.
 - 1) Manufacturers' Standard Documents: Adobe Acrobat PDF.
 - 2) Documents created specifically for Project:
 - a) Text and Graphics: Microsoft Word.
 - b) Lists: Microsoft Excel, unless otherwise noted for specific items.
 - c) Block Drawings: MicroStation or AutoCAD.
 - d) Network Diagrams: Microsoft Visio.
4. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
5. Legends and Abbreviation Lists:
 - a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
 - b. Use identical abbreviations in OTC subsections.
 - c. Submit updated versions as they occur.

6. Activity Completion:
 - a. Action Submittals: Completed when reviewed and approved.
 - b. Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.

B. Action Submittals:

1. Bill of Materials: List of required equipment.
 - a. Group equipment items by enclosure and field, and within an enclosure, as follows:
 - 1) Components: By component identification code.
 - 2) Other Equipment: By equipment type.
 - b. Data Included:
 - 1) Equipment tag number.
 - 2) Description.
 - 3) Manufacturer, complete model number and all options not defined by model number.
 - 4) Quantity supplied.
 - 5) Component identification code where applicable.
 - 6) For panels, include panel reference number and name plate inscription.
 - c. Formats: Microsoft Excel.
2. OTC block diagram and overview description. Coordinate block diagram with other Subsystems to provide a completely coordinated Wastewater ICS block diagram. Block diagram shall show all equipment connections and equipment tag numbers.
3. OTC network diagram and overview description. Coordinate network diagram with other Subsystems to provide a completely coordinated Wastewater ICS network diagram. Network diagram shall show all equipment, connections, virtual machines, server names, equipment tag numbers, and IP addresses. Both physical and logical diagrams shall be provided.
4. Bill of Materials for OTC Components: Component number, manufacturer, model number, component description, and quantity.
5. Room Layout Drawings: Coordinate with other Subsystems and submit Control Room Layout Drawings showing where all OTC hardware will be installed in existing rooms or panels. Room Layout Drawings shall be completely coordinated with other Subsystems to show the locations of all equipment in the Control Room and not just the OTC hardware locations. Show enclosure locations and sizes, furniture, OTC equipment, and service area requirements.
6. Power Connection Diagram: For OTC equipment show interconnection from power sources through uninterruptible power supplies and power distribution panels, to computer and peripherals.

7. Grounding Diagram: For OTC equipment show grounding philosophy and implementation.
8. Interconnecting Wiring and Cabling Diagrams: For OTC equipment, identify terminal receptacles, cable ID tags, actual cable lengths, and maximum distance limitations between cabinets or components.
9. Component Submittal: For each OTC component:
 - a. General data and description.
 - b. Engineering Specifications and data sheets.
 - c. Scaled drawings and mounting arrangements.
 - d. Equipment weights.
 - e. Power and grounding requirements.
 - f. External electrical interconnection and interface definitions.
10. Standard Software: For each type of standard software to be provided:
 - a. General data sheet and description.
 - b. Exact software package model number and feature list.
 - c. Associated hardware device hosting the software.
11. Shop Drawings for Specifically Manufactured OTC Equipment:
 - a. A complete connection diagram.
 - b. Data sheets on each major item, annotated as necessary to describe specific items furnished.
 - c. Scaled layout and fabrication drawings.
 - 1) Cable access areas and cable routing.
 - 2) Power termination and ground lug location.
 - 3) Data cable termination points.
 - 4) Anchor bolt size and location.
 - d. Installation and mounting detail drawings.
 - e. Equipment weights.
12. Panel Construction Drawings:
 - a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
 - b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
 - c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
 - d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
 - e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
 - f. Submit electronic copies of Drawings.

13. Panel Wiring Diagrams:
 - a. Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.
 - b. Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.
 - c. Diagram Type:
 - 1) Ladder diagrams where applicable. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
 - 2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.
14. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
 - a. Required voltages, currents, and phases(s). Include calculations and list assumptions.
 - b. Maximum heat dissipations Btu per hour. Include calculations and list assumptions.
 - c. Maximum permissible internal temperature based on operating range of internal components.
 - d. Computed maximum internal temperature. Include calculations and list assumptions. Include the impacts of internal heat generation, solar radiation and shielding.
15. Communications and Digital Networks Diagrams:
 - a. Scope: Includes connections to Ethernet network, remote I/O, and fieldbus (for example, Modbus, Profibus, Foundation Fieldbus, Device Net, etc.).
 - b. Format: Network schematic diagrams for each different type of network.
 - c. Show:
 - 1) Interconnected devices, both passive and active.
 - 2) Device names and numbers.
 - 3) Terminal numbers.
 - 4) Communication Media: Type of cable.
 - 5) Connection Type: Type of connector.
 - 6) Node and device address numbers.
 - 7) Wire and cable numbers and colors.
 - d. Ethernet Network Switch Configuration: Complete list of settings, parameters, and configuration details.

C. Informational Submittals:

1. Operations and Maintenance Manuals:
 - a. Operation and Maintenance Data, unless otherwise specified in this section.
 - b. General: Provide the following:
 - 1) Suggested startup/shutdown procedures.
 - 2) Training material.
2. Hardware: Provide the following:
 - a. All hardware cutsheets.
 - b. Detailed logical and physical network diagrams.
 - c. Detailed connectivity spreadsheet.
 - d. Detailed firmware/software version spreadsheet.
 - e. All passwords for every account or device in encrypted format with encryption key and master password.
3. Provide Manufacturer's Certificate of Proper Installation where specified.
4. Evidence of transferability to Owner of all warranties and licenses and support agreements.

D. Testing Related Submittals:

1. Factory Demonstration Test:
 - a. Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - b. Final Test Procedures:
 - 1) Proposed test procedures, forms, and checklists.
 - 2) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
 - c. Test Documentation: Copy of signed off test results.
2. System Acceptance/Performance Test:
 - a. Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - b. Final Test Procedures: Proposed test procedures, forms, and checklists.
 - c. Test Documentation: Copy of signed off test results.
3. Owner Training Plan: In accordance with Section 01 43 33, Manufacturers' Field Services.

E. Quality Control Submittals:

1. Operation and Maintenance Manuals:
 - a. Hardware:
 - 1) Updated version of hardware Shop Drawings submittals.
 - 2) Component Manufacturer's O&M Manuals: Instructions for installation, operation, maintenance, trouble shooting, and calibration.
 - 3) List of spare parts and expendables provided.
 - 4) List of recommended additional spare parts.
 - b. Software Documentation: Updated version of software Shop Drawings submittals.

F. As-Built Documents:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain As-Built documents.
2. Accuracy of As-Built:
 - a. Coordinate changes within As-Built documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
 - b. Purpose of Project As-Built documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
 - c. Make entries within 24 hours after receipt of information that a change in the Work has occurred.
 - d. Prior to submitting each request for progress payment, request Engineer's review and approval of current status of As-Built documents. Failure to properly maintain, update, and submit As-Built documents may result in a deferral by Engineer to recommend whole or any part of Contractor's Application for Payment, either partial or final.

G. Maintenance of As-Built Documents:

1. General:
 - a. Label or stamp each As-Built document with title, "AS-BUILT DOCUMENTS," in neat large printed letters.
 - b. As-Built information concurrently with construction progress and within 24 hours after receipt of information that change has occurred.

2. Preservation:
 - a. Maintain documents in a clean, dry, legible condition and in good order.
 - b. Convert as-built markups to digital format within 10 days of change.
 - c. Do not use As-Built documents for construction purposes.
 - d. Make documents and Samples available at all times for observation by Engineer.
 - e. Making Entries on Drawings:
 - 1) Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
 - 2) Color Coding:
 - a) Green when showing information deleted from Drawings.
 - b) Red when showing information added to Drawings.
 - c) Blue and circled in blue to show notes.
 - 3) Date entries.
 - 4) Call attention to entry by “cloud” drawn around area or areas affected.
 - 5) Legibly mark to As-Built documents actual changes made during construction, including, but not limited to: Locations of existing and new equipment, or Work. Locate existing equipment, and items critical to the interface between existing physical conditions or construction and new construction.
 - 6) Changes made by Addenda and Field Orders, Work Change Directive, Change Order, and Engineer’s written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.

1.05 QUALITY ASSURANCE

- A. Qualifications. PIC System Integrator shall be selected from one of the following MAWSS-approved integrators (listed alphabetically):
 1. Automation Control Service, LLC.
 2. Hargrove and Associates, Inc.
 3. Prism Systems, Inc.
 4. Revere Control Systems, Inc.
- B. OTC Coordination Meetings:
 1. OTC Schedule Coordination Meeting: Purpose: Discuss Engineer’s comments and resolve scheduling issues.

2. Startup and Training Meeting:
 - a. Purpose:
 - 1) Startup and testing planning.
 - 2) Resolve required changes to proposed training plan.
 - 3) Identify specific Owner personnel to attend training.
3. Weekly progress meetings.
4. Provide for a minimum of 4 additional meetings.

C. Project Final Completion:

1. The Project will be considered complete after:
 - a. System has been fully installed, commissioned, tested and accepted by Owner.
 - b. All testing has been completed.
 - c. All testing documentation has been submitted and approved.
 - d. O&M manuals have been submitted and approved.
 - e. All application software is archived and turned over to Owner.
 - f. All salvage and demolition has been completed.
 - g. All operations and maintenance training has been completed.
 - h. All system credentials have been turned over to Owner.
 - i. Final As-built Drawing markups have been submitted to Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Section 01 61 00, Common Product Requirements.
- B. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.
- C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.
- D. Cover panels and other elements that are exposed to dusty construction environments.

1.07 SEQUENCING AND SCHEDULING

- A. Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:
 1. OTC Kickoff Meeting Prerequisite: Schedule of Values and Progress Schedule submitted and reviewed.
 2. OTC Configuration Workshops.

3. Shop Drawing Reviews by Engineer:
 - a. Prerequisite: Engineer acceptance of Schedule of Values and Progress Schedule.
4. Test Prerequisite: Associated test procedures Submittals completed.
5. OTC Startup and Testing Meeting Prerequisite:
 - a. Factory Demonstration Test Complete.
 - b. Engineer review of preliminary training plan and prior to Functional Test.
6. Training Prerequisite: Associated training plan Submittal completed.
7. Factory Demonstration Test Prerequisite:
 - a. Related Shop Drawings approved.
8. OTC Shipment to Site:
 - a. General Prerequisites:
 - 1) Approval of OT Shop Drawings and preliminary operation and maintenance data.
 - 2) FDT complete.
9. Installation Prerequisite: Equipment received at Site.
10. Functional Test Prerequisite: OTC Startup and Testing Meeting complete.
11. Performance Test Prerequisite: Functional Test completed and facility started up.

1.08 SYSTEM DESCRIPTION

A. Design Requirements:

1. Complete detailed design of OTC and OTC drawings and diagrams
2. Provide consistent hardware and software functions for OTC. For example, provide server configurations that are standardized and common among all servers.
3. OTC design as shown and specified includes:
 - a. Functional requirements, performance requirements, and Component Specifications.
 - b. Network diagrams.
4. Typical drawings for installation details, panel power, and control diagrams.

B. Use a qualified OTC System Integrator for at least the following Work:

1. For OTC Equipment and Ancillaries:
 - a. Completing detail design.
 - b. Submittals.

- c. Equipment, enclosures, and ancillaries.
- d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
- e. Verify readiness for operation.
- f. Verify correctness of final power and signal connections (lugging and connecting).
- g. Adjusting and performance tuning.
- h. Starting up.
- i. Testing and coordination of testing.
- j. Training.
2. Verify following Work not by OTC System Integrator is provided:
 - a. Correct electrical power circuits and raceways.
 - b. Correct low voltage and fiber installation and termination.
3. Develop and implement a field integration, startup, and testing plan in compliance with OTC, ICS and package systems requirements.

1.09 EXTRA MATERIALS

- A. As specified in OT subsections.
- B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

1.10 WARRANTIES AND LICENSING

- A. Minimum 3 year warranties for all components unless otherwise specified.
- B. All warranties must be transferable to Owner. Evidence of transferability must be presented with appropriate submittals.
- C. All licenses must be transferable to Owner. Evidence of transferability must be presented with appropriate submittals.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide OTC functions shown on Drawings and required in OTC subsections. Furnish equipment items required in OTC subsections. Furnish materials, equipment, and software, whether indicated or not, necessary to effect required system.

- B. First Named Manufacturer: OTC design is based on first named manufacturers of equipment, materials, and software.
 - 1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with the General Conditions, Article 6.05 Substitutes and “Or Equals”.
 - 2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.
- C. Like Equipment Items:
 - 1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer’s services.
 - 2. Implement same or similar functions in same or similar manner. For example: switch configurations.
 - 3. Use newest equivalent product if newer model/version exist for specified product.

2.02 SYSTEM PERFORMANCE

- A. Provide newest compatible equivalent for all models and version.
- B. Network Architecture and Configuration:
 - 1. The Control Network (VLAN 10):
 - a. General: PAC/Device network.
 - b. Connections:
 - 1) PACs within the LAN for process control.
 - 2) Ethernet enabled control system devices.
 - c. Systems supported include, but are not limited to:
 - 1) Plant PACs.
 - 2) Remote PACs.
 - 2. The Supervisory Network (VLAN 20):
 - a. General: Network consisting of SCADA servers, workstations, and storage devices related to process control applications.
 - b. Connections: Any windows-based device or computer, printers, SMS modem.
 - c. Function elements and services to be supported include, but are not limited to:
 - 1) HMI Servers and Clients.
 - 2) Historian Services.
 - 3) Alarm Notification.

- 4) Maintenance Services.
 - 5) Terminal Services.
 - 6) Hardware such as printers.
 3. Management Network (VLAN 100):
 - a. General: Consist of the management interfaces of all servers, network devices and software management interfaces.
 - b. Connections: Connected to all network and server management interfaces.
 4. DMZ Network (VLAN 30):
 - a. General: Consists of the network hardware and virtual servers required to be outside of SCADA network for the purposes of traffic segregation.
 - b. Connections.
- C. Provide OTC, including servers and workstations, as specified and shown on Drawings. Required computer nodes are shown on the block diagrams and on the Specification supplements and are summarized below:
 1. Virtual Servers:
 - a. Used for Wastewater ICS control and monitoring. Virtual servers will host SCADA applications software and provide remote desktop services for SCADA HMI Applications.
 - b. Provide servers with operating systems and anti-virus software.
 - c. SCADA Applications software shall be as specified under Section 40 96 00, Applications Software. Coordinate hardware requirements with Sections 40 96 00, Applications Software and 40 96 02, OT Networking Software, to ensure hardware provided meets the minimum requirements for the software.
 - d. Y203-Y204 Domain Controllers:
 - 1) Redundant Root Domain Controllers used for the purposes of providing a forest root domain for future enterprise wide management of plant level child domains and trust between them.
 - 2) Redundant Child Domain Controllers used for the purposes of providing Active Directory Services and Authentication for CCW WWTP.
 - e. Y205 and Y206 SCADA Servers:
 - 1) VTScada HMI servers will be used to poll PACs data, monitor, and control the Wastewater ICS.
 - 2) Configure servers in redundancy mode using a separate virtual network card on a separate VLANs for the failover link.

- f. Y208 Engineering Server: SCADA development server capable of hosting 2 concurrent development sessions at any given time. PAC programming software shall also reside on this VM. The most recent, loadable PAC programs shall be stored on this VM.
 - g. Y221 VMware SCADA vCenter Management Server: VMware SCADA virtual appliance used for the purposes of managing SCADA virtual servers.
 - h. Y222 OT Management Server: Used for the purposes of network management tasks.
 - i. Y230-Y231 Wonderware Archestra (Legacy Customer HMI - P2V) Server: Used for the purposes of legacy HMI management tasks.
 - ~~2.~~ Physical Infrastructure: Consists of physical servers, switches, firewalls, network storage device, modems, time source appliance, workstations, tablets, and monitors. See Component Specifications in this section, Supplement 3.
- D. Workstations, Servers, Firewalls, Switches, KVM/KMM, NTP Appliance, Video Wall, Modems and Rack Sequencing:
- 1. One new thin client workstation shall be configured for viewing Wonderware Archestra as a replacement client for the existing thin client workstation. The new thin client workstation will communicate with the existing Wonderware Archestra servers that will be virtualized as part of this project. Provide all cabling and peripherals for connections to monitor, keyboard, and mouse in the Control Room at the Legacy Systems Desk.
 - 2. All other new servers and workstations shall be configured with the VTScada application software as described in Specification Section 40 96 00, Applications Software.
 - 3. Configure the new firewalls, switches, KVM/KMM, NTP Appliance and modems.
 - 4. New servers and workstations shall be used during Factory Demonstration testing.
 - 5. All the new equipment shall be shipped to the jobsite only after successful completion of the Factory Demonstration testing.
 - 6. Install NTP GPS outdoor antenna.
 - 7. Verify phone landline dial tone.
 - 8. New servers shall be installed in the SCADA rack which shall be installed in the Server Room. The core SCADA switches will be connected to the ICS network to communicate with plant PAC's.

9. The new workstations shall be installed in the Control Room operator console.
 10. Video Wall SCADA monitors shall be mounted in the control room in a 2x2 format. Monitors to be connected via HDMI cables. SCADA wall monitors shall be controlled by a keyboard and a mouse at the control room console via USB cabling. Video Wall Workstation shall be set up to automatically connect to the VTScada server with four concurrent VTScada sessions (one on each monitor) spanning the 2x2 grid.
 11. Video Wall Security monitors shall be provided and mounted by OTC in the control room in a stacked format. Monitors to be connected via HDMI cables. In addition, the OTC shall provide a desktop monitor for the Security workstation; desktop monitor shall be installed on the operator console. The workstation, keyboard, and mouse will be provided by the Security contractor.
 12. Coordinate with MAWSS for the backup of all servers and workstations to network attached storage (NAS) which is located at Park Forest headquarters. Adhere to MAWSS backup standard procedures and demonstrate backup functionality.
 13. Perform SCADA alerts testing via email.
 14. Perform remote VPN device configuration.
 15. Coordinate with MAWSS to implement the privileged access management (PAM) solution which is managed by MAWSS at Park Forest headquarters. Integrate PAM solution into VTScada application remote access and demonstrate functionality. Train authorized users to use the PAM solution for remote access.
 16. Coordinate with MAWSS to perform password vault administrator password management testing using the MAWSS solution as implemented at Park Forest headquarters.
 17. Coordinate with MAWSS to confirm functionality of an email relay, AntiVirus and Windows Updates using MAWSS configured services implemented at Park Forest headquarters.
 18. The application software on the new servers shall be demonstrated in the field as described in Part 3 of this Specification section.
 - a. Contractor shall manage scan status of tags during migration to prevent nuisance alarms.
- E. Refer to 40 94 13 Supplement 1 - OT Network Component List for listing of OTC Hardware.

2.03 SERVICE CONDITIONS

- A. Standard Service Conditions: The following defines certain types of environments. OTC subsections refer to these definitions by name to specify the service conditions for individual equipment units. Design equipment for continuous operation in these environments:
1. Computer Room, Air Conditioned:
 - a. Temperature: 60 degrees F to 80 degrees F.
 - b. Relative Humidity: 40 percent to 60 percent.
 - c. NEC Classification: Nonhazardous.
 2. Inside, Air Conditioned:
 - a. Temperature:
 - 1) Normal: 60 degrees F to 80 degrees F.
 - 2) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 105 degrees F.
 - b. Relative Humidity:
 - 1) Normal: 10 percent (winter) to 70 percent (summer).
 - 2) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
 - c. NEC Classification: Nonhazardous.
 3. Inside:
 - a. Temperature: 20 degrees F to 104 degrees F.
 - b. Relative Humidity: 10 percent to 100 percent.
 - c. NEC Classification: Nonhazardous.

2.04 ELECTRICAL REQUIREMENTS

- A. Electrical Raceways: As specified in Division 26, Electrical.
- B. Wiring External to OTC Equipment:
1. Special Control and Communications Cable: Provided by OTC System Integrator as noted in Component Specifications and OT subsections.
 2. Other Wiring and Cable: As specified in Division 26, Electrical.
- C. OTC Enclosure Internal Wiring:
1. Restrain by velcro or ducts or plastic wireways.
 2. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
 3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
 4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.

5. Connections to Screw Type Terminals:
 - a. Locking-fork-tongue or ring-tongue lugs.
 - b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
 - c. Wires terminated in a crimp lug, maximum of one.
 - d. Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
 - a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
 - b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
7. Splicing and tapping of wires, not allowed.
8. Separate dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
9. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
10. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
11. Conductor Color Coding: In accordance with UL508A.
12. Conductors Carrying Foreign Voltages within a Panel:
 - a. Route foreign voltage conductors into panel and land on a circuit blade disconnect type terminal block.
 - b. Use wire with pink insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with pink insulation for any other purpose.
13. Harness Wiring:
 - a. 120V ac: No. 14 AWG, MTW.
 - b. 24V dc: No. 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.
14. Panelwork:
 - a. No exposed connections.
 - b. Allow adjustments to equipment to be made without exposing these terminals.
 - c. For power and control wiring operating above 80V ac or dc use covered channels or EMT raceways separate from low voltage signal circuits.
15. Plastic Wire Ducts Color:
 - a. 120V ac: White.
 - b. 24V dc: Gray.
 - c. Communications Cables and Fiber Optic Jumpers: Orange.
16. Provide a communications plastic wire duct for communications cables and fiber optic cables between the communications devices in control panel and communications raceways. Design plastic wire duct design to take into account the minimum bending radius of the communications cable.

17. Make plastic wire ducts the same depth.
18. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.

D. Power Failure Detection and AUTO Restart:

1. Prevents errors due to power failure or short-term power fluctuations that occur when UPS is not operating.
2. Power Failure: Voltage variations in excess of plus or minus 10 percent of normal for a duration of 0.5 second or longer. Causes OTC equipment to automatically shut down as required to prevent introducing errors on disk.
3. Short-term Power Fluctuations: Voltage variations in excess of plus or minus 10 percent of normal for durations of 0.5 second to 1 millisecond. CS shuts down as above or is buffered to prevent fluctuations from causing errors.
4. OTC executes Restart program and return to normal operation when power is restored. Battery backed-up real-time clock used by CS during automatic restart to set time and date.
5. Connect UPS SNMP alarm and event messaging to SCADA System, add I/O to SCADA System and graphical overview for each treatment plant as required for Owner to monitor UPS health.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.
- B. Wiring connected to OTC components and assemblies, including power wiring in accordance with requirements in Division 26, Electrical.
- C. Electrical Raceways: As specified in Division 26, Electrical.
- D. Field Finishing: Refer to Section 09 90 00, Painting and Coating.
- E. Onsite Supervision:
 1. Require OT site representative to observe OT equipment installation to extent required in order to provide Certificates of Proper Installation.
 2. Require OT site representative to supervise and coordinate onsite OT activities.
 3. Require OT site representative to be onsite while onsite work covered by this section and OT subsystems is in progress.

3.02 TESTING

A. General:

1. Coordinate OT testing with Owner and affected Subcontractors.
2. Notify Engineer of Performance Test schedule 4 weeks prior to start of test.
3. Engineer may actively participate in tests.
4. Engineer reserves right to test or retest specified functions.
5. Engineer's decision will be final regarding acceptability and completeness of testing.
6. Test hardware to demonstrate that the setup and configuration satisfies requirements for a secure and functional network and server infrastructure on which SCADA VMs and applications software can be hosted.
7. Test Format: Cause and Effect:
 - a. Person conducting test initiates input (cause).
 - b. Specific test requirement is satisfied if correct result (effect), occurs.
8. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
9. Have space after each test item description for sign off by appropriate party after satisfactory completion.
10. Procedures, Forms, and Checklists:
 - a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
 - b. Describe each test item to be performed.
 - c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
11. Conducting Tests:
 - a. Provide special testing materials and equipment.
 - b. Wherever possible, perform tests using actual process variables, equipment, and data.
 - c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
 - d. Define simulation techniques in test procedures.
 - e. Test Format: Cause and effect.
 - 1) Person conducting test initiates an input (cause).
 - 2) Specific test requirement is satisfied if correct result (effect), occurs.

B. Unwitnessed Factory Test:

1. Scope: Inspect and test OTC to ensure it is operational, ready for FDT.
2. Location: OTC System Integrator's facility.
3. Integrated Test:
 - a. Interconnect and test OTC.
 - b. Exercise and test functions.
 - c. Provide stand-alone testing of smaller panels.
 - d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.
 - e. New servers, workstations and thin clients shall be used in testing.

C. Factory Acceptance Tests (FAT):

1. Notify Engineer of test schedule 4 weeks prior to start of test.
2. Scope:
 - a. This will be an extensive and exhaustive test of the entire SCADA system.
 - b. System. Including but not limited to the following items:
 - 1) Ensure that each and every VM is configured and communicating correctly with the other VMs.
 - 2) Contractor will need a test PAC of each type used by the Owner.
 - 3) Ensure SNMP points from Server and network hardware function properly.
 - 4) Operation of communications between PACs and servers; including, failure-mode testing (i.e. failovers, power failures, network failures).
 - 5) Operation of communications between servers and operator workstations; including, failure-mode testing.
 - 6) Up to one day of Unstructured Testing: Owner/Engineer will initiate "What-If" scenarios for the control system or its components to witness how the SCADA System responds.
 - a) Provide staff and equipment necessary to perform test as specified.
 - b) Location: Control System Integrator's facility.
 - c) Nonloop-Specific Functions: Test all nonloop-specific functions including but not limited to:
 - (1) Capacity: Demonstrate that SCADA Systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
 - (2) Failure mode and backup procedures including power failure, AUTO restart, and disk backup and reload.

- (3) Dual Computer Operation: Processor transfer modes, peripheral switching, and communications switching.
 - (4) Message logging and alarm handling.
 - (5) Communication with field interface units.
 - (6) Data acquisition.
 - (7) Human Machine Interface: Database and display configuration and use of all types of displays.
 - (8) Data collection and data retrieval.
 - (9) Report Generation: Creation of a typical report and production of specified reports.
 - (10) Control configuration processor.
 - (11) System Software: Operating system, programming languages, and utility functions.
 - c. Test entire OTC to demonstrate it is operational.
 - d. Test all OTC supplied panels.
 3. Location: OTC System Integrator's facility.
 4. Operation of communications between PAC and computers.
 5. Failed Tests:
 - a. Repeat and witnessed by Engineer.
 - b. With approval of Engineer, certain tests may be conducted by OT System Integrator and witnessed by Engineer as part of Functional Test.
 6. Make following documentation available to Engineer at test site both before and during FDT:
 - a. Drawings, Specifications, Addenda, and Change Orders.
 - b. Master copy of FDT procedures.
 - c. List of equipment to be tested including make, model, and serial number.
 - d. Approved hardware Shop Drawings for equipment being tested.
 - e. Approved preliminary software documentation Submittal.
 7. Daily Schedule for FDT:
 - a. Begin each day with meeting to review day's test schedule.
 - b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.
- D. Performance Test During and After Facility Startup:
1. FDT-Repeat:
 - a. Repeat FDT onsite with installed OTC equipment and software.
 - b. As listed in OTC subsections, certain portions of FDT may not require retesting.
 - c. Use FDT test procedures as basis for this test.

2. Once a facility's Functional Test has been completed and that facility has been started up, perform jointly with Owner's Consultant a Performance Test on associated OTC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function.
3. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.
4. Make O&M data available to Engineer at Site both before and during testing.
5. Follow daily schedule required for FDT.
6. Determination of Ready for Operation: When Functional Test has been completed.

E. System Acceptance Test:

1. After FAT has been completed and SCADA System equipment has been installed at its respective Treatment Plant, a witnessed Site Acceptance Test on associated SCADA System equipment shall be performed to demonstrate each required function on a point-by-point, screen-by-screen, and site-by-site basis to demonstrate that the new VTScada SCADA System is performing the same functions as the existing system.
2. Tests are the same as required for FAT except that entire installed SCADA System is tested using actual process variables and functions demonstrated.
3. Perform local and manual tests for each point before proceeding to remote and automatic modes.
4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
5. Make updated versions of documentation required for Site Acceptance Test available to Engineer at Site, both before and during tests.
6. Make O&M data available to Engineer at Site both before and during testing.
7. Follow daily schedule required for SAT.

3.03 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: As required by each OTC subsection.
- B. See Section 01 43 33, Manufacturers' Field Services.

3.04 TRAINING

- A. General:
 - 1. Perform OTC system training to meet specific needs of Owner's personnel.
 - 2. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
 - 3. Provide instruction on two working shift(s) as needed to accommodate the Owner's personnel schedule.
 - 4. Provide a video recording of all training sessions in a format acceptable to the Owner.
 - a. Owner reserves the right to reuse video of training sessions.
- B. Operations and Maintenance Training:
 - 1. General:
 - a. Refer to specific requirements specified in OTC Subsections.
 - b. Include review of O&M data and survey of spares, expendables, and test equipment.
 - c. Use equipment similar to that provided.
 - d. Unless otherwise specified in OTC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronic, instrumentation, or digital systems.
- C. OT Network and Hardware Training:
 - 1. Length: 2 day.
 - 2. Location: Owner's facility.
 - 3. Presenters: The seminar presenters should include the integrator responsible for configuring the system and representatives from OT application and networking software providers.
 - 4. Objective: Provide an overview for non-operations and maintenance personnel for understanding the OT networking applications software, hardware, and configurations including:
 - a. Configuration Management.
 - b. Firewall Programming and Policies.
 - c. Switch Configuration.

- d. Dell:
 - 1) Dell Training.
 - 2) Configuration.
- e. Time Tools GPS NTP.
- 5. Attended by management, engineering, IT, and other non-operations and non-maintenance personnel.
- 6. Primary Topics:
 - a. Management-oriented explanation of data management displays and printouts.
 - b. Walk-through of installed systems.
 - c. User access instructions.
 - d. Procedures for configuring each hardware type.
 - e. Things to avoid and dangers of changing parameters.
 - f. Best practice and best use.

3.05 CLEANING

- A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.06 SUPPLEMENTS

- A. Supplements listed below, follows “End of Section,” are part of this Specification.
 - 1. Supplement 1, OT Network Component List.
 - 2. Supplement 2, OT Network Software List.
 - 3. Supplement 3, OT Component Specifications.

END OF SECTION

SUPPLEMENT 1, OT NETWORK COMPONENT LIST

DELIVERY AND INSPECTION

- A. Deliver products in accordance with accepted current Progress Schedule and coordinate to avoid conflict with the Work and conditions at Site.
- B. Deliver products in undamaged condition, in manufacturer's original container or packaging, with identifying labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.
- C. Unload products in accordance with manufacturer's instructions for unloading or as specified. Record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.
- D. Remove damaged products from Site and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

HANDLING, STORAGE, AND PROTECTION

- A. Handle and store products in accordance with manufacturer's written instructions and in a manner to prevent damage.
- B. Manufacturer's instructions for material requiring special handling, storage, or protection shall be provided prior to delivery of material.
- C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.
- D. Store finished products that are ready for installation in dry and well-ventilated areas. Do not subject to extreme changes in temperature or humidity.
- E. After installation, provide coverings to protect products from damage due to construction operations. Remove coverings when no longer needed.
- F. Hazardous Materials: Prevent contamination of personnel, storage area, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

MAWSS WATER SCADA UPGRADE MAJOR HARDWARE COMPONENT LIST

Code	Item	Tag	Item Description	QTY	Manufacturer	Part#	Note
Y101	1	20-CCW-FW-01	FORTIGATE-100F	1	Fortinet	100F	Williams Perimeter SCADA Firewall - Configured by Owner
Y101	2	20-CCW-FW-02	FORTIGATE-100F HA Redundant	1	Fortinet	100F	Williams Perimeter SCADA Firewall - Configured by Owner
Y102	3	20-CCW-GPSNTP-01	TimeTools T550 GPS NTP Server Appliance	1	TimeTools	T550-00	
Y103	4	20-CCW-VHC-01	VXRAIL-500 TPM 1.2 MODULE 3 NODE	1	Dell	VXRAIL	
Y105	5	20-CCW-NAS-01	SCADA Network Storage Device	1	Synology	RS820RP+	
Y106	6	20-CCW-SW-01	Core SCADA switch 9300-24-UX-A with C9300-NM-8X-10G Expansion Module	1	Cisco	C9300-24UX-A	
Y106	7	20-CCW-SW-02	Core SCADA switch 9300-24-UX-A with C9300-NM-8X-10G Expansion Module	1	Cisco	C9300-24UX-A	
Y112	8	20-CCW-OWS-01	Precision 7920	1	Dell	Dell Precision 7920	
Y111	9	20-CCW-OWS01-MON-01, 02	24" Monitor	2	Dell	P2417H	
Y112	10	20-CCW-OWS-02	Precision 7920	1	Dell	Dell Precision 7920	
Y111	11	20-CCW-OWS02-MON-01, 02	24" Monitor	2	Dell	P2417H	
Y112	12	20-CCW-MGT-01	Precision 7920	1	Dell	Dell Precision 7920	
Y112	13	20-CCW-VID-01	Precision 7920	1	Dell	Dell Precision 7920	
Y070	14	20-CCW-LEG-WS-01	Thin Client	2	Dell	Dell Wyse 5070	For Legacy Wonderware SCADA
Y111	15	20-CCW-LEGWS01-MON-01	24" Monitor	1	Dell	P2417H	
Y111	16	20-SC-WS01-MON-01	24" Monitor	1	Dell	P2417H	Monitor for Security Workstation
Y113	17	20-CCW-MODEM-01, 02	Internet Cellular Backup Modem with Antenna	2	Sierra Wireless	AirLink Raven RV55 Industrial LTE Gateway	
Y116	18	20-CCW-OTRACK-01	Vertiv RACK	1	Vertiv	VR3150	SCADA and OT Rack
Y116	19	94-CCW-RACK-01	Vertiv RACK	1	Vertiv	VR3150	Temporary Server Rack: for relocated SCADA equipment
Y115	20	20-CCW-KVM-01	18.5" LED LCD Monitor KMM, 16P KVM	1	Vertiv	LRA185KMM (AV3216-001)	Vertiv/Avocent
Y116	21	20-CCW-SECRACK-01	Vertiv RACK	1	Vertiv	VR3150	Security Rack
Y117	22	20-CCW-VID01-MON-01	49" LCD Screen	1	LITEMAX/NEC	DLD4906-LNU-N01 /UN492S	Control Room HMI VideoWall
Y117	23	20-CCW-VID01-MON-02	49" LCD Screen	1	LITEMAX/NEC	DLD4906-LNU-N01 /UN492S	Control Room HMI VideoWall
Y117	24	20-CCW-VID01-MON-03	49" LCD Screen	1	LITEMAX/NEC	DLD4906-LNU-N01 /UN492S	Control Room HMI VideoWall
Y117	25	20-CCW-VID01-MON-04	49" LCD Screen	1	LITEMAX/NEC	DLD4906-LNU-N01 /UN492S	Control Room HMI VideoWall
Y117	26	20-SC-WS01-MON-02	49" LCD Screen	1	LITEMAX/NEC	DLD4906-LNU-N01 /UN492S	Control Room Security VideoWall
Y117	27	20-SC-WS01-MON-03	49" LCD Screen	1	LITEMAX/NEC	DLD4906-LNU-N01 /UN492S	Control Room Security VideoWall
Y134	28	20-CCW-PRINT-01	HP 11x17 Color Laser CP5225N	1	HP	CP5225N	
Y126	29	20-CCW-UPS-01, 02	UPS SCADA	2	Vertiv	GXT5-5000MVRT4UXLN with PD5-003 POD (2)	
Y126	30	20-CCW-UPS-03, 04	UPS SECURITY	2	Vertiv	GXT5-5000MVRT4UXLN with PD5-003 POD (2)	

FIREWALLS

Code	Item	Tag	Item Description	QTY	Manufacturer	Part#	Note
Y101	1	20-CCW-FW-01	FORTIGATE-100F	1	Fortinet		Williams Perimeter SCADA Firewall - Configured by Owner
Y101	2	20-CCW-FW-02	FORTIGATE-100F HA Redundant	1	Fortinet		Williams Perimeter SCADA Firewall - Configured by Owner

NTP Appliance

Code	Item	Tag	Item Description	QTY	Manufacturer	Part#	Note
Y102	1	20-CCW-GPSNTP-01	TimeTools T550-00	1	TimeTools		TIMETOOLS T550 GPS/GLONASS/BEIDOU/GALILEO DUAL-LAN NTP SERVER WITH TCXO - QTY:1 POLE MOUNTING MULTI-GNSS ANTENNA (T-3740) - QTY:1 RIGHT-ANGLED WALL MOUNT FOR MULTI-GNSS ANTENNA (MT4-GPS) - QTY:2 30M GPS ANTENNA EXTENSION CABLE RG58 (TCX-030) - QTY:1 GPS SURGE SUPPRESSOR OPTIONAL, BUT RECOMMENDED FOR OUTDOOR MOUNTED ANTENNA'S (SPP-GPS) QTY:1

SERVERS

Code	Item	Tag	Item Description	QTY	Manufacturer	Part#	Note
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Y103	1	20-CCW-VHC-01	VXRAIL-500 TPM 1.2 MODULE (3-Nodes) - Reference Contains 3 Nodes 20-CCW-VH-01 20-CCW-VH-02 20-CCW-VH-03	1	Dell		Hardware (Per Node / 3Total Nodes): Single Socket 10 Cores CPU / 3 sockets 30 Cores Total 1 Intel® 4210 2.2GHz/10 Cores per node OP-000519598 / SO-000571404 2U Form Factor 208 Power Software: VMware vSAN Standard RecoverPoint for VMs – 5VMs (Per Appliance) VMware vSphere7 Essentials Plus Professional Services & Maintenance: 60 Months HW/SW Support
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NETWORK STORAGE DEVICE

Code	Item	Tag	Item Description	QTY	Manufacturer		Note
Y105	1	20-CCW-NAS-01	SCADA Network Storage Device	1	Synology	RS820RP+	
			Rack slide rail kit	1	Synology	RKS1314	
			Hard Drives 4 TB	4	Seagate	ST4000VN0001	
			SEAGATE USB Drives	2	Seagate	STDA4000100	

SWITCHES

Code	Item	Tag	Item Description	QTY	Manufacturer		Note
Y106	1	20-CCW-SW-01	SCADA Core Switch 9300-24-UX-A with C9300-NM-8X-10G Expansion Module, Network Advantage	1	Cisco	9300-24-UX-A with C9300-NM-8X-10G	3 Year Software License Network Advantage 3 Year Support 24x7
			2 isolated power supplies (85 to 264 VAC) 1100W 85-264 Vac 50/60 Hz input				
Y106	2	20-CCW-SW-02	SCADA Core Switch 9300-24-UX-A with C9300-NM-8X-10G Expansion Module, Network Advantage	1	Cisco	9300-24-UX-A with C9300-NM-8X-10G	3 Year Software License Network Advantage , 3 Year Support 24x7
			2 isolated power supplies (85 to 264 VAC) 1100W 85-264 Vac 50/60 Hz input				
Y106	3		SCADA Core Switch 9300-24-UX-A with C9300-NM-8X-10G Expansion Module, Network Advantage	1	Cisco	9300-24-UX-A with C9300-NM-8X-10G	Shelf Spare

WORKSTATIONS

Code	Item	Tag	Item Description	QTY	Manufacturer		Note
Y112	1	20-CCW-OWS-01	Dell Precision 7920	1	Dell		
			Intel Xeon Silver 4210 2.1 GHz, 3.0 GHz Turbo, 8C, 9.6GT/s 2UPI, 11M Cache	1			
			WINDOWS 10 PRO LICENSE 64-BIT (4 Cores Plus)	1			
			NVIDIA® Quadro® P2200, 5GB, 4 DP	1			
			64GB 8x8GB DDR4 2666MHz RDIMM ECC Memory	1			
			Dual, Hot-plug, Redundant Power Supply (1+1), 1100W.	2			
			C5 SATA HDD/SSD Drives with RAID 0,1,5,10 (with PERC Controller)	1			
			PERC H730P HQ RAID Card 12 Gbps SAS	1			
			(3) 2.5" 512GB SSD Hard Drive (RAID 5) (1) HS 2.5" 512GB SSD Hard Drive	4			
			Slimline DVD ROM SATA	1			
			RAID 5	1			
			US ENGLISH (QWERTY) DELL KB-522 WIRED BUSINESS MULTIMEDIA USB KEYBOARD BLACK (5	1			
			DELL MS111 USB OPTICAL MOUSE,OPTIPLEX AND FIXED (330-9458)	1			
			Intel I350 (4x1Gbit) Quad Port Network Daughter Card	1			
			US 120V Power Cord	2			
			ReadyRails Sliding Rails With Cable Management Arm	1			
			iDRAC9 Enterprise	1			
			3 Years ProSupport with Next Business Day Onsite Service	1			
Y111	2	20-CCW-OWS01MON-01-02	24 Inch LED Monitor - Widescreen	2	Dell	P2417H	
Y112	3	20-CCW-OWS-02	Dell Precision 7920	1	Dell		
			Intel Xeon Silver 4210 2.1 GHz, 3.0 GHz Turbo, 8C, 9.6GT/s 2UPI, 11M Cache	1			
			WINDOWS 10 PRO LICENSE 64-BIT (4 Cores Plus)	1			
			NVIDIA® Quadro® P2200, 5GB, 4 DP	1			
			64GB 8x8GB DDR4 2666MHz RDIMM ECC Memory	1			
			Dual, Hot-plug, Redundant Power Supply (1+1), 1100W.	2			
			C5 SATA HDD/SSD Drives with RAID 0,1,5,10 (with PERC Controller)	1			
			PERC H730P HQ RAID Card 12 Gbps SAS	1			
			(3) 2.5" 512GB SSD Hard Drive (RAID 5) (1) HS 2.5" 512GB SSD Hard Drive	4			
			Slimline DVD ROM SATA	1			
			RAID 5	1			
			US ENGLISH (QWERTY) DELL KB-522 WIRED BUSINESS MULTIMEDIA USB KEYBOARD BLACK (5	1			
			DELL MS111 USB OPTICAL MOUSE,OPTIPLEX AND FIXED (330-9458)	1			
			Intel I350 (4x1Gbit) Quad Port Network Daughter Card	1			
			US 120V Power Cord	2			
			ReadyRails Sliding Rails With Cable Management Arm	1			
			iDRAC9 Enterprise	1			
			3 Years ProSupport with Next Business Day Onsite Service	1			
Y111	4	20-CCW-OWS02MON-01-02	24 Inch LED Monitor - Widescreen	2	Dell	P2417H	
Y112	5	20-CCW-VID-01	Dell Precision 7920	1	Dell		
			Intel Xeon Silver 4210 2.1 GHz, 3.0 GHz Turbo, 8C, 9.6GT/s 2UPI, 11M Cache	1			
			WINDOWS 10 PRO LICENSE 64-BIT (4 Cores Plus)	1			
			NVIDIA® Quadro® P2200, 5GB, 4 DP mDP to HDMI ADAPTERS/CABLES	1			

			64GB 8x8GB DDR4 2666MHz RDIMM ECC Memory	1			
			Dual, Hot-plug, Redundant Power Supply (1+1), 1100W.	2			
			C5 SATA HDD/SSD Drives with RAID 0,1,5,10 (with PERC Controller)	1			
			PERC H730P HQ RAID Card 12 Gbps SAS	1			
			(3) 2.5" 512GB SSD Hard Drive (RAID 5) (1) HS 2.5" 512GB SSD Hard Drive	4			
			Slimline DVD ROM SATA	1			
			RAID 5	1			
			US ENGLISH (QWERTY) DELL KB-522 WIRED BUSINESS MULTIMEDIA USB KEYBOARD BLACK (5	1			
			DELL MS111 USB OPTICAL MOUSE,OPTIPLEX AND FIXED (330-9458)	1			
			Intel I350 (4x1Gbit) Quad Port Network Daughter Card	1			
			US 120V Power Cord	2			
			ReadyRails Sliding Rails With Cable Management Arm	1			
			iDRAC9 Enterprise	1			
			3 Years ProSupport with Next Business Day Onsite Service	1			
Y112	6	20-CCW-MGT-01	Dell Precision 7920	1	Dell		
			Intel Xeon Silver 4210 2.1 GHz, 3.0 GHz Turbo, 8C, 9.6GT/s 2UPI, 11M Cache	1			
			WINDOWS 10 PRO LICENSE 64-BIT (4 Cores Plus)	1			
			NVIDIA® Quadro® P2200, 5GB, 4 DP	1			
			64GB 8x8GB DDR4 2666MHz RDIMM ECC Memory	1			
			Dual, Hot-plug, Redundant Power Supply (1+1), 1100W.	2			
			C5 SATA HDD/SSD Drives with RAID 0,1,5,10 (with PERC Controller)	1			
			PERC H730P HQ RAID Card 12 Gbps SAS	1			
			(3) 2.5" 512GB SSD Hard Drive (RAID 5) (1) HS 2.5" 512GB SSD Hard Drive	4			
			Slimline DVD ROM SATA	1			
			RAID 5	1			
			US ENGLISH (QWERTY) DELL KB-522 WIRED BUSINESS MULTIMEDIA USB KEYBOARD BLACK (5	1			
			DELL MS111 USB OPTICAL MOUSE,OPTIPLEX AND FIXED (330-9458)	1			
			Intel I350 (4x1Gbit) Quad Port Network Daughter Card	1			
			US 120V Power Cord	2			
			ReadyRails Sliding Rails With Cable Management Arm	1			
			iDRAC9 Enterprise	1			
			3 Years ProSupport with Next Business Day Onsite Service	1			
			Install VMWorkstation Professional for VM Disaster Recovery	1			
Y070	7	20-CCW-LEG-WS-01	Dell Wyse 5070 Thin Client	2	Dell		Legacy (Wonderware) Computer plus Spare hardware
			Wyse ThinOS, English, with PCoIP support	2			
			Extended Chassis	2			
			Dell KB216 Wired Keyboard Black (English)	1			
			Dell MS116 Wired Mouse Black	1			
			System 3 ft PC (English)	2			
			65W AC Adapter	2			
			Vertical stand	2			
			AMD Radeon 9173 PCI-E graphics card	2			
			8GB DDR4, 2400MHz, 2 SODIMM slots	2			
			16GB eMMC FLASH soldered	2			
			3 Years Return For Repair/Customer Pays Freight	2			
Y111	8	20-CCW-LEGWS01-MON-01	24" Monitor	1	Dell	P2417H	HMI Monitor for Legacy Thin Client
Y111	9	20-SC-WS01-MON-01	24" Monitor	1	Dell	P2417H	HMI Monitor for Security Workstation

MODEMS

Code	Item	Tag	Item Description	QTY	Manufacturer		Note
Y113	1	20-CCW-MODEM-01, 02	Internet Cellular Backup Modem with Antenna	2	Sierra Wireless	AirLink Raven RV55 Industrial LTE Gateway	Sierra Wireless AirLink Raven RV55 Industrial LTE Gateway with Ethernet/Serial/USB/GP S - North America - AC Adapter, Coax Extension, Wilson Electric Omni Plus Antenna, Mounting Bracket
			PowerTech PT8dBI Antenna	2	PowerTech	PT-8DBMAG-12-SM	Antenna

OT RACK

Code	Item	Tag	Item Description	QTY	Manufacturer		Note
Y116	1	20-CCW-OTRACK-01	SCADA Server Rack 42U	1	Vertiv	VR3150	
			1U Tool-less Blanking Panels (kit of 10)	2	Vertiv	VRA2000	
			Horizontal Cable Organizer 1U	2	Vertiv	VRA1002	
			Mounting Rail Brush Strip (kit of 12)	1	Vertiv	VRA2005	
			Toolless cable management rings ECRP015	2	Vertiv	VRA1009	
			Sliding Shelf	2	Vertiv	VRA3002	
			VR Bolt Down Brackets (kit of 2)	1	Vertiv	VRA4000	
			Vertiv Vertical PDU 208V VP8841	2	Vertiv	VP8841	
			Vertiv horizontal PDU 120V VP9563	1	Vertiv	VP9563	
Y115	2	20-CCW-KVM-01	18.5" LED LCD Monitor LRA185KMM, 16P KVM (AV3000/AV3216-001), 8 Cables, USB-KM, Video	1	Vertiv	LRA185KMM/ AV3216-001/LRA185KMM8D-G01	
Y116	3	94-CCW-RACK-01	Server Rack 42U	1	Vertiv	VR3150	For Temporary Server Room use.
			Sliding Shelf	2	Vertiv	VRA3002	
			VR Bolt Down Brackets (kit of 2)	1	Vertiv	VRA4000	

OT RACK - Patch Panels

Code	Item	Tag	Item Description	QTY	Manufacturer		Note
Y124	1	20-CCW-CPP-01	48 port RJ45 Patch Panel with QuickPort connectors RJ45	1	Leviton	49255-L48	Alternate Tripp Lite N252-048
			Leviton: 61110-RV6 QuickPort RJ45(Color Coded)	48	Leviton	61110-RV6	Alternate Tripp Lite Equivalent
Y125	2	20-CCW-FPP-01	2U LC Corning Patch Panel, see Fiber Optic Communication Specification	1	Corning	WCH-02P CCH-CP12-E7	WCH-02P, CCH-CP12-E7 (MM), CCH-CP12-A9 (SM)
			Rack mount 19 inch 2U per drawing for OT SCADA Rack				
			Access Type: Front and rear access slidable with lock				
			Connectors: LC type connectors for entry and exit of patch panel				
			Manufacturer" Corning Closet Connector Housing (CCH) with CCH connector panels and LC compatible adapters				
Y124	3	20-CCW-MEDIAPP-01	Multimedia Patch Panel 24 port with QuickPort connectors	1	Leviton	49255-L24	Alternate Tripp Lite N252-024
			Leviton 40835-W QuickPort USB Feed Through	4	Leviton	40835-W	Alternate Tripp Lite Equivalent
			Leviton 40834-W QuickPort HDMI Feed Through	4	Leviton	40834-W	Alternate Tripp Lite Equivalent

SECURITY RACK

Code	Item	Tag	Item Description	QTY	Manufacturer		Note
Y116	1	20-CCW-SECRACK-01	VR3150 42U Rack	1	Vertiv	VR3150	
			1U Tool-less Blanking Panels (kit of 10)	2	Vertiv	VRA2000	
			Horizontal Cable Organizer 1U	4	Vertiv	VRA1002	
			Mounting Rail Brush Strip (kit of 12)	1	Vertiv	VRA2005	
			Toolless cable management rings ECRP015	2	Vertiv	VRA1009	
			Sliding Shelf	2	Vertiv	VRA3002	
			VR Bolt Down Brackets (kit of 2)	1	Vertiv	VRA4000	
			Vertiv Vertical PDU 208V VP8841	2	Vertiv	VP8841	
			Vertiv horizontal PDU 120V VP9563	1	Vertiv	VP9563	

SECURITY RACK - Patch Panels

Code	Item	Tag	Item Description	QTY	Manufacturer		Note
Y124	1	20-CCW-SECCPP-01	48 port RJ45 Patch Panel with QuickPort connectors RJ45	1	Leviton	49255-L48	Alternate Tripp Lite N252-048
			Leviton: 61110-RV6 QuickPort RJ45(Color Coded)	48	Leviton	61110-RV6	Alternate Tripp Lite Equivalent
Y125	2	20-CCW-SECFPP-01	2U LC Corning Patch Panel, see Fiber Optic Communication Specification	1	Corning		WCH-02P CCH-CP12-E7
			Rack mount 19 inch 2U per drawing for OT SCADA Rack				
			Access Type: Front and rear access slidable with lock				
			Connectors: LC type connectors for entry and exit of patch panel				
			Manufacturer" Corning Closet Connector Housing (CCH) with CCH connector panels and LC compatible adapters				
Y124	3	20-CCW-SECMEDIAPP-01	Multimedia Patch Panel 24 port with QuickPort connectors	1	Leviton	49255-L24	Alternate Tripp Lite N252-024
			Leviton 40835-W QuickPort USB Feed Through	4	Leviton	40835-W	Alternate Tripp Lite Equivalent
			Leviton 40834-W QuickPort HDMI Feed Through	4	Leviton	40834-W	Alternate Tripp Lite Equivalent

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PRINTER

Code	Item	Tag	Item Description	QTY	Manufacturer	Part #	Note
Y134	1	20-CCW-PRINT-01	HP 11x17 Color Laser CP5225N	1	HP	CP5225N	

UPS

Code	Item	Tag	Item Description	QTY	Manufacturer		Note
Y126	1	20-CCW-UPS-01, 02	GXT5-5000MVRT4UXLN	2	Vertiv	GXT5-5000MVRT4UXLN with PD5-003 POD (2)	MAWWS (2) 208V 30A circuits
Y126	2	20-CCW-UPS-03, 04	GXT5-5000MVRT4UXLN	2	Vertiv	GXT5-5000MVRT4UXLN with PD5-003 POD (2)	MAWWS (2) 208V 30A circuits

VIDEOWALL MONITORS

Code	Item	Tag	Item Description	QTY	Manufacturer		Note
Y117	1	20-CCW-VIDMON-01	49" LCD Screen	1	LITEMAX/NEC	DLD4906-LNU-N01 /UN492S	Control Room HMI Monitor- Review Alternate LG 55SVH7F-A. 55 Inch Borderless LCD Monitor
			49",1000nits,3840x2160,HTnI.LID49C.AD2796DHP.AC100-240V,3in1,V1				
			4 Year Warranty				
			Wall Mount LVS1U	1	Legrand	LVS1U	
Y117	2	20-CCW-VIDMON-02	49" LCD Screen	1	LITEMAX/NEC	DLD4906-LNU-N01 /UN492S	Control Room HMI Monitor- Review Alternate LG 55SVH7F-A. 55 Inch Borderless LCD Monitor
			49",1000nits,3840x2160,HTnI.LID49C.AD2796DHP.AC100-240V,3in1,V1				
			4 Year Warranty				
			Wall Mount LVS1U	1	Legrand	LVS1U	
Y117	3	20-CCW-VIDMON-03	49" LCD Screen	1	LITEMAX/NEC	DLD4906-LNU-N01 /UN492S	Control Room HMI Monitor- Review Alternate LG 55SVH7F-A. 55 Inch Borderless LCD Monitor
			49",1000nits,3840x2160,HTnI.LID49C.AD2796DHP.AC100-240V,3in1,V1				
			4 Year Warranty				
			Wall Mount LVS1U	1	Legrand	LVS1U	
Y117	4	20-CCW-VIDMON-04	49" LCD Screen	1	LITEMAX/NEC	DLD4906-LNU-N01 /UN492S	Control Room HMI Monitor- Review Alternate LG 55SVH7F-A. 55 Inch Borderless LCD Monitor
			49",1000nits,3840x2160,HTnI.LID49C.AD2796DHP.AC100-240V,3in1,V1				
			4 Year Warranty				

			Wall Mount LVS1U	1	Legrand	LVS1U	
Y117	6	20-SC-WS01-MON-02	49" LCD Screen	1	LITEMAX/NEC	DLD4906-LNU-N01 /UN492S	Control Room Security Monitor Review -Alternate LG 55SVH7F-A. 55 Inch Borderless LCD Monitor
			49",1000nits,3840x2160,HTni,LID49C,AD2796DHP.AC100-240V,3in1,V1				
			4 Year Warranty				
			Wall Mount LVS1U	1	Legrand	LVS1U	
Y117	7	20-SC-WS01-MON-03	49" LCD Screen	1	LITEMAX/NEC	DLD4906-LNU-N01 /UN492S	Control Room Security Monitor Review -Alternate LG 55SVH7F-A. 55 Inch Borderless LCD Monitor
			49",1000nits,3840x2160,HTni,LID49C,AD2796DHP.AC100-240V,3in1,V1				
			4 Year Warranty				
			Wall Mount LVS1U	1	Legrand	LVS1U	

Cable/SFP

Code	Item	Tag	Item Description	QTY	Manufacturer		Note
Y109	1	01-PF-SFP-CIS10G-01	SFP-10G-SR	14	Cisco	SFP-10G-SR	
Y109	2	01-PF-SFP-DEL10G-01	SFP Dell 10GB	14	Dell	SFP-10G-USR	
Y109	3	01-PF-SFP-FORT1G-01	SFP Fortinet 1GB SX	4	Fortinet	FG-TRAN-SX	
Y138	4	01-PF-FIBCB-01	3m LC (Male) to LC (Male) Aqua OM4 Duplex Fiber OFNR (Riser-Rated) Patch Cable	10	Addonnetworks	ADD-LC-LC-3M5OM4	(Length Variable Same Cable Class)
Y139	5	01-PF-SUP-CAT6CB-BLU-01	10FT CAT6 BLUE RJ-45 CABLE M/M COPPER PATCH CABLE	4	Addonnetworks	ADD-10FCAT6-BLUE	(Length Variable Same Cable Class)
Y139	6	01-PF-MGT-CAT6CB-BLA-L01	10FT CAT6 BLACK RJ-45 CABLE M/M COPPER PATCH CABLE	12	Addonnetworks	ADD-10FCAT6-BLACK	(Length Variable Same Cable Class)
Y139	7	01-PF-PAC-CAT6CB-RED-L01	10FT CAT6 RED RJ-45 CABLE M/M COPPER PATCH CABLE	8	Addonnetworks	ADD-10FCAT6-RED	(Length Variable Same Cable Class)
Y141	8	20-CCW-CBLHDMI-01-02	HDMI Cable	4	Monoprice	13757	Control Room HMI Videowall Monitors/ Patch Cable (Length Variable Same Cable Class)
			Color: black				
			Model: 50ft HDMI Cable, M/M				
			AV Cable Type: HDMI cable				
			Interface Supported: HDMI				
			Left Connector Type: 19 pin HDMI Type A				
			Left Connector Gender: male				
			Right Connector Type: 19 pin HDMI Type A				
			Right Connector Gender: male				
			American Wire Gauge (AWG): 28				
			Length 50 ft				
Y141	9	20-CCW-SEC-CBLHDMI-01-02	HDMI Cable	2	Monoprice	13757	Control Room HMI Videowall Monitors/ Patch Cable (Length Variable Same Cable Class)
			Color: black				
			Model: 50ft HDMI Cable, M/M				
			AV Cable Type: HDMI cable				
			Interface Supported: HDMI				
			Left Connector Type: 19 pin HDMI Type A				
			Left Connector Gender: male				
			Right Connector Type: 19 pin HDMI Type A				
			Right Connector Gender: male				
			American Wire Gauge (AWG): 28				
			Length 50 ft				
Y142	10	20-CCW-CBLUSB20-01-02	50 foot USB 2.0 High Speed Active Extension / Repeater Cable	2	Monoprice	7532	Control Room HMI VideoWall KM (Length Variable Same Cable Class)
			Compliant with USB specification 2.0, 50 feet long				
			Type A male to Type A female				
			Data transfer up to 480 Mbps				
			No external power required				
			supports Windows and Macintosh systems				
Y142	11	20-CCW-SEC-CBLUSB20-01-02	50 foot USB 2.0 High Speed Active Extension / Repeater Cable	2	Monoprice	7532	Control Room Security VideoWall Monitors KM (Length Variable Same Cable Class)
			Compliant with USB specification 2.0, 50 feet long				
			Type A male to Type A female				
			Data transfer up to 480 Mbps				
			No external power required				
			supports Windows and Macintosh systems				
Y143	12	20-CCW-CBLDPHDMI01-04	DisplayPort to HDMI	4	Monoprice	12781	
Y143	13	20-CCW-SEC-CBLDPHDMI01-02	DisplayPort to HDMI	2	Monoprice	12781	

MAWSS WATER SCADA UPGRADE SOFTWARE COMPONENT DETAIL SHEET - CCW					
Item	Item Description	QTY	Manufacturer	Part #	Note
1	Windows Server 2019 Datacenter	1	Microsoft		SCADA Windows Server 2019 Datacenter (1 CPU per node (10 cores) x 3 Nodes) = Total Cores 30
2	Microsoft Server 2019 Client Access Licenses	25	Microsoft		Coordinate with MAWSS IT for Park Forest requirements.
3	Microsoft Office 2019 Standard	2	Microsoft		Microsoft Office 2019 Standard. Installed on the Operator Workstations.
4	VMWARE vSphere Essentials Plus	1	VMware	V57-ESP-KIT-C	VMWARE vSphere Essentials PlusDMZ VXRail With 3 Years Support
Other Software					
Item	Item Description	QTY	Manufacturer	Part #	Note
1	Adobe Reader	2	Adobe	Reader (free)	free version - thick clients and RDP servers
2	Network Time Sync	15	TIMESYNCTOOL	NET TIME 3.14 (free)	http://www.timesynctool.com/
3	VMWare Workstation Professional	1	VMWare	VMWare Workstation Professional 16	

Standard Hardware Specifications

Y070, Thin Client Terminal (Panel Mount)

Document History and Status

Revision	Date	Author	Reason for Change
0	7/14/2020	Gregg Gray/Jacobs	Initial Release.

- 1) SCADA Thin Clients to access HMI software.
- 2) Operating System: Windows 10 IoT.
- 3) Power: 12 VDC.
- 4) Mounting: Through Enclosure Door.
- 5) Specifications:
 - a. Screen Size: 21.5 inch.
 - b. Processor: Core i3-7100U.
 - c. Memory: 8GB DDR4.
 - d. Storage: 512 GB.
 - e. Touchscreen: PCAP Multi-touch.
 - f. Certification: UL.
- 6) Environmental:
 - a. Rating: NEMA 4 / IP65.
 - b. Operating Temperature: 0 – 60 Degrees Celsius.
- 7) Manufacturer: Zober, OIT-215.

Standard Hardware Specifications

Y101, SCADA Firewall

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	Nick Freeman/Jacobs	Original

- 1) Fortinet, Fortigate-100F.
- 2) 22x Gigabit Ethernet RJ45 ports (including 2x WAN ports, 1x DMZ port, 1x Management port, 2x HA ports, 16x switch ports with 4 SFP port shared media).
- 3) 4 SFP ports, 2x 10 Gigabit Ethernet SFP+ FortiLinks, dual power supplies redundancy.
- 4) Max managed FortiAPs (Total / Tunnel) 128 / 64.
- 5) Integrated with Active Directory services for the purposes of multifactor authentication.
- 6) Power supply: External redundant AC power supply, FRPS-100.
- 7) Warranty: Total 5 years extended hardware warranty.

Standard Hardware Specifications

Y102, NTP Time Source Appliance

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	Nick Freeman/Jacobs	Original

- 1) NTP appliance used for the purposes of providing accurate time for SCADA network and PLC devices.
- 2) Rack mountable GPS NTP Appliance.
- 3) Outdoor waterproof GPS antenna.
- 4) Outdoor surge suppressor.
- 5) Outdoor pole mounting hardware.
- 6) Power: 120V ac.
- 7) Interface Ports: Ethernet RJ45.
- 8) Manufacturers: TimeTools.
- 9) Model T550-00, no other exceptions.
- 10) Warranty: Total 6 years extended hardware warranty.

Standard Hardware Specifications

Y103, SCADA Host Hyperconverged Appliance

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	Original
1	6/1/2020	Hal McGilberry/MAWSS Team	Dell EMC VxRail preferred by MAWSS
2	2/1/21	John Shaffer/Jacobs	Added MAWSS Quote Reference

Hyperconverged virtual systems Dell EMC VxRail – Hardware/Software 5 years support Reference OP-000519598 / SO-000571404

1. VXRAIL-500 TPM 1.2 MODULE H	QTY 3
2. VXRAIL-500 RISER R740 CONFIG1NGL	QTY 3
3. VXRAIL-500 B4 RR 2-4 POST RACKS 2U1NH	QTY 3
4. VXRAIL MEMORY 32GB 2933MT RDIMM HH	QTY 18
5. VXRAIL FACTORYORD RQ 2933MHZ RDIMM	QTY 3
6. HCIA INSTALL KIT 10GBE SFP+ H	QTY 3
7. VXRAIL-500 NDC INTEL X710 QP 10GB SFP+ HFPH	QTY 3
8. CAPACITYHDD1.8TBH - VXR 1.8TB CAPACITY 10K RPM 2.5IN HDD H	QTY 9
9. VXR 400GB CACHE SSD 2.5IN H	QTY 3
10. M-PSM-HW-J-001-5Y - PROSUPPORT 4HR/MC VSAN STD HW-5 YR	QTY 3
11. PS1600W-250VACH - VXRAIL-500 DUALHOTPLG 1600W PS-250VAC H	QTY 3
12. VXRAIL-500 USA SHIPMOD GR1300	QTY 3
13. VXR NO ADDITIONAL PROCESSOR FOR GEN 2	QTY 3
14. SYSP5701SVSTDH - VXRAIL 14G P570 2U1N 1S VSAN STD H	QTY 3
15. C13-C14 PDU RACK PWR CRD 2M N. AM	QTY 6
16. VXRAIL-500 1SP570 125WL CHASSIS, FAN, HSK	QTY 3
17. HBA330CTRL1SH - VXRAIL-500 PERCHBA330RAIDCTR MINI12GB 1S	QTY 3
18. PROSV42101SH - VXR INTEL CPU SLVR 4210 2.2G,10C/20T 1SH	QTY 3

Standard Hardware Specifications

Y105, SCADA Network Storage Device (NAS)

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	

- 1) SCADA Network storage devices used for the purposes of storing.
- 2) Rack mounted 4 slot NAS appliance.
- 3) Rack slide rail kit for NAS.
- 4) 4TB SATA Drives QTY 4.
- 5) 4TB USB Drives QTY 2.
- 6) Manufacturers:
 - a) Synology NAS.
 - b) Seagate Drives.
- 7) Warranty:
 - a) NAS - Total 5 years extended hardware warranty.
 - b) Drives - Total 5 years extended hardware warranty.

Standard Hardware Specifications

Y106, Network Core and DMZ Switch

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	DRAFT
1	7/13/2020	Chris Howell / Jacobs	Spec modified for Cisco

- 1) Managed Layer 2 switch.
- 2) Configured in redundant fiber ring structure using Ring technology with multiple VLANs.
- 3) Rack Mountable.
- 4) Redundant 110/220V ac power supplies.
- 5) 10Gb Fiber ports per switch: 8 SFP+. 10Gb ports to be used only for the purposes of Hyperconverged appliance connectivity.
- 6) Copper ports per switch: 48 Multi-Gigabit 100M, 1G, 2.5G 5G 10G.
- 7) Minimum of 4 spare ports.
- 8) Manufacturer: Cisco C9300-48UXM or approved alternate. 9300-24-UX-A with C9300-NM-8X-10G.
- 9) Cisco SFP Modules, SFP-10G-SR.
- 10) Warranty: Total 5 years hardware warranty.

Standard Hardware Specifications

Y108, SCADA Field Switch

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	DRAFT
1	7/15/2020	Chris Howell/Jacobs	Change to Stratix

- 1) Managed field switch.
- 2) Where shown, configured in redundant fiber ring structure using Ring technology.
- 3) Din rail mounted.
- 4) Powered by 24V dc.
- 5) 1Gb Fiber ports: Two, minimum.
- 6) Copper ports: 8, Ethernet ports, minimum.
- 7) Minimum of 2 spare ports.
- 8) Manufacturer: Stratix 5700 Series with Full Software option, no exceptions.
- 9) Warranty: Total 5 years hardware warranty.

Standard Hardware Specifications

Y109, SFP Fiber Transceiver

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	DRAFT
1	2/2/21	John Shaffer	Added Dell, Cisco

- 1) Fiber connectors for SCADA, DMZ, and field switches.
- 2) 1G SFP Field Transceivers, 10G SFP Field Transceivers.
- 3) Manufacturers:
 - A) Cisco 10 GB SFP+
 - B) Dell 10 GB SFP+
 - C) Fortinet 1GB SFP+
- 4) Warranty: Total 5 years extended hardware warranty.

Standard Hardware Specifications

Y110, Thin Client Workstation

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	

- 1) SCADA Thin Clients to access HMI software.
- 2) Operating System: ThinOS.
- 3) Power:
 - A) 120V ac.
 - B) Interface Ports:
 - (1) 6 USB Ports or more.
 - (2) 6 Display Ports.
 - (3) 1 Gb/s RJ45.
 - C) Manufacturers:
 - (1) Dell, Wyse 5070.
 - (2) Or approved equal.
 - D) Support: ProSupport Plus: 3 Year Next Business Day Service.
 - E) Warranty: Total 5 years extended hardware warranty.

Standard Hardware Specifications

Y111, Workstation Monitor

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	

- 1) General:
 - A) Note: The following specifications outline minimum requirements for each base display.
 - B) Function: Provide viewing of client workstation.
- 2) Features:
 - A) Mounting: Base mounting as required for desktop mounting.
 - B) Screen:
 - (1) Size: 23.8 inch, Widescreen (16:9), minimum.
 - (2) Resolution: 1920 by 1080 pixels native.
 - (3) Contrast Ratio: 1,000:1 Static Contrast Ratio, minimum.
 - (4) Backlight: LED.
 - C) Power:
 - (1) 120V ac.
 - (2) Energy Star Compliant.
 - D) Interface Ports:
 - (1) VGA.
 - (2) DVI-D (HDCP).
 - (3) USB Port.
 - (4) 2 Display Ports.
 - (5) HDMI.
 - E) Manufacturers:
 - (1) Dell, P2417H.
 - (2) Or approved equal.

Standard Hardware Specifications

Y112, Management, Operator, Video Wall Thick Client Workstation

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	DRAFT
1	2/2/21	John Shaffer	Added Hot Spare, Teradici note.

- 1) Manufacturer: Dell
- 2) Model: Precision 7920.
- 3) Intel Xeon Silver 4110 2.1GHz, 3.0GHz Turbo, 8C, 9.6GT/s 2UPI, 11M Cache, HT (85W) DDR4-2400.
- 4) Windows 10 Pro for Workstations (4 Cores Plus).
- 5) NVIDIA® Quadro® P2200, 5GB, 4 DP.
- 6) 64GB (8x8GB) 2666MHz DDR4 RDIMM ECC.
- 7) Dual, Hot-plug, Redundant Power Supply (1+1), 1100W.
- 8) C5 SATA HDD/SSD Drives with RAID 0,1,5,10 (with PERC Controllers).
- 9) PERC H730P HW RAID Card 12Gbps SAS /SATA(6.0Gb/s) 2GB.
- 10) 2.5" 512GB SATA Class 20 Solid State Drive QTY 3. Hot Spare QTY 1
- 11) Optical Drives Slimline DVD ROM SATA.
- 12) RAID 5.
- 13) Dell KB216 Wired Keyboard English Black.
- 14) Dell MS116 Wired Mouse Black.
- 15) Remote Access Host Card, Dual Display, Tera2, Full Height. Required if Wyse Terminal required.
- 16) Network Cards Intel I350 (4x1Gbit) Quad Port.
- 17) US 120V Power Cord QTY 2.
- 18) ReadyRails Sliding Rails With Cable Management Arm.
- 19) iDRAC9, Enterprise.
- 20) Warranty: 3 Years Hardware with Onsite/In-Home Service after Remote Diagnosis.

Standard Hardware Specifications

Y113, Cellular Modem

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	DRAFT
1	2/2/21	John Shaffer/Jacobs	Cellular Modem

- 1) Network capable Cellular modem used for the purposes of providing network redundancy.
- 2) Power: 120V ac.
- 3) Interface Ports: Ethernet RJ45.
- 4) Manufacturers: Sierra Wireless.

Standard Hardware Specifications

Y115, KVM

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	Original

- 1) 18.5" LED LCD Monitor , 8P KVM, 8 CABLES, USB KB-US INTL.
- 2) Manufacturers: Vertiv / Avocent.
- 3) Part# LRA185KMM/ AV3216-001/LRA185KMM8D-G01-001.

Standard Hardware Specifications

Y116, Vertiv VR3150 42U Rack

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	DRAFT
1	6/30/2020	Warren Johnson/Jacobs	Equipment update
2	2/2/21	John Shaffer/Jacobs	Additional components

- 1) (Qty 1) 600mm Wide x 1100mm Deep Networking Enclosure with Sides Black, part# VR3150.
- 2) (Qty 2) 1U Tool less Blanking Panels; Kit of 10, part# /VRA2000.
- 3) 4) (Qty A/R) 1U Horizontal Cable Organizer with Metal D Rings, part# VRA1002.
- 5) (Qty 1) 19 " Rail Brush Strips, 800mm Wide; Kit of 12, part# VRA2005.
- 6) (Qty 2) Toolless D-Rings small; Kit of 10, part# VRA1009.
- 7) (Qty 1) VR Bolt Down Brackets; Kit of 2, part# VRA 4000.
- 8) (Qty 2) Shelf VRA 3002.
- 9) (Qty 2) PDU VP8841.
- 10) (Qty 1) PDU VP9563.

Standard Hardware Specifications

Y118, Video Wall Monitors (49 Inches)

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	DRAFT
1	2/2/21	John Shaffer/Jacobs	Added alternatives

- 1) Control room LCD monitors providing view of SCADA HMI or security.
- 2) Monitor Configuration: As shown on Drawings.
- 3) Screen Size: Minimum 49 inches.
- 4) Resolution: Minimum 3840x2160.
- 5) Warranty: Total 4-year hardware warranty.
- 6) Include monitor mounting hardware for Video Wall configuration.
- 7) Manufacturer: LITAMAX / NEC / LG.
- 8) Model: DLD4906-LNU-N01 / UN492S / 55SVH7F-A (55", Borderless).

Standard Hardware Specifications

Y119, Thick Client Workstation (HMI)

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	

- 1) Network management and Video Wall controller workstations.
- 2) Manufacturer: Dell Precision 7920.
- 3) Intel Xeon Silver 4110 2.1GHz, 3.0GHz Turbo, 8C, 9.6GT/s 2UPI, 11M Cache, HT (85W) DDR4-2400.
- 4) Windows 10 Pro for Workstations (4 Cores Plus).
- 5) QTY 2 NVIDIA® Quadro® P2000, 5GB, 4 DP.
- 6) 64GB (8x8GB) 2666MHz DDR4 RDIMM ECC.
- 7) Dual, Hot-plug, Redundant Power Supply (1+1), 1100W.
- 8) C5 SATA HDD/SSD Drives with RAID 0,1,5,10 (with PERC Controllers).
- 9) PERC H730P HW RAID Card 12Gbps SAS /SATA(6.0Gb/s) 2GB.
- 10) 2.5" 512GB SATA Class 20 Solid State Drive QTY 3.
- 11) Optical Drives Slimline DVD ROM SATA.
- 12) RAID 5.
- 13) Radeon Pro WX 9100, 16GB, 6 mDP WITH 6 (mDP to HDMI ADAPTERS/CABLES)
- 14) Dell KB216 Wired Keyboard English Black.
- 15) Dell MS116 Wired Mouse Black.
- 16) Teradici Remote Workstation Access Host Card.
- 17) Remote Access Host Card, Dual Display, Tera2, Full Height.
- 18) Network Cards Intel I350 (4x1Gbit) Quad Port.
- 19) US 120V Power Cord QTY 2.
- 20) ReadyRails Sliding Rails With Cable Management Arm.
- 21) IDRAC9, Enterprise.
- 22) Warranty: 3 Years Hardware with Onsite/In-Home Service after Remote Diagnosis.

Standard Hardware Specifications

Y120, Thick Client Workstation (Security)

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	

- 1) Security workstation.
- 2) Dell Precision 7920.
- 3) Intel Xeon Silver 4110 2.1GHz, 3.0GHz Turbo, 8C, 9.6GT/s 2UPI, 11M Cache, HT (85W) DDR4-2400.
- 4) Windows 10 Pro for Workstations (4 Cores Plus).
- 5) QTY 2 NVIDIA® Quadro® P2000, 5GB, 4 DP.
- 6) 64GB (8x8GB) 2666MHz DDR4 RDIMM ECC.
- 7) Dual, Hot-plug, Redundant Power Supply (1+1), 1100W.
- 8) C5 SATA HDD/SSD Drives with RAID 0,1,5,10 (with PERC Controllers).
- 9) PERC H730P HW RAID Card 12Gbps SAS /SATA(6.0Gb/s) 2GB.
- 10) 2.5" 512GB SATA Class 20 Solid State Drive QTY 3.
- 11) Optical Drives Slimline DVD ROM SATA.
- 12) RAID 5.
- 13) Radeon Pro WX 5100, 16GB, 6 mDP WITH 6 (mDP to HDMI ADAPTERS/CABLES)
- 14) Dell KB216 Wired Keyboard English Black.
- 15) Dell MS116 Wired Mouse Black.
- 16) Teradici Remote Workstation Access Host Card.
- 17) Remote Access Host Card, Dual Display, Tera2, Full Height.
- 18) Network Cards Intel I350 (4x1Gbit) Quad Port.
- 19) US 120V Power Cord QTY 2.
- 20) ReadyRails Sliding Rails With Cable Management Arm.
- 21) iDRAC9, Enterprise.
- 22) Warranty: 3 Years Hardware with Onsite/In-Home Service after Remote Diagnosis.

Standard Hardware Specifications

Y121, 48 Port RJ45 Patch Panel

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	

- 1) Copper Patch Panel, 48-port, rack mount QTY 1.
- 2) Manufacturer: Leviton.
- 3) Part Number: QuickPort.
- 4) Extreme 6+ QuickPort Connector, CAT 6 blue QTY 24.
- 5) Manufacturer: Leviton.
- 6) Part Number: 61110-RV6.

Standard Hardware Specifications

Y123, Rack mounted Power Strip

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	

- 1) 1.4kW Single-Phase Metered PDU.
- 2) 120V Outlets(13 5-15R), 5-15P, 100-127V Input.
- 3) 15ft Cord, 1U Rack-Mount.
- 4) Manufacturer: Tripplite.
- 5) Model: PDUMH15, no exceptions.

Standard Hardware Specifications

Y124, Rack mounted Multimedia Patch Panel

Document History and Status

Revision	Date	Author	Reason for Change
0	07/14/2020	John Shaffer/Jacobs	DRAFT
1	2/2/2021	John Shaffer/ Jacobs	Added Alternates
2	3/25/2021	Gregg Gray / Jacobs	Removed Alternates

- 1) 12 Port Multimedia Patch Panel
- 2) Keystone/Multimedia USB 2.0, USB3.0 HDMI
- 3) 1U Rack-Mount
- 4) Manufacturer: Tripplite
- 5) Panel Model: N062-012-KJ
- 6) Coupler Model P164-000-KP-BK HDMI (Qty.as required)
- 7) Coupler Model U060-000-KP-BK USB 2.0(Qty as required)

Standard Hardware Specifications

Y125, Rack mounted Fiber Patch Panel

Document History and Status

Revision	Date	Author	Reason for Change
0	2/2/21	John Shaffer/Jacobs	

- 1) LC Corning Patch Panel.
- 2) Corning WCH-02P, CCH-CP12-E7 (MM), CCH-CP12-A9 (SM).
- 3) 2U Rack-Mount.
- 4) Manufacturer: Corning.
- 5) Panel Model: N062-012-KJ.
- 6) Access Type: Front and rear access slidable with lock.
Connectors: LC type connectors for entry and exit of patch panel.
Manufacturer" Corning Closet Connector Housing (CCH) with CCH connector panels and LC compatible adapters.

Standard Hardware Specifications

Y126, Vertiv GXT5-5000MVRT4UXLN

Document History and Status

Revision	Date	Author	Reason for Change
0	07/20/2020	John Shaffer/Jacobs	DRAFT
1	2/2/2021	John Shaffer/Jacobs	Added POD

- 1) 5,000 VA/5,000W.
- 2) INPUT 176 - 280 VAC Input Wiring Hard-wired terminal block 3W + G (L-L-N-G).
OUTPUT 208/120VAC Outlets Hard-wire, Include POD Hardwire.
- 3) 4U Rack-Mount.
- 4) Manufacturer: Vertiv.
- 5) Model: GXT5-5000MVRT4UXLN.
- 6) POD PD5-003 POD.

Standard Hardware Specifications

Y134, SCADA Printer

Document History and Status

Revision	Date	Author	Reason for Change
0	4/2/2020	James Stewart/Jacobs	Original

- 1) CP5225N Color Laser 11x17.
- 2) Manufacturer: HP.

Standard Hardware Specifications

Y138, Fiber Patch Cable

Document History and Status

Revision	Date	Author	Reason for Change
1	2/2/21	John Shaffer\Jacobs	Added Y spec

- 1) LC (Male) to LC (Male) Aqua OM4 Duplex Fiber OFNR (Riser-Rated) Patch Multimode.
- 2) Manufacturers: Addonnetworks or equal.

Standard Hardware Specifications

Y139, CAT6 Cable

Document History and Status

Revision	Date	Author	Reason for Change
1	2/2/21	John Shaffer\Jacobs	

- 1) CAT6 RJ45 Cable (Variable Length/Color).
- 2) Manufacturers: Addonnetworks or equal.

Standard Hardware Specifications

Y141, HDMI Cable

Document History and Status

Revision	Date	Author	Reason for Change
1	2/2/21	John Shaffer\Jacobs	

- 1) HDMI Cable (Length Variable).
- 2) Manufacturers: Monoprice 13757.

Standard Hardware Specifications

Y142, USB Active Extension

Document History and Status

Revision	Date	Author	Reason for Change
1	2/2/21	John Shaffer\Jacobs	

- 1) USB Active Extension (Length variable).
- 2) Manufacturers: Monoprice 7532.

Standard Hardware Specifications

Y143, Display Port to HDMI Cable

Document History and Status

Revision	Date	Author	Reason for Change
1	2/2/21	John Shaffer\Jacobs	

- 1) Display Port to HDMI.
- 2) Manufacturers: Monoprice 12781.

SECTION 40 95 80
FIBER OPTIC COMMUNICATION SYSTEM

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. Electronic Components, Assemblies, and Materials Association (ECA): 310-E, Cabinets, Racks, Panels, and Associated Equipment.
2. Institute of Electrical and Electronic Engineers, Inc. (IEEE): 802.3, Telecommunications and Information Exchange Between Systems—Local and Metropolitan Networks.
3. Insulated Cable Engineers Association (ICEA):
 - a. S-83-596, Optical Fiber Premises Distribution Cable.
 - b. S-87-640, Optical Fiber Outside Plant Communications Cable.
 - c. S-104-696, Indoor-Outdoor Optical Fiber Cable.
4. International Organization for Standardization (ISO): 9001, Quality Management Systems—Requirements.
5. International Telecommunication Union (ITU): T G.652, Characteristics of a Single-mode Optical Fibre and Cable.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. QuEST Forum (QF): TL 9000, Quality Management Systems.
8. Rural Development Utilities Programs (RDUP):
 - a. 7 CFR 1755.902, Minimum Performance Specification for Fiber Optic Cables.
 - b. 7 CFR 1755.903, Fiber Optic Service Entrance Cables.
9. Telecommunications Industry Association (TIA):
 - a. 526-7, OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
 - b. 526-14, OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
 - c. 568-C.1, Commercial Building Telecommunications Cabling Standards.
 - d. 568-C.3, Optical Fiber Cabling Components Standard.
 - e. 598, Optical Fiber Cable Color Coding.
 - f. 606, Administration Standard for Commercial Telecommunications Infrastructure.

10. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
 - a. 455-78, FOTP-78 - IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Test Procedures – Attenuation.
 - b. 455-133, FOTP-133 IEC-60793-1-22 Optical Fibres Part 1-22: Measurement Methods and Test Procedures Length Measurement.
 - c. 492AAAA, Detail Specification for 50-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
 - d. 492AAAB, Detail Specification for 50-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
 - e. 492AAAC, Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
 - f. 492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
 - g. 492CAAB, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
 - h. 604-2, FOCIS-2 Fiber Optic Connector Intermateability Standard, Type ST.
 - i. 604-3, FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and SC-APC.
 - j. 604-12, FOCIS-12 Fiber Optic Connector Intermateability Standard, Type MT-RJ.
 - k. 942, Telecommunications Infrastructure Standard for Data Centers.
 - l. TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems-Contains Color.
11. Underwriter Laboratories (UL): 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 DEFINITIONS

- A. dB: Decibel.
- B. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.
- C. FOCS: Fiber Optic Communication System.
- D. FOPP: Fiber Optic Patch Panel.

- E. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.
- F. Hybrid Cable: Cable containing more than one type of fiber.
- G. LAN: Local Area Network.
- H. m: Micrometer.
- I. Mbps: Megabits per Second.
- J. Mechanical Splice: Connecting ends of two fibers together by means other than fusion.
- K. Megahertz (MHz): One million cycles per second.
- L. MHz: Megahertz.
- M. micro: $\times 10^{-6}$.
- N. Micron: Micrometer or one millionth meter.
- O. MUTOA: Multi-User Telecommunications Outlet Assembly.
- P. n, nano: $\times 10^{-9}$.
- Q. N: Newton.
- R. nm: Nanometer—unit of measure equal to one billionth meter.
- S. OFNP: Nonconductive Optical Fiber Plenum Cable.
- T. OLTS: Optical Loss Test Sets.
- U. OTDR: Optical Time Domain Reflectometer.
- V. PIC: Process Instrumentation and Control.
- W. Plenum: Air return path of central air handling system, such as open space above suspended ceiling.
- X. UPS: Uninterruptible Power Supply.
- Y. V ac: Volts Alternating Current.
- Z. WAN: Wide Area Network.

1.03 SYSTEM SUMMARY

- A. This section covers requirements for Fiber Optic Communications Subsystem (FOCS) and is in addition to Section 40 90 00, Instrumentation and Control for Process Systems.
- B. Major Work Items Include but are Not Necessarily Limited to: Engineering, designing, supplying, installing, adjusting, testing, documenting, and commissioning for a complete Fiber Optic Communications Subsystem (FOCS). Scope of work includes SCADA fiber optic network and separate Security fiber optic network. See contract drawings for details and routing.
 - 1. Fiber optic cable and patch cords.
 - 2. Fiber optic patch panels and enclosures. See 40 90 00, Supplement 5 for listing of fiber optic patch panels.
 - 3. Installation of a complete and fully functioning temporary FOCS including:
 - a. Installing fiber optic cable.
 - b. Fiber optic terminations.
 - 4. Installation of a complete and fully functioning final FOCS including:
 - a. Installing fiber optic cable.
 - b. Fiber optic terminations.
 - 5. Interfaces with existing fiber optic systems.
 - 6. Coordination with Owner for fiber optic connections to establish, relocate, and/or maintain off-site (WAN) communications.
 - 7. Testing of the FOCS including:
 - a. OTDR testing on existing cables.
 - b. On-the-reel fiber optic cable testing.
 - c. OLTS and OTDR testing on installed fiber optic cable system.
- C. Functional Requirements:
 - 1. Function of FOCS is to transmit digital data between network nodes. Requirements listed identify minimum acceptable system performance.
 - 2. Provide a FOCS based on referenced standards for use in the following local and wide area networks:
 - A. Fast Ethernet (100BASE-FX).
 - 3. Provide Ethernet network fiber optic rings as shown on Drawings.
 - 4. Network(s) will be used by PIC to distribute data and coordinate Owner's operations.
- D. Electrical Subcontractor to furnish and install conduit for fiber optic cable.
- E. Coordinate conduit requirements with Electrical Subcontractor.

F. Coordination with the Owner Requirements:

1. Coordinate each specific existing fiber pair to be used with the Owner.
2. Prior to demolishing the existing fiber link shown on Contract Drawings, when disconnecting each fiber link, coordinate with the Owner to ensure that all existing fiber communications remain operational.

G. Refer to P&IDs, SCADA Network Block Diagrams, Security Network Diagrams, and Electrical drawings for additional requirements.

1.04 SUBMITTALS

A. Action Submittals:

1. Block Diagram Showing:
 - a. Cable Routing and types of cables used.
 - b. Patch locations.
 - c. Catch and patch panel identification.
 - d. Cable attenuation between each patch location.
2. Cable Schedule Showing:
 - a. Cable identification.
 - b. Fiber counts for each cable and identification of used fiber pairs.
3. Component Data:
 - a. Cover sheet including tag number, component number, manufacturer and model number, major features, included options and quantities.
 - b. Manufacturer and model number.
 - c. General data and description.
 - d. Engineering specifications and data sheet.
 - e. Scaled drawings and mounting arrangements.
4. Light Budget Calculations showing:
 - a. Light emitting and receiving device pair power budget in dB.
 - b. Attenuation between emitting and receiving device including all fiber optic cables, patch cords, connectors, patches, and repeaters between devices.
 - c. Reserve light budget required by emitting and receiving device pair.
 - d. Total remaining power budget in dB after all attenuation and reserve has been subtracted.

B. Informational Submittals:

1. Manufacturer's statement that installer is certified to perform installation Work.
2. Subcontractor Qualifications:
 - a. FOCS Subcontractor: Minimum of 5 years' experience providing, integrating, installing, and commissioning of similar systems.
 - 1) Statement of Experience: List of at least three fiber optic data communications systems comparable to system specified which have been furnished and placed into operation. For each system, provide following information:
 - a) Owner's name, address, telephone number, and name of current operations supervisor or other contact.
 - b) Description of system hardware configuration, including major equipment items, number of nodes, and communication standards implemented.
 - c) System block diagram.
 - d) Dates when contract was signed, equipment was delivered, and system was accepted by Owner. Also, include originally scheduled completion date and if different from actual date, explain why.
 - e) Approximate value of listed FOCS provided in dollars.
 - b. FOCS Subcontractor's Site Representative: Minimum of 5 years' experience installing similar systems.
 - c. FOCS Installer Qualifications:
 - 1) Submit splicer training and certification by the manufacturer of the fiber splice material to be used in the fiber optic splicing procedures.
 - 2) Submit proof of certification by fiber cable manufacturer.
 - d. Qualification of Personnel:
 - 1) Resumes identifying management and technical qualifications of supervisory, local service representative, and key personnel.
 - 2) Qualification data of firm and persons to demonstrate capabilities and experience in the following areas:
 - a) Fiber optic cable handling and placement techniques.
 - b) Fiber optic fusion splicing and installation of connections.
 - c) Attenuation testing procedures.
 - e. Owner acceptance of FOCS Subcontractor does not exempt FOCS Subcontractor or Contractor from meeting Contract Document requirements nor does it give prior acceptance of subsystems, equipment, materials, or services.

3. Testing Related Submittals:
 - a. OTDR certification, current within last 12 months.
 - b. Optical Power meter certification, current within last 12 months.
 - c. Pre-Installation Test Documentation: As specified under paragraph On the Reel Testing.
 - d. Post-Installation Test Documentation:
 - 1) As specified under paragraph Post-Installation Testing and Test Report Documentation.
 - 2) An updated version of the link calculations specified under paragraph Shop Drawings including:
 - a) Actual cable lengths used.
 - b) Actual losses measured by the tests.
 - c) Revised light margin calculations.
4. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Optical Fiber Cable and Cable Splice Centers:

1. Outside, Underground/Submerged: Minus 20 degrees C to 40 degrees C.
2. Outside, Overhead: Minus 40 degrees C to 80 degrees C.
3. Outside, Aboveground in Conduit: Minus 40 degrees C to 80 degrees C.
4. Inside: 0 degree C to 40 degrees C.

B. Equipment:

1. Outside, Aboveground: Minus 40 degrees C to 80 degrees C.
2. Control Rooms, Equipment Rooms, and Telecommunications Closets: 30 percent to 55 percent relative humidity, 18 degrees C to 24 degrees C.
3. Other Interior Areas: 0 percent to 100 percent relative humidity, 5 degrees C to 35 degrees C.

1.06 SPECIAL GUARANTEE

- A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of Work specified in this specification section found defective during a period of 5 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.

1.07 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and materials:

Item	Quantity
Jumpers of each length needed	One per unit
Special maintenance tools	One complete set

- B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 GENERAL

- A. Install and use specified products within the parameters determined by the product manufacturers, codes, standards, and regulatory agencies.
- B. Provide materials and equipment labeled and/or listed in accordance with the National Electric Code.
- C. Provide manufacturer's standard finish color, except where specific color is indicated.
- D. Complete the detailed design, supply, deliver, install, test, and commission all materials necessary to provide a complete and operational Fiber Optic Cabling System (FOCS), including but not limited to:
1. FOCS and accessories, including:
 - a. Fiber optic cable.
 - b. Fiber optic connectors.
 - c. Fiber optic patch cords.
 2. FOCS system testing, including:
 - a. On-the-reel fiber optic cable testing.
 - b. Fiber optic cable system testing.

2.02 MATERIALS

- A. Fiber Optic Cable:

1. Fiber Characteristics: Multimode
 - a. Comply with TIA/EIA 568 and ANSI X3T9.5.
 - b. 50/125 μ m graded-index glass.
 - c. Tight-buffered, 900 μ m buffer.

- d. Maximum attenuation:
 - 1) 850 nm: 2.8 dB/km.
 - 2) 1,300 nm: 1.0 dB/km.
- e. Minimum effective Modal bandwidth: 5350 MHz-km.
- f. Color-coded buffer as per TIA/EIA 598.
- g. Minimum bend radius, buffered fiber: 1-inch.
- h. Proof Testing: 100 kpsi.
- 2. Cable:
 - a. Fiber Count: 12 fibers per cable, or as shown on the Drawings.
 - b. All Dielectric Construction: No electrically conductive components in the fiber optic cable are allowed.
 - c. Gel Free: Fibers tight-buffered, not in gel-filled loose-tube.
 - d. Style: Distribution.
 - e. Water blocked.
 - f. Strength Member:
 - 1) Nonconductive; integral part of cable; supports stress of installation and load during use.
 - 2) Fiberglass epoxy rod, aramid fiber, Kevlar.
 - 3) Minimum Tensile Strength: 600 pounds.
 - g. Protective Covering:
 - 1) Polyvinylchloride (PVC).
 - 2) Continuous and free from holes, splices, blisters, and other imperfections.
 - h. Minimum Bend Radius:
 - 1) Short-term under Tension: 20 times cable diameter.
 - 2) Long-term Tension: 15 times cable diameter.
 - i. Identification:
 - 1) Identify with Identification Devices in accordance with Section 26 05 05, Conductors.
 - 2) Use waterproof tags and identifications.
 - j. Special Features:
 - 1) Indoor Use: Must be flame-retardant. Ratings shall be compliant with NFPA and NEC standards.
 - 2) Outdoor Use:
 - a) Direct burial rated.
 - b) UV Resistant.
 - c) Suitable for installation in buried conduit.
 - k. Manufacturer:
 - 1) Corning, FREEDM® Cables.
 - 2) Approved Equal.

B. Connectors:

1. Features:
 - a. In accordance with the requirements of TIA/EIA 568, Section 12.4.3 or Annex F.
 - b. Connector Type:
 - 1) Connectors at field-mounted patch panels are SC type.
 - 2) Connectors at network racks are LC type.
 - c. Pull Strength: 0.2 N minimum.
 - d. Durability: Sustain minimum 500 mating cycles without violating other requirements.
 - 1) Ferrules: Free-floating low loss ceramic.
 - 2) Polarizing key on duplex connector system.

C. Quantity: Connectorize fibers, minimum per cable: Multimode: as shown on Drawings:

1. Attenuation:
 - a. In accordance with requirements of TIA/EIA 568, Section 12.4.4.
 - b. Maximum of 0.75 dB per connector pair.
2. Manufacturer:
 - a. Corning.
 - b. Or approved equal.

D. Patchcords:

1. General:
 - a. Features: In accordance with TIA 568-C.3. Cable ratings shall be compliant with NFPA and NEC standards.
 - b. Function: Connect fiber centers to network nodes, such as Ethernet switches.
 - c. Fiber Characteristics: In accordance with requirements for fiber optic cable.
 - d. Cable Configuration:
 - 1) Individual tight-buffer thermoplastic, fibers single mode, to match fibers being jumpered on.
 - 2) Protected with kevlar strength members and enclosed in thermoplastic jacket.
 - e. Connectors:
 - 1) As required by Article Connectors.
 - 2) On-axial Pull Strength: 33 N.
 - 3) Normal-to-Axial Pull Strength: 22 N.
 - f. Color: Manufacturer standard.
 - g. Length: Manufacturer standard, to meet requirements as shown.

- h. Connector Types:
 - 1) Field-mounted Patch Panel: SC type.
 - 2) Network Racks: LC type for multimode LC: Typical of 0.1 dB and maximum of 0.3 dB.
 - 3) Patch panel and network rack: SC connector on one end and a LC connector on the other end.
- i. Manufacturer:
 - 1) Corning.
 - 2) Or approved equal.

E. Patch Panel (Rack-Mount Type):

- 1. General:
 - a. Features: Provides a secure place to terminate fiber optic cables.
 - b. Features:
 - 1) Rack mount on SCADA and Security Network Racks.
 - 2) Size: 19-inch rack-mount, 2U, 3U, or 4U as shown on Contract Drawings.
 - 3) Access Type: Front and rear access slidable with lockable capability.
 - 4) Connectors: LC type connectors for entry and exit of patch panel.
 - c. Quantity and Size: Refer to section 40 94 13 and Operational Technology (OT) drawings. All fibers shall be terminated and connected to a connector on the connector panel in the patch panel.
 - d. Manufacturer:
 - 1) Corning Closet Connector Housing (CCH) with CCH connector panels and LC compatible adapters.
 - 2) Or approved equal.

F. Patch Panel (NEMA 12):

- 1. General:
 - a. Features: Provides a secure place to terminate fiber optic cables.
 - b. Features:
 - 1) Wall or panel mount.
 - 2) Compartments: Two; one for fiber optic cable and one for jumpers to individual equipment.
 - 3) Coil Former: Former to wind slack cable around, provides controlled long-radius bends.
 - 4) Connectors: SC type connectors for entry and exit of patch panel.

- c. Quantity and Size: Refer to specification section 40 90 00, Supplement 5. All fibers shall be terminated and connected to a connector on the connector panel in the patch panel.
- d. Manufacturer:
 - 1) Corning patch panel (WCH) with CCH connector Panels and SC compatible adapters.
 - 2) Or approved equal.

G. Patch Panel (NEMA 4X):

- 1. General:
 - a. Features: Provides a secure place to terminate fiber optic cables.
 - b. Features:
 - 1) Wall, rack, or pole mount.
 - 2) NEMA 4X, IP66.
 - 3) Compartments: Two; one for fiber optic cable and one for jumpers to individual equipment.
 - 4) Coil Former: Former to wind slack cable around, provides controlled long-radius bends.
 - 5) Connectors: SC type connectors for entry and exit of patch panel.
 - c. Quantity and Size: Refer to specification section 40 90 00, Supplement 5. All fibers shall be terminated and connected to a connector on the connector panel in the patch panel.
 - d. Accessories: Provide grounding kit and conduit fittings as required for each installation.
 - e. Manufacturer:
 - 1) Corning patch panel (EDC) with CCH connector panels and SC compatible adapters.
 - 2) Or approved equal.

H. Patch Panel (NEMA 3S):

- 1. General:
 - a. Features: Provides a secure place to terminate fiber optic cables.
 - b. Features:
 - 1) Wall mount.
 - 2) Compartments: Two; one for fiber optic cable and one for jumpers to individual equipment.
 - 3) Coil Former: Former to wind slack cable around, provides controlled long-radius bends.
 - 4) Connectors: SC type connectors for entry and exit of patch panel.

- c. Quantity and Size: Refer to specification section 40 90 00, Supplement 5. All fibers shall be terminated and connected to a connector on the connector panel in the patch panel.
- d. Manufacturer:
 - 1) Corning industrial patch panel (ICH) with CCH connector Panels and SC compatible adapters.
 - 2) Or approved equal.

2.03 CONDUIT

- A. Provided under Division 26, Electrical.

2.04 ACCESSORIES

- A. Hardware: Provide cable clamps, strain reliefs, blocking and grommet kits, closures, and fan outs for complete installation.

PART 3 EXECUTION

3.01 PREPARATION

- A. Conduits are provided under Division 26, Electrical.
 - 1. Ensure installed conduit system conforms to fiber optic system requirements, including:
 - a. Conduits: Size and number.
 - b. Access Holes, Handholes, and Pull Boxes: Location and size, to ensure cables may be installed without exceeding manufacturer's limitations.
 - c. Outlet Boxes: Size to coordinate with outlet cover plates for adequate volume and bend radius.
 - 2. Spare Conduit: No cables shall be pulled into spare conduit.
 - 3. Expansion Plugs: Seal conduit to stop ingress of water and grit with fabricated expansion plugs.
 - 4. Existing Conduit: Refer to Electrical Drawings.
 - 5. Ensure duct bank, conduit, and other confined routing is free and clear of debris before cable placement.

3.02 GENERAL METHODS

- A. Fiber Optic Cable:
 - 1. Follow the cable manufacturer's recommendations for bend radius, maximum pulling tension, and buffer tube bending radius. Do not exceed the pulling tension or minimum cable bend radius limits specified by the manufacturer.

2. Provide abrasion protection for cables or wire bundles, which pass through holes or across edges of sheet metal.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Provide protection for exposed cables where subject to damage.
5. Fiber optic Cable splices: Not allowed for any fiber optic cable.

3.03 INSTALLATION

A. Fiber Optic Cable:

1. Specified fiber counts, routing, origination, and terminating points are indicated on Drawings.
2. Installation by manufacturer's certified installer.
3. Install cables in accordance with manufacturer's requirements.
4. Install cable directly from shipping reels. Ensure that cable is:
 - a. Not dented, nicked, or kinked.
 - b. Not subjected to pull stress greater than manufacturer's specification.
 - c. Not bent to a radius below manufacturer's minimum bend radius.
 - d. Not subjected to treatment that may damage fiber strands during installation.
5. Cables per Conduit: In accordance with NFPA 70 NEC conduit fill limitations.
6. If calculation indicates cable will attenuate signals more than 8 dB, reroute may be allowed if approved by Engineer.
7. Connector: Insertion loss on multimode connections exceeding 0.5 dB and 0.4 dB on single-mode connections not permitted.
8. Identification:
 - a. Identify cable on both ends, in access holes, and pull points.
 - b. In accordance with TIA 606.
9. Arrange cable, equipment, and hardware to provide neat appearance and accessibility for servicing.
10. Access Holes:
 - a. Provide supports for cables in access and handholes at minimum 600 mm centers along sides.
 - b. While maintaining minimum bend radius, lace cables neatly to supports to keep them out of way of personnel.

B. Cable Terminations:

1. In accordance with TIA 568-C.3.
2. Fan out fiber cable to allow direct connectorization of connectors.
 - a. Sleeve over individual fibers with transparent furcation tubes.
 - b. At point of convergence of furcation tubes, provide strain relief with metal or high density plastic fan-out collar.

3. Break-out Kits:
 - a. Terminate cables using manufacturer-supplied break-out kits.
 - b. Terminate in accordance with manufacturer's recommendations.
4. Slack:
 - a. Fiber Centers, Hubs, and Switches: Minimum, 3-meter slack fiber at each end, coiled neatly in cable management equipment.
 - b. Communications Management Outlets: Minimum, 1-meter slack fiber, coiled neatly in outlet box.
5. Connectors:
 - a. Terminate 100 percent fibers in each cable to specified connector.
 - b. Connect into fiber management system.

C. Conduit: Provided by Division 26, Electrical.

3.04 LABELING CONVENTIONS

- A. Cable Scheme: Cables will have a consistent Control Panel to/from (To/from denoted by an underscore) label format, which includes the Control Panel tag numbers with their Locations/Descriptions. For example, the fiber cable between the Blower Building and Electrical Building will have the following label: 82-CP-1 Blower Building _83-CP-1 Electrical Building.
- B. Port Scheme for Fiber Optic Patch Panels & Network Switches: Ports will have a consistent label with the Control Panel tag number and the Control Panel location/description of where the cable has originated from.

3.05 FIELD QUALITY CONTROL

- A. Perform inspections and tests specified hereinafter.
- B. General Inspection Requirements:
 1. As part of any performance test, inspect cable, material, and equipment for physical damage, continuity, and proper connection.
 2. Verify identification and labeling at required locations for visibility, condition, legibility, and accuracy.
 3. Verify cable connection, cable support, and terminations are properly installed.
- C. General Test Requirements:
 1. At the completion of fiber optic cable installation, conduct performance tests and complete corresponding test reports for delivery to the Engineer.

2. Furnish test equipment and personnel required for tests. Tester shall be calibrated within 1 year of the test being performed. Provide a photocopy of the equipment calibration certificate. Technicians performing the tests require current training certification for the equipment being used and the media being tested. Provide a photocopy of their training/certification documentation prior to the start of testing.
3. Tests shall demonstrate that cable, material, and equipment components and assemblies operate in accordance with the Contract Documents.

D. General Test Report Requirements:

1. Include the following section in each test report:
 - a. Project identification, location, contractor, and test date.
 - b. Scope of testing.
 - c. List the test equipment identification number used for testing.
 - d. List of technician(s) performing the tests identified in the scope of testing.
 - e. Summary of Test Results.
 - f. Individual Test Data Sheets: Each sheet shall contain identification sufficient to correlate test result with installed cable.
2. Submit record copies of completed test reports to the County no later than one week after completion of the testing included in the report.
 - a. Submit hardcopy of test reports providing reproducible quality printing.
 - b. Submit individual test data reports on electronic media along with the software needed to read the media.

- E. Fiber optic strands, which fail to meet performance test criteria and defective terminating devices, shall be replaced by the Contractor. Test reports shall include test data from both the cable that failed and its replacement cable.

3.06 PRE-INSTALLATION FIBER OPTIC CABLE SYSTEM TESTING

- A. Perform optical time domain reflectometer (OTDR) on-the-reel tests for each fiber strand within the fiber optic cable after delivery to the Project Site.
- B. Preparation:
1. Assign a unique number to each reel. Record this reel number on the manufacturer's product test data shipped with the cable reel, and on each test report that references cable taken from the reel. Installed cable segments shall be traceable to the reel, and thus to the manufacturer's test data. If the manufacturer's product test data is not shipped with the cable reel, arrange for the cable distributor to provide a copy.
 2. Submit documentation providing the proposed testing sequence, expected duration, and scheduled date and time for testing to the Engineer.

C. Performance Tests:

1. Verify that each reel holds one continuous cable.
2. Review factory-produced manufacturer's product test data to confirm conformance to product specifications included elsewhere in the Contract Documents.
3. Verify cable length and attenuation is consistent with manufacturer's data sheet and reel identification.
4. Test each fiber optic strand for continuity and loss in the units of dB/km using a recording OTDR with disk storage capabilities.
 - a. Multimode Fiber: Test each 50/125-micron fiber optic strand at 850 nm and 1,300 nm in 1 direction.

D. Test Reports: Submit a test report for each reel with fiber optic components, including factory and field test results for each fiber, according to the general test report requirements.

1. Test Summary Report. The test report will include:
 - a. Assigned reel identification number.
 - b. Copy of the OTDR calibration certificate.
 - c. Manufacturer's product test data.
 - d. Cable identification as it appears in the cable records.
 - e. Cable identification as it appears on the OTDR printout.
 - f. Cable identification as it is labeled according to the Specifications.
 - g. Pass or fail status for each fiber strand.
2. The individual test data sheets shall consist of the OTDR printouts, one per fiber strand.

3.07 EXISTING FIBER OPTIC SYSTEM TESTING

A. Perform optical time domain reflectometer (OTDR) for each existing fiber cables to check continuity, length, anomalies and approximate attenuation. The fiber cables to be tested, including spare fiber strands, shall be located between the Headworks Control Panel (91-CP-1 / existing DCU-4) and the following control panels:

1. Screening Train 1&2 Control Panel (MCP-1).
2. Screening Train 3&4 Control Panel (MCP-2).
3. Grit Removal Train 1&2 Control Panel (LCP-1).
4. Grit Removal Train 3&4 Control Panel (LCP-2).
5. Grease/Septage Receiving Control Panel (MCP-3).

Field verify and coordinate with the Owner on existing fibers to test as shown on the Contract Drawings.

- B. Preparation: Submit documentation providing the proposed testing sequence, expected duration, and scheduled date and time for testing to the Owner/Engineer.
- C. Performance Tests:
 - 1. Fibers Tested: Test each existing spare fiber.
 - 2. Test each existing fiber optic strand for continuity and loss in the units of dB/km using a recording OTDR with disk storage capabilities.
 - a. Multimode Fiber: Test each 62.5/125-micron fiber optic strand at 850 nm and 1,300 nm in 1 direction.
- D. Test Reports: Submit a test report for existing fiber optic components, including field test results for each fiber, according to the general test report requirements.
 - 1. Test Summary Report. The test report will include:
 - a. Copy of the OTDR calibration certificate.
 - b. Cable identification as it appears in the cable records.
 - c. Cable identification as it appears on the OTDR printout.
 - d. Cable identification as it is labeled according to the Specifications.
 - e. Cable Segment Identification:
 - 1) Cable run number.
 - 2) Source location and FOPP identification.
 - 3) Destination location and FOPP identification.
 - f. Test Equipment Identification:
 - 1) Calibration date.
 - 2) Light source serial number.
 - 3) Receiver serial number.
 - g. Anomalies greater than 0.3 dB.
 - h. Fiber strand number.
 - i. Measured segment attenuation.
 - 2. The individual test data sheets shall consist of the OTDR printouts, one per fiber strand.
 - 3. The Owner/Engineer will evaluate the test results and issue a change order request if repairs or replacement of the fiber optic cable is required.

3.08 POST-INSTALLATION FIBER OPTIC CABLE SYSTEM TESTING

- A. General:
 - 1. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with ANSI Z136.2.

2. Perform bi-directional OTDR testing and OLTS testing for system span loss and continuity.
3. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
4. Data Recording: Perform Link and channel test results from OLTS and OTDR shall be recorded in test instrument upon completion of each test for subsequent uploading to a PC in which administrative documentation may be generated.
 - a. Record end-face images in memory of test instrument for subsequent uploading to a PC and reporting.
5. Perform Testing:
 - a. On each cabling segment (connector to connector).
 - b. On each cabling channel (equipment to equipment).
 - c. After the splice enclosure has been sealed and the electrical hand hole has been closed to check for macrobending problems.
 - d. Using high-quality test cords of same fiber type as cabling under test.
 - 1) Test cords for OLTS testing shall be between 1 meter and 5 meters in length.
 - 2) Test cords for OTDR testing shall be approximately 100 meters for launch cable and at least 25 meters for receive cable.

B. Test Configurations:

1. Link Test Configuration: Perform metered tests on each fiber optic segment through FOPP terminations at each end of the cable section.
2. Channel Test Configuration: Perform metered tests on each fiber optic channel, including all link segments, patch cords, and work area station cords through the connectors at each end, but not including connections to active equipment.

C. Optical Loss Testing:

1. Calculate the maximum allowable span loss for each fiber optic link or channel by adding the theoretical fiber loss based on length and allowances of 0.5 dB per connector.
2. Provide Optical Loss Testing (OLTS) on installed fibers. Test each installed and connectorized fiber optic link and channel for end-to-end attenuation through FOPP.
3. Test multimode at 850 nm and 1,300 nm in accordance with TIA 526-14A, Method B, One Reference Jumper or equivalent method.
4. Perform tests in both directions.

D. OTDR Testing:

1. General: Provide bi-directional OTDR testing on all fiber optic cables.
2. Terminate meter jumpers using connectors and fiber like those installed in the system as noted previously.

E. Test Reports: Include field test results for each fiber strand.

1. The test summary will include:
 - a. Cable identification as it appears in the cable records.
 - b. Cable identification as it is labeled according to the Specifications.
 - c. Pass or fail status for each strand. A strand has failed if it does not pass any one required test.
2. The individual test data will include:
 - a. Project Identification.
 - b. Cable Segment Identification:
 - 1) Cable run number.
 - 2) Source location and FOPP identification.
 - 3) Destination location and FOPP identification.
 - c. Test Equipment Identification:
 - 1) Calibration date.
 - 2) Light source serial number.
 - 3) Receiver serial number.
 - d. Fiber optic manufacturer's specifications.
 - e. Calculated Segment Attenuation:
 - 1) Cable length in kilometers and feet.
 - 2) Calculated link loss at 850-nm wavelength.
 - 3) Calculated link loss at 1,310-nm wavelength.
 - f. Fiber strand number.
 - g. Measured segment attenuation.
 - h. Test technician and date of testing.
3. Provide a digital copy of OTDR results with a copy of the manufacturer's viewing application.

3.09 SUPPLEMENTS

A. Supplement listed below, following "End of Section," is part of this Specification.

1. As-Built Fiber Optic Cable Installation Form.

END OF SECTION

PROJECT: CC Williams WWTP Dewatering

Contractor:

Signed by:

AS-BUILT FIBER OPTIC CABLE INSTALLATION

Sheet 1 of 1

Cable Identification:

Routing: From:

In:

(Identify field panel, control room, etc. in building)

Through: 1

(Identify access hole, building, gallery, etc.)

Through: 2

Through: 5

Through: 3

Through: 6

Through: 4

Through: 7

To:

In:

See As-Built Conduit Installation forms for identification of conduits cable is routed through.

Acceptable Attenuation:

Multimode Fibers

cable length*

850 nm: 3.0 dB/km x km + 1.5 dB = dB

1300 nm: 1.0 dB/km x km + 1.5 dB = dB

*Contractor to provide actual length installed, within ± 0.1 km.

Fiber ID	Use/Spare	Measured Attenuation (dB)			
		Hub-to-Node		Node-to-Hub	
		850 nm	1,300 nm	850 nm	1,300 nm

SECTION 40 96 00
APPLICATIONS SOFTWARE

PART 1 GENERAL

1.01 WORK INCLUDED

- A. General: Work includes design, furnishing, configuring, testing, documenting, training and starting up the Process Instrumentation and Control (PIC) Applications software (programming) for a complete and fully functioning system, including:
1. Provide all applications software in accordance with the Mobile Area Water and Sewer System (MAWSS) Standards.
 2. HMI Applications Software (Trihedral VTScada):
 - a. Load and configure VTScada software onto virtual machines as specified in OT Sections 40 94 13 and 40 96 02. Configure for VTScada redundancy. This includes the CC Williams WWTP and the Park Forest Headquarters.
 - b. Provide applications software to develop VTScada operator interface graphics and database for all control signals connected to the CC Williams WWTP. At minimum, these include:
 - 1) 20-CP-1, Dewatering Building.
 - 2) 50-CP-1, Chlorine/SO2 Building (if Additive Alternate #1 is selected).
 - 3) 82-CP-1, Blower Building.
 - 4) 83-CP-1, Final Clarifiers Electrical Building.
 - 5) 83-CP-2, Sidestream Pump Station.
 - 6) 85-CP-1, Secondary Digester Building.
 - 7) RTU-4, Headworks (if Additive Alternate #9 is not selected).
 - 8) 91-CP-1, Headworks (if Additive Alternate #9 is selected).
 - 9) MCP-1, Screening Train 1&2.
 - 10) MCP-2, Screening Train 3&4.
 - 11) MCP-3, Grease/Septage Receiving.
 - 12) LCP-1, Grit Removal Train 1&2.
 - 13) LCP-2, Grit Removal Train 3&4.
 - 14) 20-VCP-20-1, Belt Filter Press 1.
 - 15) 20-VCP-20-2, Belt Filter Press 2.
 - 16) 20-VCP-20-3, Belt Filter Press 3.
 - 17) 20-VCP-20-4, Belt Filter Press 4.
 - 18) Generator Control Panel.
 - c. Configure trending and historical data point collection using VTScada's built-in Historian database. Configure for redundancy.

- d. Configure alarm callout rosters using VTScada's built-in remote alarm notification services. Configure for redundancy.
 - e. Develop report templates and automatically generated reports as specified herein using VTScada's built-in report generation tools.
 - f. Configure thick, thin, and zero clients as necessary for connection to the VTScada system.
 - g. Configure security within VTScada to be compliant with the OT Authentication methodology.
 - h. Configure VTScada as a Master Application at the Park Forest Headquarters facility. The Master Application shall include a primary and backup server.
 - i. Configure VTScada as a read-only Master Application within the Park Forest DMZ (De-militarized Zone).
3. HMI Applications Software (Wonderware Archestra):
- a. The existing CC Williams WWTP uses Wonderware Archestra as its SCADA package. This application runs on existing primary and backup servers.
 - b. The Archestra servers are to be relocated twice during the Project.
 - 1) First, to the temporary server room while the existing Control Building is demolished, and the Dewatering Building Control Room is being built. During this time, the Archestra application shall remain in full control of the plant. There shall be no functional differences.
 - a) Since the servers are redundant, one shall be moved first, proven functional in the temporary control room, and then the second server may be relocated.
 - b) Two (2) View client workstations shall also be relocated to the temporary control room so that the Plant may continue operate normally from the temporary location.
 - 2) Second, once the Server Room is ready in the new Dewatering Building, and fiber optic connectivity is established, then the Archestra servers shall be converted into the Virtual Machine (VM) environment. There these servers will continue to run the plant as the VTScada system is brought online.
 - c. Application Note - Existing RTU-1 (Emerson Bristol platform) will be demolished along with the existing Operations Building. During the temporary operations phase of the project, the existing Archestra application shall continue to monitor and control the signals for equipment in RTU-1. The RTU-1 tags shall be converted within the application to interface with new 82-CP-1 (Allen-Bradley CompactLogix). Provide any necessary additional Wonderware I/O driver licensing and configuration to allow communications using the appropriate Allen-Bradley protocol.

- d. As the Programmable Automation Controllers (PACs) are converted from Emerson Bristol to Allen-Bradley hardware, existing in-plant systems will be migrated from the Archestra application to the VTScada application.
 - e. Once all in-plant systems are migrated, the Archestra application will continue to run as a legacy interface to external interfaces such as the Wright-Smith WWTP and Lift Stations.
 - f. Perform clean-up of the existing Archestra application once all in-plant systems are migrated to VTScada. Remove obsolete links and lock navigation to allow operators to only view graphics with valid data. Where practical, delete unused graphics and obsolete data base points.
 - 4. PAC Application Software:
 - a. Provide PAC programming to meet the functional requirements specified herein. PACs to program include:
 - 1) 20-CP-1, Dewatering Building.
 - 2) 50-CP-1, Chlorine/SO2 Building (if Additive Alternate #1 is selected).
 - 3) 82-CP-1, Blower Building.
 - 4) 83-CP-1, Final Clarifiers Electrical Building.
 - 5) 83-CP-2, Sidestream Pump Station.
 - 6) 85-CP-1, Secondary Digester Building.
 - 7) 91-CP-1, Headworks (if Additive Alternate #9 is selected).
 - 5. Provide updates to the Owner's HMI and Historian, PAC, and Tag Naming Standards.
- B. Major applications software work items include:
- 1. Application coordination meetings.
 - 2. Applications software workshops.
 - 3. Applications software submittals.
 - 4. Applications software development.
 - 5. Software testing.
 - 6. Software installation.
 - 7. O&M development.
 - 8. Startup.
 - 9. Training.
 - 10. Software support.

1.02 DEFINITIONS

- A. Refer to Section 40 90 00, Instrumentation and Control for Process Systems, for definitions and abbreviations.

1.03 SOFTWARE DESIGN WORKSHOPS

- A. Location: C. C. Williams WWTP, during the course of the Project. Virtual meetings may be permitted by the Engineer.
- B. Objective: To provide a vehicle for the Owner to oversee the applications software development.
- C. Documentation: Software Supplier summarize resolutions reached in each workshop and distribute copies to Owner and Engineer.
- D. Workshops:
 - 1. Quantity: A minimum of 12.
 - 2. Duration: Eight-hour meetings.
 - 3. Content:
 - a. HMI Applications (VTScada) Software Workshop #1.
 - b. HMI Applications (VTScada) Software Workshop #2.
 - c. Trending, Reporting, and Alarm Notification Software Workshop.
 - d. PAC Applications Software Workshop.
 - e. Control Strategy Workshop #1.
 - f. Control Strategy Workshop #2.
 - g. Control Strategy Workshop #3.
 - h. Control Strategy Workshop #4.
 - i. Control Strategy Workshop #5.
 - j. Control Strategy Workshop #6.
 - k. Control Strategy Workshop #7.
 - l. Control Strategy Workshop #8.
- E. Workshops:
 - 1. HMI Applications (VTScada) Software Workshop #1:
 - a. Objectives:
 - 1) Review Owner's HMI and Historian Standards. PIC programmer shall lead the discussion and propose how the standards will implemented. Any proposed deviations shall be discussed and documented.
 - 2) Using the current Wonderware Archestra application as a reference point, discuss graphical and functional changes as they will be implemented in VTScada.
 - 3) Establish expectations for the residual functionality of the Wonderware Archestra application. This will include the legacy connections to the Wastewater Lift Stations and the Wright-Smith WWTP.
 - b. Topics to be Reviewed/Confirmed:
 - 1) Owner's HMI Standards
 - 2) Owner's Tag Naming Standards

2. HMI Applications (VTScada) Software Workshop #2:
 - a. Objectives:
 - 1) Present mock-up VTScada graphics to elicit Owner feedback on the graphical interfaces, navigation, and general functionality. Requested changes shall be documented.
 - 2) Present database overview of implemented tag names which comply with the Owner's standards. Requested changes shall be documented.
 - 3) Discuss which database tags should be logged for historical purposes.
 - 4) Discuss which database tags should be marked for alarming and alarm callout.
 - b. Topics to be Confirmed:
 - 1) VTScada baseline graphics.
 - 2) Tagname database naming, logging, and alarming.
3. Trending, Reporting, and Alarm Notification Software Workshop:
 - a. Objectives:
 - 1) Establish historical data trending requirements, including user access, presentation, and functionality.
 - 2) Confirm creation of reports, data source, frequency, and user access.
 - 3) Confirm required scheduled reports including data sources, report production, and file storage.
 - 4) Establish ad-hoc report requirements, including user access and data sources.
 - 5) Establish/confirm alarm callout groups and priorities.
 - 6) Determine alarm callout roster criteria/participants. Gather user contact information if available.
 - b. Topics to Be Confirmed:
 - 1) Trend Display Features and Groups.
 - 2) Required Number and format of Daily Reports.
 - 3) Required Number and format of Weekly Reports.
 - 4) Required Number and format of Monthly Reports.
 - 5) Required Number and format of Ad-hoc Reports.
 - 6) Scheduled report appearance.
 - 7) Report storage requirements.
 - 8) Alarm callout criteria and procedures.
4. PAC Applications Software Workshop:
 - a. Objectives:
 - 1) Review Owner's PAC Programming Standards. PIC programmer shall lead the discussion and propose how the standards will implemented. Any proposed deviations shall be discussed and documented.
 - 2) Review Owner's Control Strategy Template Standards. PIC programmer shall lead the discussion and propose how the standards will implemented. Any proposed deviations shall be discussed and documented.

- b. Topics to be Finalized/Confirmed:
 - 1) PAC programming software package and version to be used.
 - 2) PAC program documentation requirements.
 - 3) Tag structures (data types) used within the PAC program.
 - 4) PAC program structure and organization.
- 5. Control Strategy Workshops:
 - a. Objectives:
 - 1) Review Owner's Control Strategy Template Standards. PIC programmer shall lead the discussion and propose how the standards will implemented.
 - 2) Use P&IDs, Loop Specifications, and existing PAC programs to present how the proposed control system design and Applications Software will meet the functional requirements specified herein.
 - 3) Discuss the specific control strategy narratives for all new processes and all existing C.C. Williams processes. Processes shall be discussed on a loop by loop basis.
 - 4) PIC programmer shall document all processes (new and existing).
 - a. Topics to be Confirmed:
 - 1) Specific process control strategy narratives.
 - 2) P&ID drawings.

1.04 SUBMITTALS

A. Action Submittals:

- 1. Standards Update Submittal. Provide updates to the Owner's standards in Microsoft Word format with tracked changes. Include all modifications/additions made during specified standards workshop. Owner standard documents include:
 - a. HMI and Historian Standards.
 - b. PAC Programming Standards.
 - c. Control Strategy Narrative Templates.
 - d. Control Systems Interfaces.
- 2. SCADA HMI (VTSada) Submittal:
 - a. Submit after SCADA HMI Workshop #1 and at least two (2) weeks prior to SCADA HMI Workshop #2. Include a summary of SCADA HMI Workshop #1.
 - b. Submittal shall include the mock-up graphics to be presented at SCADA HMI Workshop #2. Graphics shall be full-color.
 - c. Submittal shall include sample tagname database which demonstrates compliance to the Owner's tag naming standards.

3. Reporting Software Submittal:
 - a. Submitted after Reporting Workshop. As a minimum, submittal shall include summary of the Reporting Workshop including all draft reports.
 - b. Draft of all reports generated on a daily, weekly, monthly basis.
 - c. Reports schedule.
4. Remote alarm notification submittal:
 - a. Submitted after Remote Alarm Notification workshop. As a minimum, submittal shall include summary of the Remote Alarm Notification Workshop including all alarms.
 - b. List and acknowledgement settings.
 - c. Notification users.
 - d. Schedule.
5. Historical Data and Trending Submittal:
 - a. Submitted after Historical Trending Workshop. As a minimum, submittal shall include summary of the Trending Workshop including list of data to be trended and frequency.
6. PAC Submittal:
 - a. Submit after PAC Applications Software Workshop. The submittal shall include a summary of the PAC Applications Software Workshop.
 - b. Submit listing of PAC tagname database. Database may be a representation of typical database tagnames used for this Project.
 - c. Submit any custom function blocks to be implemented in the PAC programming. Include data declarations and descriptions of function input/outputs.
 - d. Submit a listing which shows the PAC task structure and organization.
 - e. Submit PAC code samples which illustrates the documentation of the PAC code. Samples must be specific examples used for this Project.
7. Control Strategy Narratives Submittal:
 - a. Submit after Control Strategy Workshops.
 - b. Include Control Strategy narratives for all new and existing C.C. Williams WWTP processes. These narratives shall incorporate any changes to the process controls that were identified in the control strategy workshops.
 - c. Include any markups to the P&ID drawings. These markups shall be in the form of electronic, redline markups to PDF versions of the conformed P&ID drawings.

B. Quality Control Submittals:

1. Training Submittals: Detailed training material including detailed outline of all training material.
2. Testing Related Submittals:
 - a. Proposed Graphic Displays submitted before Factory Demonstration Testing.
 - b. Factory Demonstration Test (FDT) procedures submitted after HMI Software Design Coordination Meeting.
 - c. Performance Acceptance Test (PAT) procedures.
3. Operation and Maintenance Manuals:
 - a. In accordance with Section 01 78 23, Operation and Maintenance Data.
 - b. Software Documentation:
 - 1) Updated version of software shop drawings submittals.
 - 2) Application software documentation for all subsystems.
 - 3) Software: Provide the following: Backup of all programs, graphics, configurations, etc. of all Application Software on a USB drive included in the O&M Manual.

PART 2 PRODUCTS

2.01 SYSTEM FUNCTIONAL REQUIREMENTS

A. Functional requirements are defined in the following sections:

1. Section 40 94 13, Operational Technology (OT) Components.
2. Section 40 96 02, OT Networking Software.

2.02 HMI APPLICATION SOFTWARE

A. The C.C. Williams WWTP currently has a functional SCADA system using Wonderware's Archestra product. Provide all applications software for the following:

1. When fiber optic network connectivity is confirmed in the temporary control room, relocate the existing Archestra servers to the temporary control room environment.
2. Install two (2) Archestra View Clients (existing hardware) in the temporary control room for operator access.
3. Existing UPS units shall be relocated to provide backup power for the computers.
4. Confirm that all previously functional operations are still functional in the new location.

5. As sub-systems are migrated to the new SCADA system, those sub-systems shall be marked as such in the Archestra application and control links made non-functional in Archestra.
 6. Once all of the CC Williams plant functions are fully migrated to the new SCADA system, only the legacy connections to the Lift Stations and the Wright-Smith WWTP should remain. Perform a final clean-up of Archestra graphics such that only navigation to functional features are enabled.
 7. The legacy Archestra servers shall be virtualized (physical to virtual machine conversion) onto servers in the new Server Rack. These servers shall remain a redundant server pair to support the legacy systems. Configure one (1) Archestra View Client in the new control room which shall allow operators to still interact with the legacy systems via the MAWSS WAN.
- B. The MAWSS standard SCADA software for new development is Trihedral's VTScada product.
1. Provide VTScada software as identified in 40 96 00, Supplement 3.
 2. License VTScada software to MAWSS. Coordinate with MAWSS for specific contact information.
- C. All new graphics shall be developed using VTScada. Provide all applications software for the following:
1. Load the VTScada software onto virtual machines as specified in Sections 40 94 13, Operational Technology (OT) Components, and 40 96 02, OT Networking Software. See also 40 96 00, Supplement 3, SCADA Software Listing.
 2. Configure the VTScada architecture for redundancy and automatic failover.
 3. Configure all client and DMZ computers as specified in Sections 40 94 13, Operational Technology (OT) Components, and 40 96 02, OT Networking Software. See also 40 96 00, Supplement 3, SCADA Software Listing.
 4. Develop VTScada graphics that convey accurate information to the plant operations staff so they can make informed process control decisions and provide the platform to execute the control decisions.
 5. Graphics shall comply with MAWSS HMI Standards.
 6. Workshops shall be utilized to coordinate with the Owner and confirm implementation details.
 7. Integrate existing Allen-Bradley based PAC control panels into the VTScada application. Existing Archestra functionality for these panels shall be converted to VTScada. These panels include:
 - a. MCP-1, Screening Train 1&2.
 - b. MCP-2, Screening Train 3&4.

- c. MCP-3, Grease/Septage Receiving.
- d. LCP-1, Grit Removal Train 1&2.
- e. LCP-2, Grit Removal Train 3&4.
- 8. If Additive Alternate #9 is not selected, integrate existing Emerson Bristol Babcock based PAC control panel RTU-4 (Headworks) into the VTScada application. Existing Archestra functionality shall be converted to VTScada.

2.03 HISTORIAN APPLICATIONS SOFTWARE

- A. Configure historical data collection and storage using built-in, redundant VTScada historian features. Provide all applications software for historical data logging using primary and backup applications on new virtual machines. Primary and backup servers will be configured as a redundant pair where if one server fails the other server will become primary.
- B. Data logging shall comply with MAWSS Historian Standards.
- C. Workshops shall be utilized to coordinate with the Owner and confirm implementation details.
- D. Historian data shall be replicated into the DMZ Historian (VTScada Master Application) for external interfaces.
- E. Implement historical data trending within the VTScada application.

2.04 REPORTING APPLICATIONS SOFTWARE

- A. Provide reporting functionality using the built-in reporting features of VTScada.
- B. Coordinate with Owner to develop up to thirty (30) custom reports which may include the following daily, monthly, or yearly reports:
 - 1. Equipment Runtime.
 - 2. Equipment Starts/Stops/Cycles.
 - 3. Flow Averages and Totals.
 - 4. Level Averages.
 - 5. Chemical usage.
 - 6. Generator information.
 - 7. Power usage information.
 - 8. Other information as determined in workshops.

- C. Workshops shall be utilized to coordinate with the Owner and confirm report format and implementation details.
- D. Implement a schedule for automatic report generation. Ad-hoc reporting capabilities are built in to the VTScada software.

2.05 REMOTE ALARM NOTIFICATION APPLICATIONS SOFTWARE

- A. Configure alarm notification and callout functionality using built-in VTScada features.
- B. Workshops shall be utilized to coordinate with the Owner and confirm implementation details.
- C. Provide all applications software for remote alarm notification primary and backup applications on new virtual machines. Primary and backup servers will be configured as a redundant pair where if one server fails the other server will become primary.
 - 1. Coordinate with Owner contact personnel to receive alarm notification.
 - 2. Coordinate with Owner contact personnel alarm notification schedule.
 - 3. Install and configure remote alarm notification method, i.e. modem, email or text notification mechanism.
 - 4. Provide applications software for a minimum of 250 remote alarm notifications.

2.06 PAC APPLICATIONS SOFTWARE

- A. Provide all applications software to provide facility automatic control, alarm functions, and continuous loop control. Specific PAC functional requirements are described in the loop specifications. New PAC hardware is the Allen-Bradley ControlLogix platform. The PAC programming software shall be Rockwell Software's Studio5000.
 - 1. Provide PAC Programming software as identified in 40 96 00, Supplement 3.
 - 2. License PAC software to MAWSS. Coordinate with MAWSS for specific contact information.
 - 3. Load the PAC software onto the Engineering Workstation. All PAC programs shall reside on the Engineering Workstation.
- B. The PACs in new control panel CP-20-1 shall be configured as redundant processors with automatic failover. Provide all applications software to implement PAC redundancy.

- C. For existing PAC systems which utilize the Emerson Bristol Babcock hardware, those shall be converted to Allen-Bradley ControlLogix Remote I/O and will communicate via ethernet-based Device Level Ring (DLR) to the redundant PACs in 20-CP-1, Dewatering Building. Provide all applications software to migrate the existing Bristol programs to be integrated into the Studio5000 master program in 20-CP-1. These PAC panels include:
1. 83-CP-1, Existing Final Clarifiers Electrical Building.
 2. 85-CP-1, Secondary Digester Building.
 3. 91-CP-1, Headworks Electrical Building (if Additive Alternate #9 is selected).
- D. For the existing PAC in control panel 83-CP-2, Sidestream (SWAT) Pump Station, the hardware will be converted to Allen-Bradley ControlLogix Remote I/O and will communicate via ethernet-based Device Level Ring (DLR) to the redundant PACs in 20-CP-1. Provide all applications software to migrate the existing Allen-Bradley PLC-5 program to be integrated into the Studio5000 master program in 20-CP-1.
- E. For new PAC control panel 82-CP-1, the hardware platform is Allen-Bradley CompactLogix. This PAC is not part of the 20-CP-1 master program; this PAC communicates directly to VTScada. Provide all applications software to migrate the existing Bristol program in RTU-1 (Operations Building) in the Studio5000 program for 82-CP-1.
- F. Coordinate PAC data exchange with package (vendor) control panels which include:
1. 20-VCP-20-1, Belt Filter Press 1.
 2. 20-VCP-20-2, Belt Filter Press 2.
 3. 20-VCP-20-3, Belt Filter Press 3.
 4. 20-VCP-20-4, Belt Filter Press 4.
 5. Generator Control Panel.
- G. PAC programs shall comply with MAWSS PAC Programming Standards.

2.07 SOURCE QUALITY CONTROL

- A. Factory Demonstration Test (FDT): Test all non loop-specific functions including, but not limited to:
1. Failure mode and backup procedures including power failure, AUTO restart, and disk backup and reload.
 2. Communications Testing: Confirm communications between all servers and PAC equipment.

3. SCADA (HMI) Testing:
 - a. Security: Login and domain authentication.
 - b. All graphics modifications.
 - c. Automatic failover between primary and secondary servers.
 - d. Message logging and alarm handling.
 - e. Database and display configuration and use of all types of displays.
 4. Historian Testing:
 - a. Data collection and data retrieval.
 - b. Data transfer from local Historian to DMZ Historian.
 5. Report Generation: Manually trigger all automatic schedules to produce all daily, monthly and yearly reports.
 6. Web-Based HMI:
 - a. Database and display configuration and use of all types of displays.
 - b. Login and settings for each user.
 7. PAC and OIU Testing:
 - a. Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and Loop Specifications:
 - 1) One of each type function; for example, if there are filter backwash sequence control for several identical filters, demonstrate controls for one filter.
 - 2) One of each type of function in each panel; for example, but not limited to annunciator operation, controller operation, and recorder operation.
 - 3) All required and shown functions for 100 percent of loops.
- B. Perform FDT at the PICS Subcontractor's factory. For each test, a complete system including PACs shall be set up by the PICS Subcontractor in the factory. PICS Subcontractor shall test selected actions initiated at the CS nodes and verified at the PAC I/O points and vice versa. For additional requirements refer to Section 40 90 00, Instrumentation and Control for Process Systems.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Functional Test: Complete an unwitnessed functional test to ensure the CS is ready for performance testing. At a minimum repeat the FDT for the functional test.

- B. Performance Acceptance Test: Include the same types of testing that are specified for Factory Demonstration Test.
 - 1. Duplicate the FDT onsite witnessed by the Owner and Contractor.
 - 2. Perform test at the same time as the PICS PAT so that the complete system is tested.
 - 3. Provide a set of PAT procedures and checklist for each loop containing a CS function. Include as-built I/O list and block diagram.
 - 4. Provide testing showing that the CS meets the requirements of the Loop Descriptions.
 - 5. Show all reports with real data. Demonstrate manual data entry.
 - 6. Demonstrate all specified network functions including all computers that are part of the network.
 - 7. Demonstrate Ethernet switch management, network diagnostics, and network load viewing capabilities.
 - 8. Test operation of the historian including all reports, graphs, and trends.
 - 9. Show that the graphic displays for package systems have been incorporated into the Plant HMI graphic screens. Demonstrate proper operation of all control, monitoring, and alarming requirements.

3.02 TRAINING

- A. Reporting Training (Onsite): Integrator shall provide one (1) 1-day training seminar on report software including:
 - 1. Access printed and stored scheduled reports.
 - 2. Basic ad-hoc report generation.
- B. Remote Alarm Notification Training (Onsite): Integrator shall conduct two (2) 1/2 day training sessions to review with Owner's operation and maintenance personnel remote alarm notification. Training sessions shall be performed on separate days to accommodate operational shifts. Training shall include:
 - 1. Review of alarm configurations.
 - 2. Alarm acknowledgement.
 - 3. Adding/deleting alarms from notification lists.
 - 4. Call-out roster maintenance.

3.03 SUPPLEMENTS

- A. Supplements listed below, follow "End of Section" and are a part of this Specification.
 - 1. MAWSS HMI and Historian Standards.
 - 2. SCADA PAC Configuration Standards.
 - 3. SCADA HMI and PAC Software List.

END OF SECTION

HMI and Historian Standards

February 2020

Mobile Area Water & Sewer System (MAWSS)



Document History and Status

Revision	Date	Author	Reason for Change
0	2/26/2020	Nick Freeman/Jacobs	

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Acronyms and Abbreviations

AI	analog input
AO	analog output
DI	discrete input
DO	discrete output
HMI	human-machine interface
I/O	input/output
MAWSS	Mobile Area Water & Sewer System
PC	personal computer
PID	proportional integral derivative
PAC	programmable automation controller
SCADA	supervisory control and data acquisition

1. Introduction

This section provides conventions and standards used in developing the human-machine interface (HMI) graphics and tag databases for the Mobile Area Water and Sewer System (MAWSS).

The purpose of these standards is to ensure uniformity across all HMI applications.

HMI standards include system terminology, system configuration, input/output (I/O) driver configuration, graphic display standards, graphic organization and navigation, font definitions, plant process color conventions, equipment state indication, control actions, scripting, database conventions, alarm configuration, historical data calculations/collection/display, and security configuration.

General Note: Standards listed are subject to change after discussions with MAWSS.

2. System Terminology

Table 2-1 lists common terminology and acronyms used in this document.

Table 2-1. Terminology and Acronyms

Term or Acronym	Meaning/Definition
Driver (Software Driver)	A program written to interface two unique pieces of hardware. The primary driver of interest on this project is provided to allow the host computer to communicate with the Allen Bradley Programmable Automation Controller (PAC).
Event	A control system or process transition that is printed or archived to record operator or system actions. Events include pump transitions, operator logins, and similar non-alarm occurrences.
HMI	The human machine interface is the primary computer interface for operators and plant personnel. These can be full desktop personal computers (PCs) with added application software or bundled panel-type computers with embedded software systems. Touch screens, monitors, keyboards, and pointing devices are used to interact with the industrial process. HMIs are used for visualization and monitoring.
I/O	Input/output refers to the physical connections for measuring and controlling the parameters of the field equipment. There are four primary I/O types used in the system: 1) analog inputs (AI) measure continuous values, such as level, flow, and speed; 2) analog outputs (AO) control continuous values, such as valve position or pump speed; 3) discrete inputs (DI) detect discrete values, such as on/off or open/closed; and 4) discrete outputs (DO) control discrete values such as pump on/off or valve open/closed.
PLC/PAC	Programmable logic controller refers to the controllers that perform control logic for the facility or individual unit process. MAWSS has standardized on ControlLogix and CompactLogix PLCs, which are called programmable automation controllers (PAC). Thus, this document refers to PLCs as PACs.
SCADA	Supervisory control and data acquisition are software applications responsible for acquiring, monitoring, and controlling data from process control hardware. Operators and other plant personnel use these PC-based systems to supervise and interact with the process to ensure safe and efficient operation.
Scan Time	Rate at which data are pulled from the device driver to the HMI tag database.
Thin Client	Computer or device that allows operator access to the application without having the VTScaDa software installed on them.
Widget	Reusable combinations of graphics and tag displays.

3. System Architecture

In general, each treatment facility and major pump station will have a multiple physical servers that host multiple virtual machines. The physical servers are separated into various functional groups or “clusters” of virtual machines. There are non-SCADA machines that perform child domain control and user authentication functions. There are management machines that perform automated backup functions, manage the virtual machine (VM) environments, and manage Operation Technology (OT) components such as firewalls and switches. The SCADA cluster hosts the primary VTScada and the backup VTScada machines. The VTScada applications have native I/O servers that communicate to the PACs within the plant using the Ethernet-based Allen-Bradley Common Interface Protocol (CIP). The Historian databases are integrated into the VTScada applications. Redundancy and automatic failover of the SCADA system, the I/O drivers, and the Historian databases are inherent to the VTScada architecture. The SCADA cluster will also host a development machine for VTScada application maintenance/development and PAC programming using the Rockwell Software Studio5000.

Thin clients are utilized at the plant level to allow operator access to the VTScada application. These thin clients connect to the active VTScada server using remote desktop protocol (RDP) or by using an HTML5 compliant browser. Thick clients are also utilized in some instances; particularly if implementation of a video wall is required at the plant. The thick client provides multiple monitor support in a more seamless environment. Thick clients can also provide additional VTScada backup functionality in the event of a failure on the primary and backup servers.

To support the plant level architecture, there will be a multiple physical servers hosting virtual machines at the enterprise level. These clusters will be located at the Park Forrest Headquarters and provide central management for the Non-SCADA machines (parent/child domain controllers, master authentication server), management machines (backup, VM management, OT management), and SCADA machines (hosting the master VTScada applications for all plants). In addition, there is a De-militarized Zone (DMZ) cluster of virtual machines that create a layer of secure isolation between the SCADA systems and the Enterprise or Business networks. Within that DMZ, there will be a cumulative copy of all VTScada Historian information. That Enterprise level Historian allows access to the historical data by external systems while still protecting the local plant level data systems.

4. Graphics

The SCADA system is designed to convey monitoring information on the facility status and to provide operator access to control functions to allow for the facility operation. The SCADA system will provide the following functionality:

- Methods for securely logging in and out of the SCADA system
- Methods to navigate between graphic screens for the various process areas of the facility
- Standard pertinent information, such as current date and time
- Control functions, such as setpoint changes and equipment controls
- Limitations on access to control functions through system security configuration

The graphics are designed to fit a wide-screen format with a resolution of 1920 x 1080 (high definition).

4.1 Graphic Displays and Layout

In general, the following graphic displays will be provided for each facility:

- System Level
 - System Overview Map

MAWSS HMI and Historian Standards

- System Totals
- System Security
- System Alarm Summary
- System Server Status
- Lift Station Summary
- System High Service Pumping Summary
- Others as needed
- Facility Level
 - Process Overview Graphic
 - Facility Process Graphics (one for each unit process/area)
 - Facility Flow Totals Graphic
 - Facility Runtime Graphic
 - Facility Alarm Summary Page
 - Facility communication Page
 - Facility Server Status Page
- Popups

Remote sites may be included as their own facility or may be assigned to a larger facility. Exact assignment shall be determined.

Important Note: Graphics shall be designed such that changes to universal graphics (such as navigation bars/title bars/etc) can be made in an efficient manner. For example, if each facility process graphic contains a facility navigation bar and an additional unit process is added. There needs to be an efficient means to add the new facility to the facility navigation without having to go into each facility graphic to update the navigation bar.

4.1.1 System Graphics

In general, system graphics overview graphics that encompass more than one plant's information. The primary purpose of system graphics is to show related information for all of the plants in the system.

Include description of system graphics including the following information:

- Layout description: What is the standard background color?
- Navigation: What is the means to navigate between system graphics? What is the means to navigate between system and facility level graphics?
- Title Bar:
 - Date/Time format and location? Font and color?
 - Graphic Title location? Font and color?
 - Login box? Current logged in user?

- System Alarm Bar
 - Columns included?
 - Location?
 - Size?

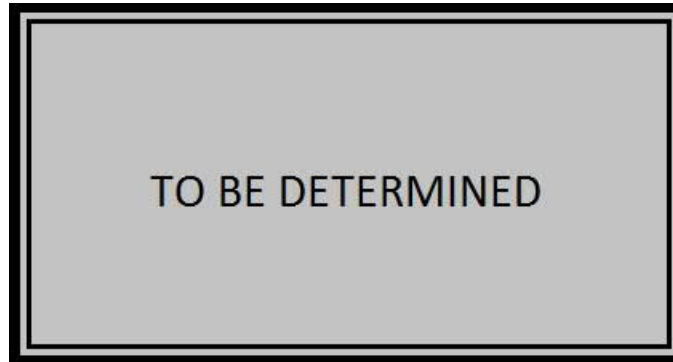


Figure 4-1. Standard System Graphic Layout

4.1.2 Facility Graphics

Facility graphics are graphics that show detail of a particular plant. These graphics include the following information: process area, plant navigation, and plant alarm bar.

Include description of standard facility graphics including the following information:

- Layout description: What is the standard background color?
- Navigation: What is the means to navigate between facility graphics?
- Title Bar:
 - Date/Time format and location? Font and color?
 - Graphic Title location? Font and color?
 - Different title bar color for different facilities?
 - Login box? Current logged in user?
- Facility Alarm Bar
 - Columns included?
 - Location?
 - Size?

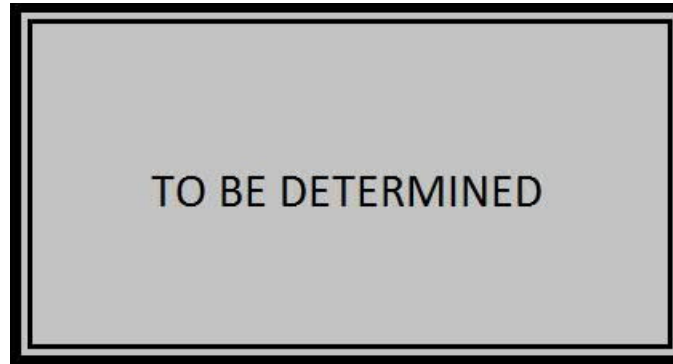


Figure 4-1. Standard Facility Graphic Layout

4.1.3 Poppers

A popup is any graphic that is displayed on top of a system or facility graphic. Poppers are generally used for specific control of equipment, however, may be used to display alarms if there is not sufficient space for process alarms on a main system or facility graphic. Poppers are not full-size graphics and shall appear in an area of the graphic that will not cover important information on the process graphic.

- Layout description: What is the standard background color?
- Popover Title: Font size, text color, background color.
- Means for control: buttons vs hand switches
- Display of statuses: indicator lights versus dynamic text?
- Means of alarming: dynamic text, annunciator boxes? Colors and layout of alarms on popovers

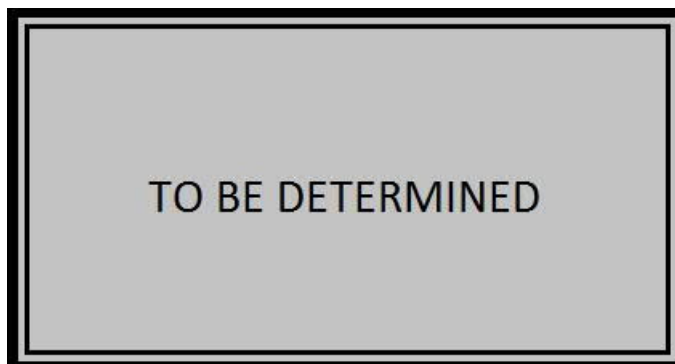


Figure 4-1. Standard Popover Layout

4.2 Graphic Conventions

4.2.1 Graphic Display Characteristics

Equipment identification numbers or names are not displayed on graphics unless there are several parallel equipment items. The minimum text required to identify each item will be used. For example, a well pump known as number 3 is labeled with a 3 on the well graphic.

Analog values are depicted graphically wherever appropriate (tank level, system pressure, flow, and others). Gauges and bar graphs are not used where graphic space is limited; text is the preferred method of representation in these cases. When a bar graph is used, an analog text link is also provided. Engineering units are displayed adjacent to the indication. Where several related analog variables are located on a single display, they are displayed as a vertically aligned set (for example, process value and setpoint on a proportional integral derivative (PID) controller).

4.2.2 Targets

Targets serve as the primary operator interaction within the control system. Targets are selectable areas on a graphic screen that invoke the system to perform some action. Selectable means that the area can be pointed to by the mouse and picked by pressing the left mouse button. By selecting a target, the operator tells the system to perform some action. The following target actions are present in the system:

- Equipment control target: Selecting an equipment control target causes a faceplate control screen to appear that enables the operator to place the equipment in Manual or Auto, start or stop equipment, put in or out of service, change a setpoint, or otherwise change the equipment status.
- Navigation target: Selecting a navigation target causes another graphic screen to replace the current graphic. The display that appears is related to the target's graphical representation or text related to it.

4.2.3 Graphic Names

4.2.3.1 System Level Names

System-level graphics shall be named as follows:

System_XXX

Where:

XXX is overview graphic name.

A list of needed system overview graphics will be discussed, and a standard list of overview names shall be created.

System-level graphic titles will be the same as the graphic name without the underscore.

4.2.3.2 Facility Level Names

Facility-level graphics shall be named as follows:

AAAA_BBBB

Where:

AAAA = Four-character facility name (Refer to Section 2.1 in Programmable Automation Controller Programming Standards for facility abbreviations.)

BBBB = Unit Process or Area

The first letter of the unit process or area shall be capitalized.

The facility unit process graphic titles will be the same as the graphic name without the facility name or underscore.

4.2.3.3 Popup Names

Popups that are used at several different facilities are named as follows:

PopPublic_DDDDD

Where:

DDDDD is the equipment/device description.

Popups that are used at a single facility only are named:

AA_DDDDD

Where:

AA = Two-character facility name

DDDDD = Equipment/Device description

4.3 Text and Colors

In general, the VTScada standard label font will be used for static labels and dialog boxes. The VTScada analog label font will be used for all dynamic value displays.

Colors shall be determined.

4.3.1 State Colors

Table 4-1 lists the standard colors that will be used for the different states. These will be used on indicator lights. Dynamic text will be used to indicate equipment state.

Table 4-1. State Colors

Color	State
Green	Off / Stopped / Open
Red	On / Running / Closed / High Level
Violet	Fail/Fault
Yellow	In Transition / Local/Manual / Reverse
White	Remote / Auto / Forward
Magenta	Low Level
To Be Determined	Invalid/Unknown

4.3.2 Units

The English system of units shall be used in most cases. Table 4-2 lists abbreviations (including capitalization) that shall be used.

Table 4-2. Abbreviations

Unit of Measure	Abbreviation
foot/feet	ft
inch(es)	in
second(s)	sec
hour(s)	hr
gallon(s) per minute	gpm
million gallon(s) per day	mgd
gallon(s) per hour	gph
pound(s) per square inch	psi
gallon(s)	gal
degree(s) Fahrenheit	deg F
milligram(s) per liter	mg/l
watt(s)	watt
ampere(s)	amp

4.3.3 Pipeline Color

Pipes shown on a graphic display will not include any animation. The standard short horizontal pipe image with matching tees and angles shall be used. Figure 4-1 shows following colors that shall be used for the various process flows.

Potable Water – Blue –
(Red-0; Green-0; Blue-255; opacity 255)



Raw Sewage – Brown
(Red-180; Green-145; Blue-92; opacity 255)



Hypochlorite – Yellow –
(Red-255; Green-255; Blue-0; opacity 255)



Raw Water – Dark Green
(Red-0; Green-128; Blue-0; opacity 255)



Figure 4-1. Pipeline Color

Remaining flow stream pipeline colors to be determined

4.4 Equipment State Indication and Control Actions

Standard VTSkada widgets or images shall be used for equipment. Exact images to be used and details on device level controls shall be determined.

5. Tag Database Conventions

5.1 Tag Structure

Context tags shall be used to create a tag hierarchy to make it easier to locate tags in the browser.

The top-level context tag will be the facility name. Additional context tags will be created within the top-level facility context for the different areas' unit processes within that facility. Unit processes and areas shall be fully spelled out (no abbreviations). All PACs and associated drivers at that facility shall also be included under the facility context tag.

For example, Figure 5-1 shows an example of the hierarchy for the Williams Wastewater Treatment Plant (WWTP). Different context tags were added for the belt filter press area and headworks area.

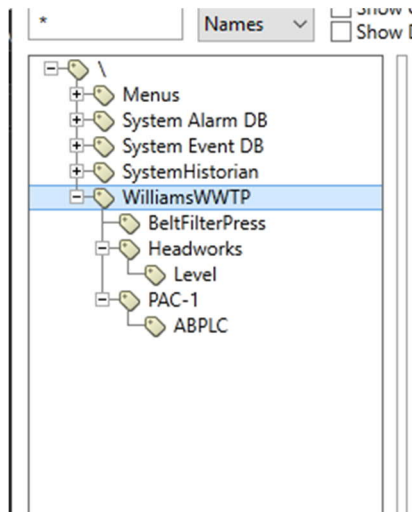


Figure 5-1. Williams WWTP Example Hierarchy

5.2 Instrument and Equipment VTSkada Tag Standard

The tag names used in VTSkada shall be descriptive and follow the tag hierarchy described above. Equipment designators shall be assigned below their respective unit process/area context tag and then individual attribute tags shall be created underneath. Tag names and descriptions shall match tag naming convention shown in SCADA PAC Configuration Standards.

5.3 Utilizing VTSkada Tag Blocks

All inputs and outputs from VTSkada to/from the PAC shall use the I/O and calculations type. Analogs shall be configured using the analog mode and discretes shall use the digital mode. Use of the legacy I/O and calculations types (such as analog control, analog input, analog status, etc.) is not acceptable.

6. Special Functions

6.1 PAC Communication Alarm

VTScada shall monitor a discrete heartbeat tag in the PAC, and two simulation analog tags will be used as counters to monitor changes in the discrete heartbeat tag. For direct Ethernet communication over fiber, if either counter exceeds 60, then a PAC communication alarm is generated. The counter may need to be higher for radio communications.

6.2 Time Synchronization

All SCADA servers shall be synchronized using the GPS NTP server. The use of the Allen Bradley ControlLogix Time Synchronization Module shall be considered for time synchronization of PACs.

6.3 Scripting

In general scripting in the native VTScada text format is not allowed. The use of scripting requires MAWSS and Engineer approval. Applications shall be built using the built-in VTScada standard application.

6.4 Tool Tips

For each piece of equipment and each instrument, provide a tool tip which shows the equipment/instrument equipment or ISA tag name.

7. Alarms and Messaging

7.1 Application Alarm Configuration

Each VTScada application shall use the alarm configuration shown on Figure 7-1.

Display	Alarms	Historical Data Viewer	Other
<h3>Visual Indications</h3> <div> <div>On Server</div> <div>On VIC *</div> <div> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Flash alarm icon in title bar when there are unacknowledged alarms <input type="checkbox"/> <input type="checkbox"/> Flash title bar red when there are unacknowledged alarms <input checked="" type="checkbox"/> <input type="checkbox"/> Flash unacknowledged alarms in alarm list </div> <div>* Flashing on a VTScada Internet Client consumes extra bandwidth</div> <div> <input checked="" type="checkbox"/> Highlight unacknowledged alarms in alarm list <input type="checkbox"/> Use priority color for alarm list text <input type="checkbox"/> Allow popup notification when alarm trips <input checked="" type="checkbox"/> Require confirmation when Acknowledge All is clicked </div> <div>Time format in alarm list: 11:00:00 PM</div> <div>Date format in alarm list: Jan 31, 2013</div> </div>			
<h3>Sounds & Speech</h3> <div> <input checked="" type="checkbox"/> Disable all alarm sounds <input type="checkbox"/> Speak alarms instead of playing sounds Configure speech lexicon: Lexicon </div>			
<h3>Automatic Page Navigation</h3> <div> <input type="checkbox"/> Enable automatic page navigation when an alarm triggers <input type="checkbox"/> Open the target page in a pop-up window Time without user activity before switching to automatic navigation: 300 seconds Minimum time to display a page after switching to it: 10 seconds </div>			
<h3>Alarm Notes</h3> <div> <input type="checkbox"/> Require note when acknowledging alarm 0 Minimum length of acknowledge note <input checked="" type="checkbox"/> Require note when shelving alarm 0 Minimum length of shelf note <input checked="" type="checkbox"/> Require note when unshelving alarm 0 Minimum length of unshelve note </div>			
<h3>Alarm Notification</h3> <div> Notification priority: <input checked="" type="radio"/> Do not notify on alarms <input type="radio"/> Notify on priority 1 alarms only <input type="radio"/> Notify on priority 1 or 2 alarms Delay to notify on priority 1 alarms: 300 seconds Delay to notify on priority 2 alarms: 900 seconds Delay between notifications: 10 seconds </div>			

Figure 7-1. Application Alarm Configuration

7.2 Alarm Priorities

The following alarm priorities shall be used:


1. Critical:
 - a. Life Safety alarms (such as chemical leak, fire)
 - b. Communication failures
 - c. Main computer equipment failure (servers/PACs)
 - d. No high service pump running
 - e. Critical process alarms – as identified by MAWSS
2. High:
 - a. High importance alarms – as identified by MAWSS
3. Warning:
 - a. Low importance alarms – as identified by MAWSS
4. Notice: As needed.

7.3 Alarm Summary Page and Alarm Bar

Alarms are visually displayed. When an alarm is sensed from a monitored alarm area, an alarm will appear on process displays in the form of dynamic text or graphic representation. The alarm will also dynamically appear in the alarm summary as previously described. The alarm summary is a scrollable alarm list that will contain the following fields:

- Acknowledge State
- Date In
- Time In
- Status
- Tag name
- Description
- Value

The built-in VTScada alarm page shall be used that has tabs to access the following: alarm history, active alarms, unacknowledged alarms, current alarms, shelved alarms, disabled alarms, and configured alarms (refer to Figure 7-2).



All									
Database Alarm Actions Reports & Analysis History Filter View Source									
History Active Unacked Current Shelved Disabled Configured									
Time	Event	System	Area	Name	Description	Value	Setpoint	Units	Workstation
Dec 13, 2019 03:05:14 PM	Event	System	Application		Application Started (0 min 31 sec)				DESKTOP-UVU058G
Dec 12, 2019 05:11:27 PM	Event	System	Application		Application Started (0 min 38 sec)				DESKTOP-UVU058G
Dec 12, 2019 03:08:59 PM	Event	System	Application		Application Started (4 min 12 sec)				DESKTOP-UVU058G

Figure 7-2. VTScada Alarm Page

Additional columns, such as audit trails, will be discussed with MAWSS.

The built VTScada alarm page shall be modified for the alarm bar, which will always be visible (refer to Figure 7-3).

Time	Ack	Status	Area	Name	Description

Figure 7-3. Alarm Bar

7.4 Alarm Notification

While VTScada has built-in alarm notification capabilities, Win-911 shall be used to provide remote notification.

The list of alarms to be remotely alarmed will be discussed and confirmed with MAWSS.

7.5 Events

Events are system-level notifications or operator actions performed through the HMI system. These actions are stored in a database for retrieval. The following are examples of events that will be logged in the database:

- Application status (started/stopped)
- Equipment change of controls mode status (Auto/Manual)
- Operator setpoint changes
- Alarm acknowledgement
- Operator login and logout

8. System Security

8.1 Overview

All VTScada applications shall use third-party security for user authentication and authorization. All users will be managed via domain controllers. VTScada privileges are managed via roles, and those roles are assigned to Windows groups.

8.2 Roles

There will be four configured roles within the application, including:

- Administrators
 - Access to all privileges within the application
 - Ability to modify application configuration (add/delete tags, modify pages)
 - Ability to manage version control
 - Ability to manage account control (security)
- Supervisors
 - Ability to shelve and disable alarms
 - Ability to modify alarm setpoint setting
 - Access to Admin pages (Internet Client Monitor Admin)
- Operators

- Access to view graphics
- Access to standard operational control functions
- Ability to acknowledge, silence, and mute alarms
- Ability to modify process setpoints
- View-Only
 - Access to view graphics for monitoring only
 - Historical data monitoring

Table 8-1 shows a functional matrix of role permissions.

Table 8-1. Role Permissions
HMI and Historian Standards

Function	Administrators	Supervisors	Operators	View Only
Modify Security	✓			
System Configuration	✓			
Version Control	✓			
Enable/Disable Alarms	✓	✓		
Shelve Alarms	✓	✓		
Real Time Control	✓	✓	✓	
Acknowledge Alarms and Reset Faults	✓	✓	✓	
Real Time Monitoring	✓	✓	✓	✓
Historical Data Monitoring	✓	✓	✓	✓

8.3 Page Security Settings

Security can be assigned to all graphics and shall be assigned for critical and secure graphics (for example, graphics with IP addresses and other critical information).

The graphics to include security shall be determined.

8.4 Tag Security Settings

Privileges for control and data entry are managed via the tag security. Tag security will be enforced via the roles described in Section 8.2, Roles.

9. Historical Data Collection and Display

9.1 Data to Store in Historical Database

In general, the following data will be historically saved:

- Scaled analog input
- Analog output (scaled)
- Select process control setpoints
- Running status for motorized equipment

- Valve closed status
- Valve open status
- PID setpoints
- PID control variables
- Previous day totals
- Previous day cycle counts
- Previous day runtimes
- Remote/local status
- Auto/Manual status

Additional data to store in the historical database will be confirmed with MAWSS.

9.2 System Historian Tag Properties

Each application has a SystemHistorian tag that defines historical data collection. The following options shall be selected:

- Represent system downtime as missing data. This allows data that are missing to be shown as missing data and not held at the last good value.
- Diagnostic Tracing is enabled (refer to Figure 9-1).
- Keep all data (refer to Figure 9-2). Do not delete old data and do not limit the number of records per tag.

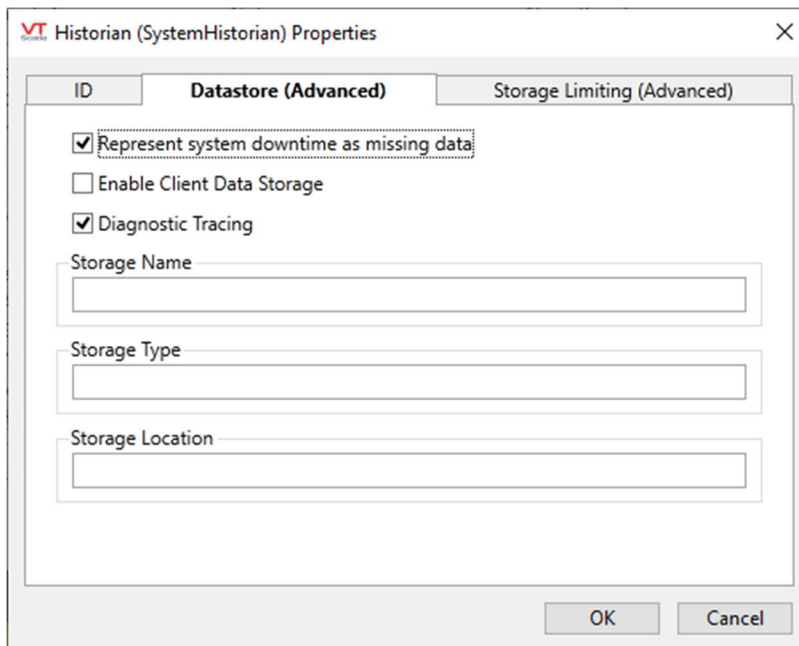


Figure 9-1. SystemHistorian Tag with Represent System Downtime as Missing Data Selected

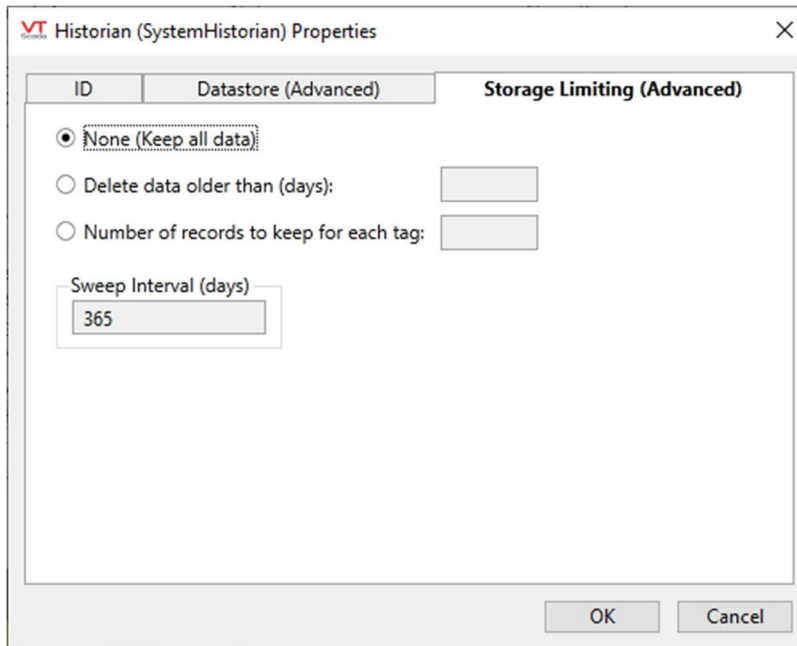


Figure 9-1. SystemHistorian Tag with Keep all Data Selected

9.3 Individual Data Logging

Tags will be configured to historically collect through the I/O and Calculations Type block. Deadbands shall be used to minimize system noise.

Supervisory Control and Data Acquisition

Programmable Automation Controller Programming Standards

February 2020

Mobile Area Water & Sewer System
(MAWSS)



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1. Introduction and Overview

1.1 Purpose

This document provides standards for control system software development for Mobile Area Water & Sewer System (MAWSS). Components of these standards include programmable automation controller (PAC) interface, PAC tag naming convention, and PAC standards.

The purpose of standardization is to consistently implement PAC software. These standards are the basis for future development of the control system and allow consistent implementation of software, efficiency in code development, reduced spare parts, lower training costs, reduced troubleshooting time, more intuitive operational controls, and a more consistent end product.

1.2 General Programmable Automation Controller and Control Systems Overview

PAC standards shall be based on the Allen-Bradley Logix family of PACs. The PACs are the latest in the progression of Allen-Bradley control hardware and are programmed using Rockwell Software's Studio 5000 product. The control system uses Ethernet TCP/IP communication protocols to achieve the required system functionality.

1.3 Terminology

Table 1-1 lists common terminology and acronyms used in this document.

Table 1-1. Terminology and Acronyms

Term or Acronym	Meaning/Definition
ANSI	American National Standards Institute
AO	analog output
AOI	add-on instruction
API	American Petroleum Institute
APPLICATION SOFTWARE	Software to provide functions unique to this project and that are not provided by standard software alone. Configuring databases, tables, displays, reports, parameter lists, ladder logic, and control strategies required to implement functions unique to this project.
BCD	binary counted decimal
DI	discrete input
FB	function block
FBD	function block diagram
HMI	human-machine interface
HMI	Human-machine interface: refers to the operator workstations used for monitoring and control of the facility.
I&C	instrumentation and control
I&C	Instrumentation and control system: generally refers to individual plant instrumentation and controls.
I/O	input/output
IL	instruction list
ISA	Instrument Society of America

Table 1-1. Terminology and Acronyms

Term or Acronym	Meaning/Definition
LD	ladder diagram
mA	milliamp
MAWSS	Mobile Area Water & Sewer System
NFPA	National Fire Protection Association
OOR	out of range
OWNER	MAWSS
PAC	programmable automation controller
PICS	Process instrumentation and control system.
PID	proportional integral derivative
PLC/PAC	Programmable logic controller refers to the controllers that perform control logic for the facility or individual unit process. MAWSS has standardized on ControlLogix and CompactLogix PLCs, which are called programmable automation controllers (PAC). Thus, this document refers to PLCs as PACs. t
SCADA	supervisory control and data acquisition
SCADA	Supervisory control and data acquisition system: generally used in reference to system-wide control and data acquisition system.
STANDARD SOFTWARE	Commercial software package that is independent of the project on which they are used. Standard software includes system software and process monitoring and control software.
SYSTEM SOFTWARE	Application-independent software developed by digital equipment manufacturers and software companies. Includes but is not limited to operating systems, programming languages such as C++, assemblers, file management utilities, text editors, debugging aides, and diagnostics.
TELEMETRY	Communication modes, such as ultra-high frequency and spread spectrum radio, leased telephone line, and auto dialers that are used for communication between the plant, the Operations Center, and offsite equipment, such as remote water wells.
TOD	time of day
UDT	user-defined data type
WORKSTATION	Personal computer operator-machine interface, printers, and ancillary components.

1.4 Standards and Codes

The following organizations have generated standards to use as guides to assure component and system quality and reliability, govern nomenclature, define configuration and construction parameters, and address specific details outlined in this document.

- Instrument Society of America (ISA)
- Underwriters Laboratories, Inc.
- American Water Works Association
- National Electrical Manufacturers Association
- Occupational Safety and Health Administration
- American National Standards Institute (ANSI)
- National Fire Protection Association (NFPA)
- Scientific Apparatus Manufacturers Association

SCADA PAC Programming Standards

- Institute of Electrical and Electronic Engineers
- National Electrical Code (ANSI/NFPA-70)
- American Petroleum Institute (API) RP550 Manual on Installation of Refinery Instruments and Control Systems (API RP550)

2. PAC Tagging Standards

Documentation standards include PAC tagging for points and add-on instructions (AOIs) for assets. The following sections describe the tag convention used for each type.

2.1 Facility Designations

Each location/facility has been assigned a unique facility description. Facility descriptions will be used as part of the PAC tag. The facility designations are referenced in subsequent sections of this document as *FAC*. Table 2-1 list facility designations.

Table 2-1. Facility Designations

Facility Designation	Facility
ABLN	Abilene
ACEH	Ace Hardware
ADBN	Audubon Dr.
ADBR	Adobe Ridge Tank
AGST	Augusta
AIRP	Airport/Snow BS
ALDN	Alden Dr
ANTN	Anton
ARSN	Airport/Snow Rd.
ARTK	Adobe Ridge Tank
ASHP	Ashland Place (Upham)
AZCM	Azalea/Campbell
AZLA	Azalea
BAYA	Bay Rd. # 1
BAYB	Bay Rd. # 2
BCKS	Bucks RWPS
BFBS	Bear Fork BS
BKBY	Brookley Bay Front
BKFD	Bakersfield
BKGL	Brookley Golf Ln.
BKHS	Baker High School
BKRD	Baker Rd. Screens
BLAR	Bel Air Mall
BLKY	Blakely
BLSW	Belsaw
BNBR	Bentbrooke
BNSD	Benson Dr.
BRCD	Bricord
BRFK	Bear Fork Booster
BSHP	Bishop

Table 2-1. Facility Designations

Facility Designation	Facility
CCW	CC Williams WPCP
CHNS	Chin St
CHPH	Chapel Hill
CHSH	Cheshire
CHBS	Cottage Hill Booster Station
CHTK	Cottage Hill Tank
CMBS	Columbus
CNST	Center St.
COST	Conti St.
CPLD	Copeland Island (OSTF)
CPTN	Conception
CRSW	Crenshaw
CSGD	Coast Guard
DGRV	Dog River Dr.
DGSA	Degussa
DIPF	DIP 54
DKLE	Deakle
DLCH	Delchamps (Moff./Sch.
DNLR	Daniels Rd.
DNMK	Denmark
DRVR	Deer River
DRWD	Driftwood Dr.
DWNY	Downey Dr.
DYSM	Dykes/Summerlake
EDWD	Edwards
EGLC	Eagle Chemical
EGLD	Eagle Dr.
EGLM	Eagle/Michigan
ELNG	Elong
ERSR	East Reservoir
ESVA	Eslava Lift Station & SWAT
ETML	Eight Mile
FARD	Faure Dr.
FLST	Florida St.
FGTK	Fairgrounds Tank
FRMN	Furman
FYLN	Faye Ln.
GBLN	Giblin
GFDL	Gulfdale

Table 2-1. Facility Designations

Facility Designation	Facility
GLDS	Gaillard Street PS
GLRD	Gill Rd.
GMNC	Gimon Circle
GNTS	Ghent St
GRCT	Grove Ct.
GRBS	Grelot Booster Station
GRTK	Grelot Tank
GXMN	Gamax/Marion
HAMK	Hammock
HCNA	Hutchens OSTF
HCNB	Hutchens # 2
HGNS	Higgins Rd.
HLBN	Halliburton
HCBS	Hillcrest Booster
HLRD	Hale Rd.
HLWD	Hillwood Dr.
HMC	Halls Mill Creek
HMST	Homestead
HRBR	Harbor
HTNS	Houston/Sligo
HTRP	Hatter's Pond
INCK	Indian Ck. Circle W
INFR	Infirmery
INTP	International Paper
IRBS	Island Rd. Booster Station
IRTK	Island Rd. Tank
JRBS	Johnson Rd. Booster Station
JRTK	Johnson Rd. Tank
JKLN	Jakes Ln.
JYCT	Joy Ct
KRMG	Kerr McGee
LCMB	Lipscomb Landing
LELN	Lee's Ln
LFCH	Life Church
LSLE	Louiselle
LSXXX	Lift Station XXXX
LTIP	Light Ind. Park
LRTK	Lott Rd. Tank
LTVA	Lott/Virginia

Table 2-1. Facility Designations

Facility Designation	Facility
LVOK	Live Oak
LVRT	Levert
MBLS	Mobile St.
MCRY	McCrary
MDWL	Meadowlake
MGMS	M.G.M. School
MGNA	Magnolia Springs # 1
MGNB	Magnolia Springs # 2
MGNP	Magnolia Pt.
MGNV	Magnolia Village
MRBS	Moffett Rd Booster Station
MRCA	Marcia
MRGN	Morgan
MRGT	Margaret
MRTN	Martin Dr.
MSBS	Mississippi St. Booster Station
MSTK	Mississippi St. Tank
MYLD	Myland
MYRS	Myers WTP
NSHT	Neshota
NTGM	Nottingham
OSBS	Oldshell Rd. Booster
OLDM	Old Military
PLNC	Pillan/Conception
PNTD	Pinto Island
PRCA	Perch Ck.
PRCB	Perch Ck. SS
PRFB	Pier 4/Battleship
PRKF	Park Forrest
PRPT	Perch Point
PWDA	Princeton Woods # 1
PWDB	Princeton Woods # 2
PWDC	Princeton Woods # 3
QMS	QMS
RBCH	Rebecca Hills
RDGR	Ridge Rd
RDNY	Radney
RGHS	Regulator House
RGLH	Rangeline/Hamilton

Table 2-1. Facility Designations

Facility Designation	Facility
RMND	Richmond
RSTN	Ralston Rd
RTIN	Rest Inn
RTIP	Rite Industrial Park
RTUA	RTU
RTUB	RTU
RVDA	Riviere Du Chien # 1
RVDB	Riviere Du Chien # 2
RVDC	Riviere Du Chien # 3
RVLG	River Landing
RVSD	Riverside
SRBS	Schillinger Rd. Booster
SCTP	Scott Paper
SDNP	Sidney Phillips
SEMS	Semmes
SHNF	Southern Fasteners
SHRP	Shell Rd. Place
SHSP	Southern Sprinkler
SHWY	Scenic Hwy
SLCO	Salco Gates
SLND	Saraland
SLTD	Salt Docks
SMAV	Smith Ave.
SMKR	Smokerise
SMRP	Summer Place
SMTH	Smith WWTP
SNDI	Sand Island Rd
SNMO	San Marino
SNBS	Snow Rd. Booster
SNWE	Snow Rd. Ext.
SPGM	Springhill Memorial
SPGR	Spring Grove
SHBS	Springhill Booster Station
SHTK	Springhill Tank
SPTR	Spanish Trail
SPYD	Shipyard
STCK	Stickney WTP
STDK	State Docks
STMIR	Stimrad Rd

Table 2-1. Facility Designations

Facility Designation	Facility
SWYR	Sawyer
TDAC	Todd Acres
TMC	Three Mile Creek
TMSW	3-Mile SWAT
VGNA	Virginia St. Lift Station
VLYR	Valley Rd.
VNTA	Venetia # 1
VNTB	Venetia # 2
VNTC	Venetia # 3
WDBR	Woodbridge
WDCH	Woodchase
WDHA	Woodland Hills # 1
WDHB	Woodland Hills # 2
WDHC	Woodland Hills # 3
WLBR	Waller Brothers
WMRT	Walmart
WRDL	Wards Ln.
WRSM	Wright Smith WPCP
WSTD	Western Dr.
WTST	Water St.
ZBCH	Ziebach

2.2 Unit Process Designation

Each unit process type is assigned a descriptive unit process tag that can be used across all facilities (refer to Table 2-1). For example, high-service pumping, filtration, and dewatering are all processes that are assigned a unique unit process description. Where multiple instances of a particular type of unit process occur, the unit process description is capped by an “x” that refers to the unit process number. Table 2-2 lists all unit process descriptions. The unit process designation is referenced in subsequent sections of this document as *UPX*.

Table 2-2. Unit Process Designations

Unit Process Designation	Unit Process
AERDIG	Aerobic Digester
AERTNx	Aeration Basin X
AIRSCR	Air Scour
ALUM	Alum
ANDIG	Anaerobic Digester
BCKWSH	Backwash

Table 2-2. Unit Process Designations

Unit Process Designation	Unit Process
BFPx	Belt Filter Press
BISULF	Bisulfite
CLARx	Clarifier
CL2	Chlorine
CCB	Chlorine Contact Basin
CLRWLL	Clearwell
CLO2	Chlorine Dioxide
ELEC	Electrical
FILTxx	Filters
FSHWTR	Flush Water
FUEL	Fuel
HDWRK	Headworks
HYDPER	Hydrogen Peroxide
INTDIG	Intermediate Digestion
GAS	Gasoline
GRITx	Grit
GVTHKx	Gravity Thickener
LIME	Lime
MISC	Miscellaneous Processes such as PLCs, RIOs
NACLO2	Sodium Chlorite
NRCY	NRCY
ODRCTL	Odor Control
PLNTDR	Plant Drain
POTPRM	Potassium Permanganate
PRCLRxx	Primary Clarifier)
PRSLDG	Primary Sludge
RECYCL	Recycle
RAS	RAS
RS	Raw Sewage
SCUM	Scum
SECLRxx	Secondary Clarifiers
SECSDG	Secondary Sludge
SHLDTK	Solids Holding Tank
THKSDG	Thickened Sludge
TKFILT	Trickling Filter
W3WTR	W3 Water
WAS	Waste Activated Sludge
WWPS	Wastewater Pump Station

2.3 Equipment Tags/Numeric Identifier

Unique descriptive tags have been assigned to identify each type of equipment used across all facilities. Equipment tags will be used as part of the PAC tag. The equipment tags are referenced in subsequent sections as *TAG*. As part of a PAC tag, the equipment tag shall be concatenated with a numeric identifier QQ, such that combined it reads TAGQQ. Table 2-3 lists the equipment tags.

Table 2-3. Equipment Designations

Equipment Designation	Equipment
ASV	Air Scour Valve
BLWx	Blower
BSCx	Bar Screen
BSNx	Basin
BWSV	Backwash Supply Valve
BWWV	Backwash Waste Valve
CLSx	Classifier
CLLx	Collector
CYCx	Cyclone
DEGx	Degritter
DIGx	Digester
DIS	Discharge
EFF	Effluent
FLCx	Flocculator
FCV	Flow Control Valve
GENx	Generator (Chemical, Electrical)
GRDx	Grinder
GSTK	Ground Storage Tank
Gx	Gate
INFV	Influent Valve
LCVx	Level Control Valve
MCCx	Motor Control Center
MTRx	Motor
MXz	Mixer Z (Z = Unit Number)
PMPx	Pump
PXTY	Pump X, Train Y
RIOx	Remote I/O
SCRx	Scrubber
SEPx	Separator
SPBx	Splitter Box
SV	Solenoid Valve
SWGR	Switchgear
TKx	Tank X
TRx	Train X
UPS	Uninterruptible Power Supply
VLV	Valve (if valve does not otherwise have a valve identification tag)

Where the equipment tag is capped by an “x” refers to the equipment number distinguishing between multiple instances of the same equipment type.

2.4 PAC Tag Naming Convention

The software tagging system will be used for defining tags in the PAC. Tagging in the HMI system will be constructed similarly; however, modifications may be necessary to meet system requirements. Tags defined for real input/output (I/O) shall all be Controller Scoped tags. Tags that are internal but used by the SCADA system shall all be Controller Scoped tags. Internal-only tags can be defined as Program Scoped tags as necessary.

In this manner, all PAC tags for all real I/O in all systems can be uniquely identified regardless of in which PAC they reside. Table 2-4 lists the naming convention for PAC tags.

Table 2-4. PAC Tag Naming Convention

Value	Format	Description
FAC	xxx	Unique Facility Description (refer to Table 2-1)
UPX	xxx#	Unit Process Description (refer to Table 2-2)
TAG	xxxx	ISA Identifier or Equipment Identifier as shown on the I/O List
QQ	##	Numeric Identifier
cSuffix	xxx	Suffix shall vary depending on the datatype and/or AOI that is being referenced.

Tags must be unique inside each PAC. Additionally, the HMI accessed tag structure must be unique across the system when all tags are collected into the HMI.

The suffix of the tag will depend on the device being addressed. For all information associated with an instrument, either a user-defined data type (UDT) or pre-defined datatype (from a PlantPax AOI) shall be used. Thus, all tags associated with the function of an instrument are combined into a master grouping of tags.

Tag suffix with leading signal type identifier “c” attribute only apply when the tag needed is outside of the UDT for the PlantPax AOI. The tag suffix is composed of a leading signal type identifier with remaining letters representing the type of signal (refer to Table 2-5). Table 2-6 list examples of tag suffixes.

Table 2-5. c = Leading Signal Type Identifier for the Suffix

Suffix	Description
alm_	Alarm signal from PAC to SCADA
cmd_	Command signal between the PAC and SCADA
sts_	Status indication signal from PAC to SCADA
in_	Input PAC signal (discrete or communication) from field
out_	Output PAC signal (discrete or communication) to field
prog_	Internal PAC programming parameter

Table 2-6. Suffix Examples = type of signal

Example	Description
alm_Fail_Close	Fail to Close Alarm
alm_Fail_Start	Fail to Start Alarm
alm_Fail_Stop	Fail to Stop Alarm
cmd_Auto	Command to place device in Auto

Table 2-6. Suffix Examples = type of signal

Example	Description
cmd_Auto_Open	Command to open in Auto
cmd_Auto_Start	Command to start in Auto
cmd_Man_Close	Command to close in Manual
cmd_Man_Open	Command to open in Manual
cmd_Man_Stop	Command to stop in Manual
sts_Auto	Status device is in auto
sts_Close	Status device is closed
sts_Open	Status device is opened

A similar designation is used for groups of tags associated with devices and internal programming groups.

For example, XYZ_UP_MTR1234.cmd_Auto_Start is the auto start command for motor 1234 for Unit Process UP in facility XYZ.

3. PAC Programming Standards

3.1 Programming Platform

The programming shall use the PlantPax control module library from Rockwell Automation throughout the PAC. The latest compatible library available from Rockwell Software at the start of the programming effort shall be used during the entire programming effort. If a newer version is released, the PlantPax modules do not need to be upgraded to the latest. PlantPax allows for the standardization of a common automation platform between all PACs.

Rockwell Automation's PlantPax modules are memory-intensive on the processor. At the completion of code development prior to startup, all unused PlantPax AOIs are to be removed and purged from the PAC code.

3.2 Overall Structure

The Programming Task is subdivided into Task and Events. Task is subdivided into MainTask. Events are divided into Timer Events and I/O Events. Events will not be used.

3.2.1 MainTask

The MainTask will be set as a continuous task with an appropriate watchdog interval set based on the overall program scan time (refer to Figure 3-1). The watch dog time will be set to three times the normal average overall scan time.

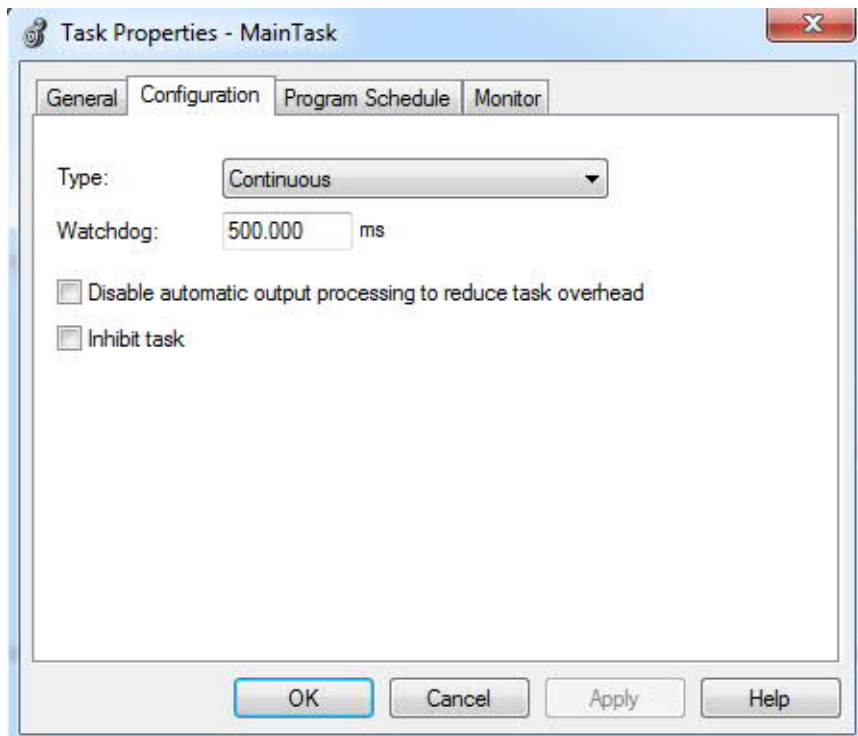


Figure 3-1. MainTask Properties

The ControlLogix Processor conforms to the International Electrotechnical Committee 61131-3 specification. This specification includes specific language sets. The available languages are:

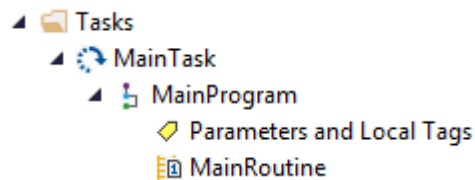
- Function block diagram (FBD)
- Ladder diagram (LD) language
- Instruction list (IL)
- Structured text
- Sequential control

ControlLogix controllers do not include IL.

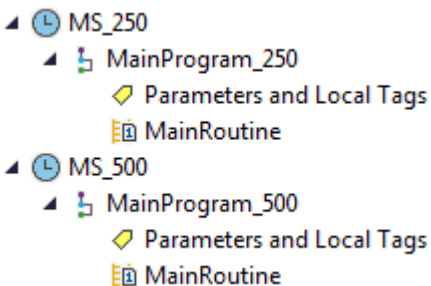
3.2.2 Task

The Task section will contain the MainTask Continuous section and multiple Periodic Tasks, as required.

3.2.2.1 Main Task



3.2.2.2 Periodic Tasks



The naming of Periodic Task will reflect the periodic timing in milliseconds as displayed (refer to Figure 3-2).

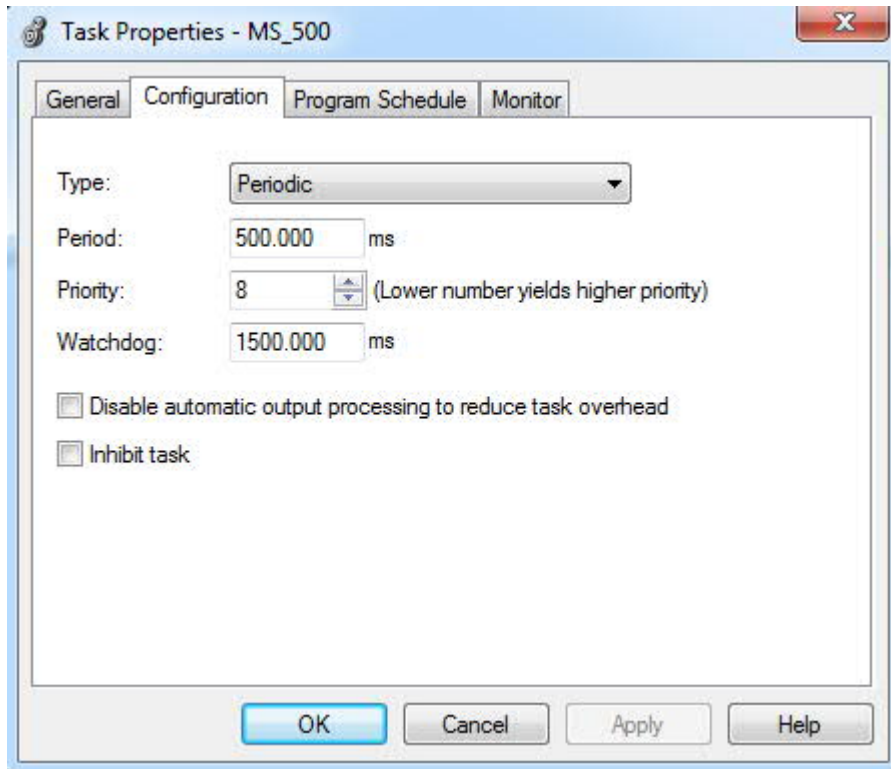


Figure 3-2. Periodic Task Properties

The sections will contain programming segregated by operational process groups and device type. A program section naming standard will be used to identify program groups by unit operation. The programming language type is self-documenting when the section is created.

The preferred language for use with low level programming will be LD. Specific individual items may be programmed in alternate languages when it is appropriate to use the language for a specific task. Examples for alternate language use include complicated mathematical equations, sorting routines, or lookup tables.

Logical groups of programming will be packaged into AOIs and handled as objects when they do not already exist in the PlantPax library. Examples PlantPax AOIs will be single-speed motors (P_Motor), variable-speed motors (P_VSD), and motor-operated valves (P_ValveMO) (refer to Figure 3-3).

Programmable Automation Controller Programming Standards

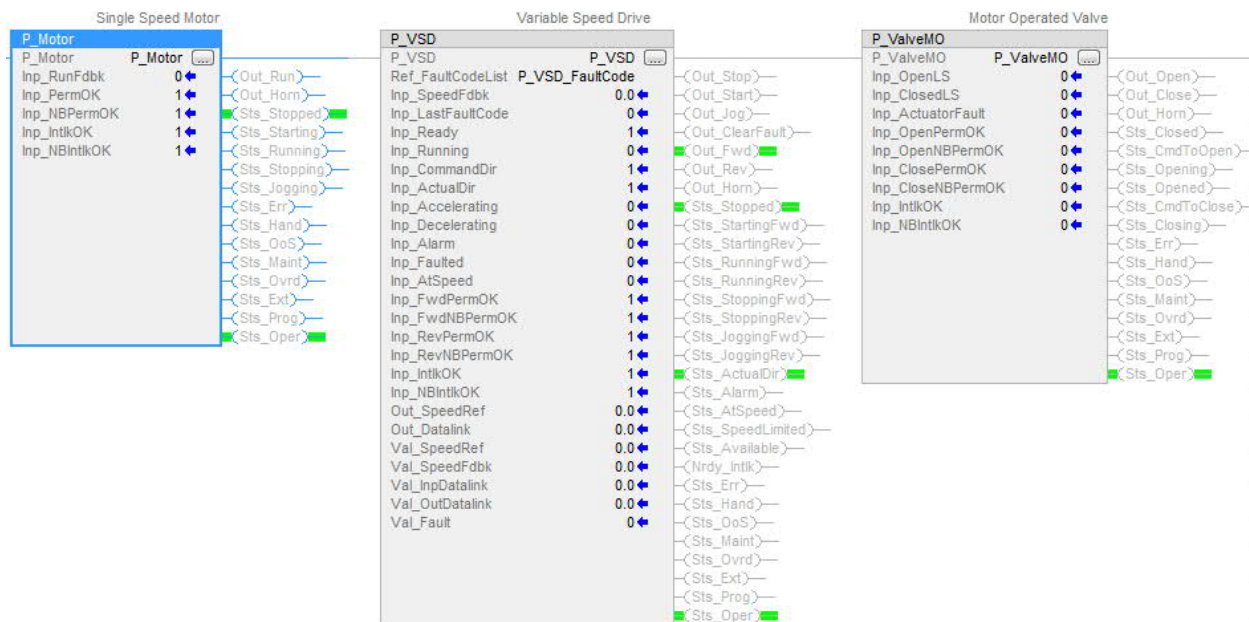


Figure 3-3. Example PlantPAX AIOs

3.2.2.3 MainTask

The MainTask will contain sections (Sections) and subroutine sections (SR Sections). The Sections will contain overall programming routines for sequential control, device control, and interlock/alarming. Overall programming for sequential control of the devices and interlocks will be performed in LD. When alternate languages are used, the components will typically be placed in user-definable function blocks (FBs) (AOI) with an FB representation being used in the main program.

Subroutines will be used as appropriate. Examples of subroutine use include program initialization during cold controller startup and mapping physical I/O to internal PAC points. Looping subroutines for plant operation will not be used.

3.2.2.4 Periodic Task

The Periodic Task will contain time-sensitive sections, such as flow totalizers and proportional integral derivative (PID) controllers.

Periodic Tasks will contain a PlantPax task monitor on the first rung of the main routine. The task monitor shall be used for alarming if the periodic task is executing too slowly and the alarm is to be included with other system alarms (refer to Figure 3-4).

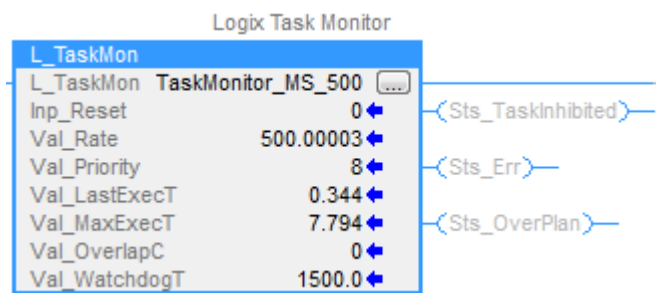


Figure 3-4. PlantPAX Task Monitor

3.2.3 Initialization Routine

One MainTask will call this subroutine once on the first scan on PAC startup. This program is not executed again, unless the PAC is stopped and restarted. This file initializes all PAC tags with default values required to smoothly begin operation of the water treatment plant processes by the PAC, even after a cold start or replacement of the PAC. Process control loops or programs that use PAC tags containing values that would be reset to 0 when the PAC restarts should use this file to establish initial default settings for those values. Examples include the following:

- Confirm default settings for any setpoints or addresses that could have changed
- Initialize any bits that should be on when the PAC starts
- Reset message statements and errors that could occur on power down or loss of power

3.2.4 Analog Configuration

Analog cards will be configured at installation. The card will be configured to report the analog counts spanned from 0 to 100 for real counts or 0 to 10,000, based integer counts, as reported by the card. Available selected card faults and status will also be configured to report. Card input scaling from raw units to real units and alarm limits will be done in the card configuration.

3.2.5 Analog I/O

3.2.5.1 Analog Inputs

The analog I/O will be scaled to engineering units in the PAC and assigned a REAL data type. By scaling the analog data in the PAC, it provides a method of data mapping the fixed I/O locations to internal tags that can be reused throughout the program. If an analog signal is relocated, a change will be required in one file in the controller.

Analog inputs will typically be scaled for 0 to 20 milliamperes (mA) current range in the card configuration. This approach facilitates the sensing of defective field instrumentation and allows the HMI setting on “under range” alarms at a point slightly below 4 mA.

The rest of the program will use the scaled engineering units generated by the PlantPAX P_AIn AOI using the P_Ain.Val tag. See Section 3.6.3, Analog Generated Alarms, for AOI tags.

3.2.5.2 Analog Outputs

Analog output (AO) values that are stored in REAL data types are converted to appropriate datatypes and scaled to the appropriate resolution based on card type for transmission to the AO modules representing a range of 4-20 mA.

3.2.6 Discrete Data

Discrete data will be mapped from tags assigned to wired I/O points to tags that will be used throughout the program as well as referenced by the HMI package. This type of data mapping allows for HMI development simulation and minimizes the rework associated with changing I/O points in the field. Document the original I/O point tag and the mapped tag on the I/O list and in the program. Minimal process conditioning will occur in this file, typically limited to binary negation.

3.2.7 PAC Synchronization

The PAC is synchronized to the network time server using the Allen Bradley Logix5000 Clock Update Tool. Older PLCs that do not interface with this tool will have a bit set at a specific time from the HMI for time synchronization.

3.2.8 Faults

3.2.8.1 PAC Fault Monitoring and Resets

Several conditions may be monitored in the PAC and reported to the HMI to assist in troubleshooting. The following conditions will be among those monitored:

- Rack faults and excessive retries

3.2.8.2 Fault Routines

Fault routines are to be contained in the MainProgram Task in their own MainFaults task. Faults of I/O are to be monitored and generated at the PAC level within the routine. Operational faults from code within timed tasks for each system are to be propagated to the MainRoutine for fault handling task. Most PlantPax AOIs already contain faults that shall be used instead of writing custom faults for PlantPax modules. The faults generated from the individual PlantPax AOIs are to be propagated to the MainProgram fault routine task also. Communication to the SCADA system will come from the faults contained within the MainProgram fault routine task. All faults are to be latched and require an operator to reset or silence the fault alarm.

3.2.9 PAC to PAC Communication

3.2.9.1 Message Commands

Communication with other PACs/PLCs will be executed with the MSG message blocks in the PAC. Each PAC communication link will have an individual section for incoming and outgoing data. The preferred method of communication shall be message reads from each PAC. Message write commands are to be avoided unless necessary.

Message commands are to be contained within a timed task and not continuously executed. Timed tasks will conserve the communication bandwidth usage. Critical communication shall be at faster rates as compared to non-critical communication data that should be at a slower message read rate.

3.2.9.2 User-Defined Data Types

The data read in a message command shall use custom UDTs of an array for each data type. The size of the array shall allow for all communication necessary from the source PAC plus 50 percent per each data type. This allows for future expansion of communication without the need to resize, redefine, and re-download the PAC code for the UDT to increase the size of the array.

3.2.9.3 Watchdog Timers

Included in custom UDT array would be loss of communication logic including a watchdog timer for each remote PAC. Watchdog timers are to be generated in each PAC (constantly changing values) and all PACs are to monitor the watchdog timer for continuous changes from each associated PAC required for cross-communication. At failure/stale watchdog timer data for a pre-determined period, a PAC alarm is to be generated.

3.2.9.4 Produced/Consumed Tags

Produced/Consumed tags are to be avoided because changing a produced/consumed tag requires a recompile and redownload of the PAC while the PAC is offline.

3.2.10 Historical Data

Historical data should be primarily stored on the SCADA Historian system. Custom UDT arrays are to be generated in the PAC to temporarily store data to be collected by the SCADA system during periods of

communication outages. The length of time historical data should be stored locally shall be determined by a reasonable outage as defined and required by MAWSS. Upon reconnection of communication with the SCADA system, all data are to be transferred back to the SCADA Historian.

3.2.11 Chemical Dosage

Dosage of materials to the system are to be controlled via the PlantPAx P_Dose AOI. All information for configuring and executing a dose to a system is available through the AOI (refer to Figure 3-5).

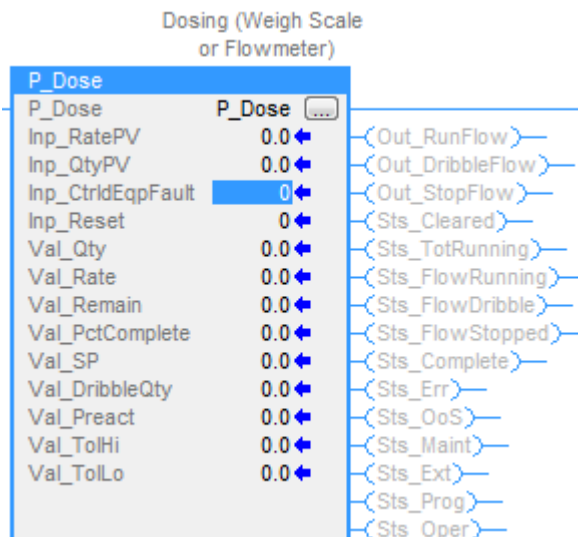


Figure 3-5. Chemical Dosage AOI

3.2.12 Runtimes

The PlantPAx AOI P_RunTime contains all the logic to accumulate runtimes for each of the motors. The AOI will need to be implemented for each motor and/or each piece of equipment where accumulated runtimes need to be logged (refer to Figure 3-6).

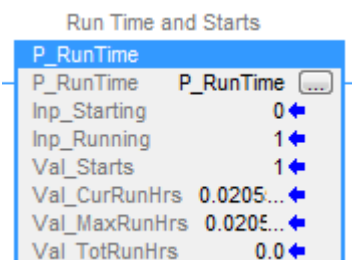


Figure 3-6. RunTime AIO

3.2.13 Totalizers

For equipment using flow meters to accumulate flow data or other similar type, the use of the built-in totalizer (TOT) shall be used to measure data (refer to Figure 3-7).

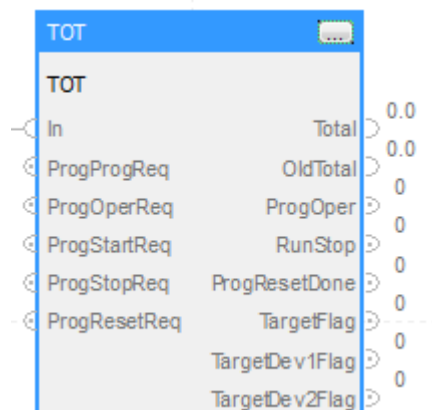


Figure 3-7. Totalizer

3.2.14 Daily Accumulations

For equipment with runtimes, daily totals will be calculated for all applicable data. At 7:00 AM, daily totals will be moved to yesterday's totals and then the daily totals will be cleared. Additionally, monthly total and last month totals will be maintained.

3.3 Data Structure

3.3.1 Data Types

The ControlLogix processors contain base and special data types as listed in Tables 3-1 and 3-2, respectively.

Table 3-1. Base Data Types

WORD:	Represents a "bit string 16," meaning the length of data is 16 bits
INT:	Represents an integer value. The range of values are -32768 through 32767.
UINT:	Represents an unsigned integer value. The range of values are 0 through 65535.
BOOL:	Must be a ON (1) or OFF (0).
REAL:	Represents a floating-point value. The range of values are 8.43e-37 through 3.36e+38.
BYTE:	Represents a Byte value. The range of values are 16#00 through 16#FF.
DINT:	Abbreviation of Double Integer format (coded on 32 bits). The range of values are -231 to 231-1. Example: -2147483648, 2147483647.
UDINT:	Abbreviation of Unsigned Double Integer format (coded on 32 bits) unsigned. The range of values are 0 to (2 to the power of 32) - 1. Example: 0, 4294967295.
DWORD:	Abbreviation of Double Word type format (coded in 32 bits). The range of values are 16#0 to 16#FFFFFFFF.
STRING:	ASCII standard character string. A character string has a maximum length of 2,048 characters.
TIME:	Expresses a duration in ms. Coded in 32 bits, this type makes it possible to obtain periods from 0 to 2 32-1 ms. The units of type TIME are the following: Days (d), Hours (h), Minutes (m), Seconds (s) ms. A literal value of the type TIME is represented by a combination of previous types preceded by T#, t#, TIME# or time#. Examples: T#25h15m, t#14.7S, TIME#5d10h23m45s3ms

Table 3-2. Special Data Types

TOD:	<p>Abbreviation of Time of Day. The TOD type coded in binary counted decimal (BCD) in 32-bit format contains the following information:</p> <p>Hour coded in an 8-bit field</p> <p>Minutes coded in an 8-bit field</p> <p>Seconds coded in an 8-bit field</p> <p>Note: The 8 least significant bits are unused.</p> <p>The Time of Day type is entered as follows: HMI: TOD#<Hour>:<Minutes>:<Seconds></p> <p>Hour 00,23 Minute 00,59 Second 00,59</p> <p>The left 0 is always displayed, but can be omitted at the time of entry. Example: TOD#23:59:45.</p>
DT:	<p>Abbreviation of Date and Time. The DT type coded in BCD in 64-bit format contains the following information:</p> <p>Year coded in a 16-bit field</p> <p>Month coded in an 8-bit field</p> <p>Day coded in an 8-bit field</p> <p>Hour coded in an 8-bit field,</p> <p>Minutes coded in an 8-bit field</p> <p>Seconds coded in an 8-bit field</p> <p>Note: The 8 least significant bits are unused.</p> <p>The DT type is entered as follows: HMI: DT#<Year>-<Month>-<Day>-<Hour>:<Minutes>:<Seconds></p> <p>Year 1990,2099 Month 01,12 Day 01,31</p> <p>Hour 00,23 Minute 00,59 Seconds 00,59</p> <p>The left 0 is always displayed, but can be omitted at the time of entry. Example: TOD#23:59:45.</p>
DATE:	<p>Abbreviation of Date. The DT coded in BCD in 32-bit format contains the following information:</p> <p>Year coded in a 16-bit field</p> <p>Month coded in an 8-bit field</p> <p>Day coded in an 8-bit field</p> <p>The DATE type is entered as follows: HMI: D#<Year>-<Month>-<Day></p> <p>Year 1990,2099 Month 01,12 Day 01,31</p>

3.3.2 PAC Tag Structure

Refer to Section 2, PAC Tagging Standards.

3.3.3 User-Definable Function Blocks

For instances where PlantPAx does not have an available AOI, user-definable FBs will be used to control individual devices and contain common logic elements.

For typical digital control components, the internal structure of the FB will be built using ladder logic. For more complex blocks or calculations, structured test may be used; however, the representation in the main program will be FB or ladder logic.

3.4 PID Control

The PID controller is used for analog control of a device or group of devices to maintain a process setpoint. Examples are flow from a membrane feed pump, flow through a membrane concentrate valve, or pressure control for a set of high-service pumps.

PID transitions between Auto and Manual will be based on the state of the attached device(s). When at least one device is operating in Remote/Auto, the PID will be in Auto. When no devices are operating in Remote/Auto, the PID will be in Manual. When equipment is operating in Remote/Manual, the PID tracks the device for bumpless transfer to Remote/Auto. The PlantPax P_PIDE AOI is to be used (refer to Figure 3-8).

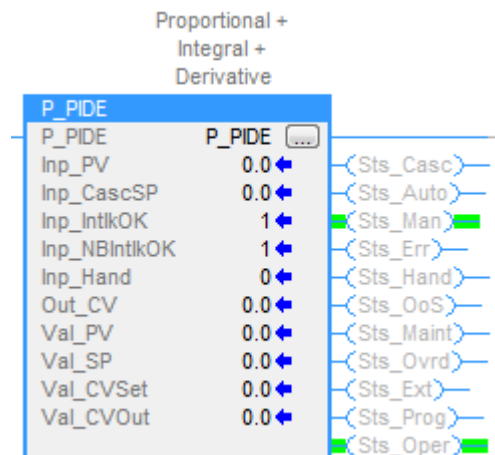


Figure 3-8. PID AOI

3.5 Lead/Lag Control

When multiple devices can control a process at the same time in Auto, a lead/lag system will be implemented to determine the equipment that should be operated. Lead/Lag management, equipment alternation, or sequencing is performed in the applicable process area program files. Lead/Lag control will be managed through the PlantPax P_LLS AOI block (refer to Figure 3-9).

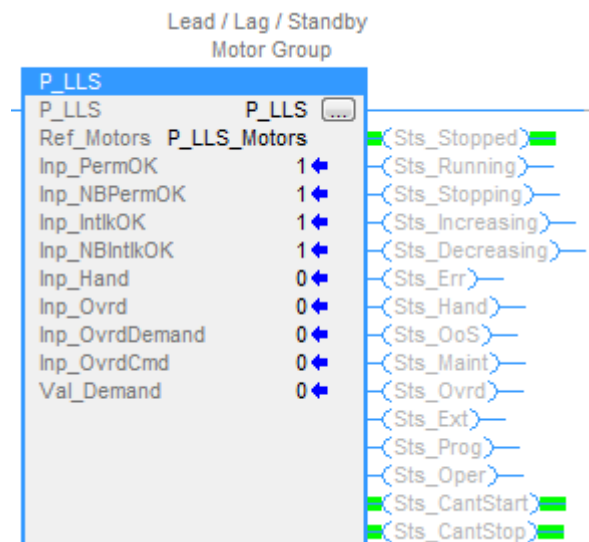


Figure 3-9. Lead/Lag Control AOI

3.6 Alarm Handling

Alarm conditioning will include logic to minimize nuisance alarms that are generated at inappropriate points in the process sequence. This will include preconditional logic (pump on before allowing a high-pressure alarm), time delay logic, and dead-band logic. Refer to control strategy document for specific details of alarm functionality and interactions; descriptions below are only meant as general functionality.

All alarm functions are to use PlantPAx P_Alarm AOI for alarming, acknowledgement, and reset functions for digital input alarms and process-based alarms (refer to Figure 3-10).

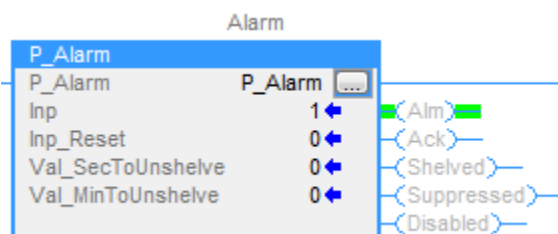


Figure 3-10. Alarm AOI

3.6.1 Digital Input Alarms

Digital input (DI) alarm conditions are sensed by dedicated discrete inputs. These DI alarms will be used by the PAC logic as software interlocks for process control. These DIs remain on as long as the process condition remains in alarm and may be latched, requiring a reset from the HMI.

3.6.2 Process-Based Alarms

Process-based alarms are discrete alarms generated by the PAC based on process conditions, or a combination of process conditions. The PAC will generate alarms if equipment fails to perform as expected. These alarms remain on in the PAC while the alarm condition exists. Specific alarms may latch and require operator restart, such as motor fail to start.

3.6.3 Analog-Generated Alarms

Analog-generated alarms are generated based on analog measurements. The PAC will generate any HighHigh, High, Low, and LowLow alarms that are necessary for a given analog measurement. These alarms may be used for other logic or interlocks. Typically, the high and low are not latched and used for alarms only. Typically, the high and low are latched and used for interlocks (refer to Figure 3-11).

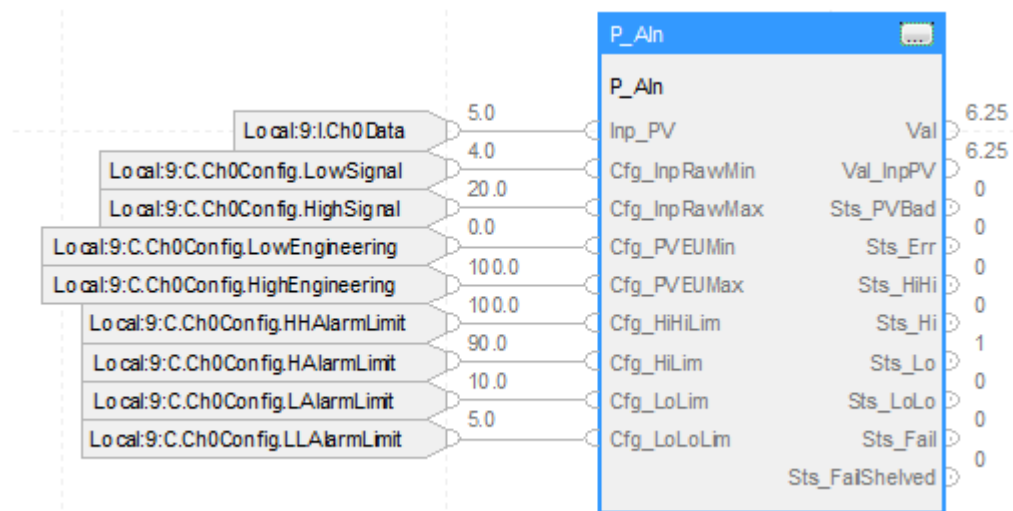


Figure 3-11. Level Interlocks

3.7 Typical Programming Elements

3.7.1 PAC Faults

The PAC can monitor certain conditions and generate diagnostics in the form of fault codes. On a minor error, the PAC will continue to operate. On a major error, the PAC will enter a fault mode and will no longer solve logic. Outputs will default to their failed state.

PAC failed state will be determined during narrative development based on process; examples include:

- High-service pumps – Fail last (all running pumps continue to run)
- Membrane feed pump – Fail off

The following is a list of typical minor faults, which do not fault the processor:

- Math overflow indicates a register is exceeding its limit and the logic should be reviewed.
- PID Setpoint out of range (OOR) indicates that the setpoint to a PID block is out of its configured limits and that the PID block is no longer working properly. Limits should be added prior to the PID block to ensure the setpoint does not go OOR.

3.8 Sequence Control

Standard sequence control algorithms will be used to coordinate equipment and functions for the membrane trains and additional internal functions as required. The sequential control will consist of the following components:

- 1) An integer register that defines the current step and associated mutually exclusive bits for use in code
- 2) Advance conditions that define the conditions that the system will transition from one step to another step

This approach provides a solid backbone structure to base control, is easily documented, and open to future process changes with limited programming should changes be required. The concept is similar to Sequential Function Chart programming without the limitations that may occur with Sequential Function Charts.

SCADA SOFTWARE (C.C. WILLIAMS WWTP)				
Part Description	Manufacturer	Qty	Associated PC/Server(s)	Notes
VTScada 25K Dual Server Premium (25,000 tags)	Trihedral (Delta)	1	CCWHMI01 CCWHMI02 (VTScada Primary Server, VTScada Backup Server)	Includes: (2) Development Runtime 10K (2) Alarm Notification 10K (1) Unlimited Thin Clients (1) 24/7 Support; 1 year (1) VTScada Training Course \$1000 credit (transfer to MAWSS)
VTScada 25K Runtime (25,000 tags)	Trihedral (Delta)	1	CCWVID01 (VTScada Video Wall)	Includes: (1) 3rd Party Data Sharing, 10K (1) 24/7 Support; 1 year
Allen-Bradley Studio 5000, Professional Edition	Rockwell	1	CCWENG01 (Engineering Workstation)	Includes: Logix Designer Perpetual License
SCADA SOFTWARE (PARK FOREST)				
VTScada 25K Runtime (25,000 tags)	Trihedral (Delta)	2	PFMAHMI01 PFMAHMI02 (VTScada Master App Primary, VTScada Master App Backup)	Includes: (1) 3rd Party Data Sharing, 10K (1) 24/7 Support; 1 year
VTScada 25K Runtime (25,000 tags)	Trihedral (Delta)	1	DMZHMI01 (VTScada Master App Read-Only)	Includes: (1) 3rd Party Data Sharing, 10K (1) 24/7 Support; 1 year

SECTION 40 96 02
OT NETWORKING SOFTWARE

PART 1 GENERAL

1.01 WORK INCLUDED

- A. General: Work includes design, furnishing, testing, documenting, training and starting up the security, network management, and application software for the functioning ICS Security Zone and DMZ Security Zone Virtual Machines as shown on the Drawings.
- B. Major applications software work items include:
 - 1. Work sequence and schedule.
 - 2. Software workshops.
 - 3. Software and configuration submittals.
 - 4. Applications software development.
 - 5. Software testing.
 - 6. Software installation.
 - 7. O&M development.
 - 8. Owner training.
 - 9. Startup.

1.02 DEFINITIONS

- A. Abbreviations:
 - 1. AV: Antivirus.
 - 2. CPU: Central Processing Unit.
 - 3. CVE: Common Vulnerabilities and Exposures.
 - 4. DMZ: Demilitarized Zone.
 - 5. GPO: Group Policy Object.
 - 6. GPS: Global Positioning System.
 - 7. HDD: Hard Disk Drive.
 - 8. HMI: Human-Machine Interface.
 - 9. I&C: Instrumentation and Control.
 - 10. I/O: Inputs and Outputs.
 - 11. ICS: Industrial Control System.
 - 12. IDS: Intrusion Detection System.
 - 13. IGS: Industrial Gateway Server.
 - 14. IPS: Intrusion Prevention System.
 - 15. IP: Internet Protocol.
 - 16. IT: Information Technology.
 - 17. I&C: Instrumentation and Controls.

18. LAN: Local Area Network.
19. LDAPS: Lightweight Directory Access Protocol over SSL/TLS.
20. MAS: Multiple Address System.
21. MFA: Multi-Factor Authentication.
22. NAS: Network Attached Storage.
23. NIC: Network Interface Card.
24. NIST: National Institute of Standards and Technology.
25. NTP: Network Time Protocol.
26. O&M: Operation and Maintenance.
27. OIT: Operator Interface Terminal.
28. ORT: Operational Readiness Test.
29. OT: Operational Technology.
30. OU: Organizational Unit.
31. P&ID: Process and Instrument Diagram.
32. PC: Personal Computer.
33. PIC: Process Instrumentation and Control.
34. PAC: Programmable Automation Controller.
35. PMCS: Process Monitoring and Control Software.
36. PoE: Power Over Ethernet.
37. PAT: Performance Testing.
38. PLC: Programmable Logic Controller.
39. PMCS: Process Monitoring and Control Software.
40. PNP: Plug and Play (PnP).
41. PRA: Privileged Remote Access.
42. PW: Password.
43. RADIUS: Remote Authentication Dial-In User Service.
44. RAID: Redundant Array of Independent Disks.
45. RDS: Remote Desktop Services.
46. SAM: Security Accounts Manager.
47. SAN: Storage Area Network.
48. SCADA: Supervisory Control and Data Acquisition System.
49. SDT: Software Demonstration Test.
50. SLA: Service Level Agreement.
51. SMB: Server Message Block.
52. SNMP: Simple Network Management Protocol.
53. SQL: Structured Query Language.
54. USB: Universal Serial Bus.
55. VLAN: Virtual Local Area Network.
56. VM: Virtual Machine.
57. VPN: Virtual Private Network.
58. WMI: Windows Management Instrumentation.

B. Instructor Day: 8 hours of actual instruction time.

C. Software:

1. Programming of computers, switches, firewalls, and machines using all types of programming language.
2. Configuring of digital devices using all types of configuring process.
3. Programs or configuration data stored in read only memory, programmable read only memory, read/write memory, disk, tape, or other storage device.

D. Types of Software:

1. Standard Software: Software packages that are independent of project on which they are used. Standard software includes system software and process monitoring and control software.
 - a. System Software: Application independent software developed by Microsoft. Includes, but is not limited to, Microsoft's Windows operating system; file management utilities; text editors; debugging aids; and diagnostics.
 - b. Process Monitoring and Control Software (PMCS): Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing capability for, data acquisition, monitoring, alarming, man-machine interface, data collection, data retrieval, trending, report generation, control, and diagnostics.
2. OT Networking Software: Software packages intended to provide Information Technology (IT) type functions for industrial control systems. These include antivirus, network monitoring, virtual machine management, active directory, and backup management.
3. Application Software:
 - a. Software to provide functions unique to this Project and that are not provided by standard software alone.
 - b. Configuring databases, tables, displays, reports, parameter lists ladder logic, and control strategies required to implement functions unique to this Project.

1.03 WORK SEQUENCE AND SCHEDULE

A. General: All work provided under this section shall be in accordance with a Milestone Breakdown and System Delivery Plan.

B. System Delivery Plan (SDP):

1. The intent of the SDP is to:
 - a. Coordinate and communicate applications and OT Networking software design and testing activities.

- b. Coordinate interactions with the Owner regarding software configuration, workshops, submittal reviews, contractor(s) progress, test witnessing, training, etc.
 - c. Communicate and clarify required work sequences and major milestones.
- 2. Minimum Content:
 - a. Work sequence and schedule.
 - b. OT Networking software workshops.
 - c. OT Networking software submittals.
 - d. OT Networking software development.
 - e. Software testing.
 - f. Software installation.
 - g. O&M development.
 - h. Owner training.
 - i. Startup.

1.04 SOFTWARE DESIGN WORKSHOPS

- A. Location: Owner's facility during the course of the Project.
- B. Objective: To provide a vehicle for the Owner to oversee the applications and networking software development.
- C. Documentation: Software Supplier to summarize resolutions reached in each workshop, including cost and schedule impacts and distribute copies to Owner and Engineer.
- D. Order and minimum topics to be covered in each Software Design Workshop.
 - 1. Networking Software Design Kickoff Workshop that establishes project processes, including:
 - a. Contractor, integrator, and Owner coordination and communication.
 - b. Required coordination workshops and workshop agendas
 - c. Submittal process.
 - d. Owner input and involvement in OT network software configuration.
 - e. Minimum functional requirements of OT networking software.
 - 2. Networking Software Configuration Workshop:
 - a. Software and Configuration:
 - 1) VM Configuration.
 - 2) Accounts and Account Management.
 - 3) Backup Management
 - 4) Overall security configurations.

- 5) OT Management:
 - a) Identify ongoing support/system management roles and responsibilities.
 - b) Develop support/system management matrix
- 6) Discuss and document choices.

1.05 SUBMITTALS

A. Action Submittals:

1. Manufacturers standard literature for all application and network software types and version being provided for each physical and virtual device.
2. Virtual Machine Mapping Diagram: Provide a drawing showing all virtual machine communication and mapping between virtual machines.
3. IP address assignments, VLAN mappings, VM network interface card settings.
4. Preliminary firewall policies.
5. Remote access flow diagram.
6. Authentication flow diagram.
7. Security Standards Submittal:
 - a. Review and develop security standards in a participative workshop with the Owner and Engineer.
 - b. Documented and submitted as security software standards.

B. Informational Submittals:

1. Networking Software Schedule of Values and Progress Schedule:
 - a. Submit within 30 days after first Preconstruction Conference.
 - b. Upon acceptance by Engineer, shall form basis and schedule of Submittal reviews, test witnessing, and partial payments.
 - c. Prior to this acceptance, Engineer will not review Submittals, witness tests, or consider requests for partial payment.
2. Owner Training Plan: In accordance with Section 01 43 33, Manufacturers' Field Services.
3. Testing Related Submittals:
 - a. Test Forms:
 - 1) Proposed test procedures, forms, and check lists:
 - a) Software Demonstration Tests (SDT).
 - b) Operational Readiness Test (ORT).
 - c) Performance Acceptance Test (PAT).

- b. Test Procedures: Conduct tests using Engineer accepted test procedures, forms, and checklists. Conduct testing of OT system prior to testing SCADA related applications software.
 - c. Test Documentation: Copy of signed of test procedures when tests are completed.
- 4. Operations and Maintenance Manuals:
 - a. In accordance with Section 01 78 23, Operation and Maintenance Data, unless otherwise specified in this section.
 - 1) User's manuals for OT networking and application software packages.
 - 2) Networking and OT Applications software source files.

PART 2 PRODUCTS

2.01 COORDINATION WITH OWNER

- A. Coordinate with Owner on required configuration of CC Williams OT network. System shall be compatible with OT network installed at Park Forest Headquarters and shall incorporate configuration standards developed as part of Park Forest network development.
- B. The following configurations and OT network software packages are expected to be developed by Owner for Park Forest OT Network. These configuration and packages are expected to be developed prior to development of CC Williams OT Network. Configurations and packages developed at Park Forest shall be assumed to be Owner's standards and incorporated and utilized in the development of the CC Williams OT Network where possible.
 - 1. VM and VLAN configuration and management.
 - 2. ICS Domain Controller and active directories.
 - 3. Privileged Access Management.
 - 4. Network Monitoring.

2.02 VM APPLICATION SOFTWARE DESIGN CRITERIA

- A. VMware:
 - 1. ESXi 6.7 (or latest stable version) must be installed on all virtual hosts.
 - 2. vCenter must be installed and used (where required) to manage multiple hosts.

3. All VM's shall be configured per the following parameters:

	Domain Controllers	VTSCADA	Backup Servers	Member Servers
CPUs	2 vCPUs	4 vCPUs	2 vCPUs	2 vCPUs
Memory	8 GB	16 GB	8 GB	8 GB
HDD 1	100 GB	100 GB	100 GB	100 GB
HDD 2	100 GB	1 TB	1 TB	100 GB
NICs	1 x 1 Gbps	1 x 1 Gbps	1 x 1 Gbps	1 x 1 Gbps

- B. All Virtual Hosts must use a RAID array capable of handling a single drive failure as a minimum.
- C. Windows:
1. All VM's must use a 64-bit version of Windows Server 2019 Datacenter Operating System.
 2. A Read-Only Domain Controller is required on the DMZ and integrated with systems and/or services also within the DMZ.
 3. Integrator shall coordinate with Owner on Forest Root Domain and Park Forest active directory configuration for inclusion in development of CC Williams active directory.
 4. Active Directory will be used to centralize user accounts, security groups and group policy objects. Active Directory Organization Unit (OU) structure shall follow (but is not limited to):

Root Domain (eg. wwtp.local)				
Organizational Unit (OU)	Sub Folder	Sub Folder	Account(s)	Description
Vendors	<Vendor 1>	I&C	<as required>	OU for I&C Staff User Accounts
		OT	<as required>	Operational Technology (OT) User Accounts
	<Vendor 2>	I&C	<as required>	As above
		OT	<as required>	As above
Utility	OT		<as required>	OT User accounts of members employed by the Utility

Root Domain (eg. wwtp.local)				
Organizational Unit (OU)	Sub Folder	Sub Folder	Account(s)	Description
	Developers		<as required>	Developer accounts
	Managers		<as required>	Manager accounts
	Supervisors		<as required>	Supervisor accounts
Service Accounts			<domain>/HMIservice	Must be an admin on every HMI system
			SQLDataRetrieval	Optional SQL Domain Accounts instead of mixed mode. Otherwise use Mixed Mode with SA account and strong PW. Mixed mode is recommended.
			SQLSysAdmin	
Security Groups	HMI Administrators			Add users to the following security groups.Type: Domain Local/Security
	HMI Developers			Type: Domain Local/Security
	Global HMI Administrators			Type: Global/Security
	Global HMI Developers			Type: Global/Security

5. Group Policy Objects must be configured and applied to all systems, including (but not limited to):

- a. An Audit Policy shall be created and applied to all servers and workstations. The policy shall include:
 - ‘Audit Credential Validation’ is set to ‘Success and Failure’

- Audit 'Application Group Management' is set to 'Success and Failure'
- Audit 'Computer Account Management' is set to 'Success and Failure'
- Audit 'Other Account Management Events' is set to 'Success and Failure'
- Audit 'Security Group Management' is set to 'Success and Failure'
- Audit 'User Account Management' is set to 'Success and Failure'
- Audit 'PNP Activity' is set to 'Success'
- Audit 'Process Creation' is set to 'Success'
- Audit 'Account Lockout' is set to 'Success and Failure'
- Audit 'Group Membership' is set to 'Success'
- Audit 'Logoff' is set to 'Success'
- Audit 'Logon' is set to 'Success and Failure'
- Audit 'Other Logon/Logoff Events' is set to 'Success and Failure'
- Audit 'Special Logon' is set to 'Success'
- Audit 'Removable Storage' is set to 'Success and Failure'
- Audit 'Audit Policy Change' is set to 'Success and Failure'
- Audit 'Authentication Policy Change' is set to 'Success'
- Audit 'Authorization Policy Change' is set to 'Success'
- Audit 'Sensitive Privilege Use' is set to 'Success and Failure'
- Audit 'IPsec Driver' is set to 'Success and Failure'
- Audit 'Other System Events' is set to 'Success and Failure'

- Audit 'Security State Change' is set to 'Success'
 - Audit 'Security System Extension' is set to 'Success and Failure'
 - Audit 'System Integrity' is set to 'Success and Failure'
- b. A complex password policy shall be created and applied to all servers and workstations following these requirements:
- All passwords must be a minimum of 12 characters in length.
 - All passwords must be alphanumeric, using a combination of capital letters and special characters.
 - Passwords must be rotated every 90 days.
 - Password history restrictions for the past 10.
- c. A new Server device hardening policy shall be created and applied to all workstations. The policy shall include the following:
- "Network security: Do not store LAN Manager hash value on next password change"
 - "No auto-restart with logged on users for scheduled automatic updates installations"
 - "All removable storage classes: Deny all access"
 - "Network Access: Do not allow anonymous enumeration of SAM accounts and shares" – DISABLED
 - "Accounts: Guest Account Status" – DISABLED
- d. A new Workstation device hardening policy shall be created and applied to all workstations. The policy shall include the following:
- "Prohibit access to Control Panel and PC settings"
 - "Network security: Do not store LAN Manager hash value on next password change"
 - "Prevent access to the command prompt"

- “No auto-restart with logged on users for scheduled automatic updates installations”
 - “All removable storage classes: Deny all accesses”
 - “Prohibit User Install”
 - “Accounts: Guest Account Status” – DISABLED
 - “Network Access: Do not allow anonymous enumeration of SAM accounts and shares” – DISABLED
 - “Interactive Login: Machine Inactivity Limit” – set to 900 seconds.
- e. A new Cyber Security hardening policy shall be created and applied to all servers and workstations. The policy shall include the following:
- SMBv1
 - USB ports
 - Execute access on removable disks
 - Changes to proxy settings
- f. Application Whitelisting shall be enforced on all servers and workstations connected to the SCADA network per recommendations from the NIST 800-167 standard.
- g. Whitelisting shall be enforced using two (as a minimum) AppLocker GPO’s for domain bound Servers and Workstations.
- h. Once baseline servers, engineering and operator workstations are created rules shall be generated automatically utilizing the contents of the C drive (the primary HDD) to create AppLocker GPO’s which shall include (but are not limited to) the following:
- Executable Rules
 - Windows Installer Rules
 - Script Rules

- i. AppLocker GPO's shall permit by exception (all required SCADA software and related applications installed on a domain bound workstation and or server system by an authorized technician) and deny all other forms of software from installation and or execution.
- 6. Operator and/or Engineering Workstations, Thin/Thick Clients must:
 - a. Use the Windows 10 Professional Operating System
 - b. Be connected to the SCADA Domain.
 - c. Have Group Policies applied including application whitelisting.
- D. Microsoft Office Professional may be installed on Engineering Workstations only – NOT thin/thick clients or operator stations.
- E. Adobe Reader may be installed on Engineering Workstations only – NOT thin/thick clients or operator stations.
- F. Time:
 - 1. (Including but not limited to): All Servers, Workstations, Controllers, HMI, OITs must have clocks set to the correct localized time zone and synchronize with a primary local (preferably GPS) time source including a secondary source using NTP or equivalent protocols.
- G. An E-mail Relay (at Park Forest) will be used to forward critical alerts to key personnel. Coordinate with Owner on relay server configuration.

2.03 SECURITY APPLICATION SOFTWARE DESIGN CRITERIA

- A. Contractor to provide specified firewalls for inclusion into CC Williams OT Network. Owner will configure firewalls based on Owner's standard firewall configuration.
- B. Integrator shall coordinate with Owner on security configurations necessary for the development of CC Williams OT network. This may include:
 - 1. Fortigate Firewall configurations.
 - 2. FortiManager.
 - 3. FortiAnalyzer.
 - 4. FortiAuthenticator.

- C. Cylance AV shall be installed on all servers and workstations (Thin/Thick Clients, Operator & Engineering Desktops/Laptops). Endpoint protection client shall:
 - 1. Pull updates from a central server located in the Park Forest DMZ and not directly via the internet.
 - 2. Automatically download and install the updated signature immediately upon release by the vendor.
 - 3. Scan for updates every 60 minutes.
 - 4. Perform a daily scan of the system and report to the central infrastructure monitoring platform in real-time (eg. PRTG, Solarwinds) for warnings and detection of known malware.
- D. Beyond Trust Privilege Remote Access (PRA) Appliance :
 - 1. Will be installed by Owner within the Park Forest DMZ network of the SCADA environment.
 - 2. Integrator shall coordinate with Owner as necessary to:
 - a. Configure Integrator use of PRA application during configuration and testing of CC Williams OT network.
 - b. Permit access to CC Williams OT Network servers, workstations, and applications.

2.04 BACKUP AND CHANGE MANAGEMENT SOFTWARE DESIGN CRITERIA

- A. Owner will install and configure a backup management software application at Park Forest as necessary to back up PAC and HMI programs running on production equipment in the field. Integrator shall coordinate with Owner to ensure backup of CC Williams applications and devices.
 - 1. Provide necessary SQL Server software and PAC/HMI developer software and licensing as required to enable automated backups.
 - 2. Install the Program Export Event Module to export configs of all devices attached to the system to a secure local File Server and backed up by Veeam.

PART 3 EXECUTION

3.01 TESTING

- A. Testing steps below are by no means an exhaustive list, the Integrator must devise testing scenarios referencing items in server 3.01 with input from the Owner.
- B. The Integrator must submit test sheets to the Owner for review and approval prior to testing.

C. The Integrator must submit test sheets to the Owner upon each completed test for review and signoff.

D. General:

1. **Setup / Testing Environment:**

- a. Test laptop must be connected to core network Management VLAN.
- b. Ensure all Virtual Hosts are connected and operational.
- c. Ensure all core networking equipment (switches, firewalls) are powered on

2. **Test Virtual Host Drive Failure** – virtual hosts RAID cluster should be designed in such a way that disk failures have little effect on the cluster beyond the temporary loss of the capacity and I/O resources of that disk. When a disk is determined to have failed, the host will continue servicing I/O transparently using the mirrored data copies. The expected result from a drive failure is no change in available logical space or drop in I/O.

3. **Test Network Failure** - All Virtual Hosts offer redundant network ports for network connections via the core switches to allow for full network redundancy. These ports should be in an active / passive bond for failover. If access to the primary port is lost to either core switch network, the secondary port will activate with little to no disruption to the cluster node. Once the primary port becomes available again the network will fail back to that port. By sending “Ping” packets to any internal VM, the tester should see that there are little to no packet drops when the cable is pulled from the primary port. This is repeated for all nodes in the cluster.

4. **Workstation and Network Share communications** - Verify that the workstation/users can access network shares.

5. **Test Backup System:**

- a. Demonstrate scheduled system backups of all systems are running as required and completing successfully.
- b. Demonstrate automated backup to Thick workstation and run VM with VMware Workstation Pro.
- c. Demonstrate backup replication from NAS to Cloud system (or equivalent) for offsite storage.

- d. Run restoration jobs for critical systems to ensure the integrity of the backup image and functionality of the system, which may include (but is not limited to): Domain Controllers, SCADA HMI, Historian and Application Servers.
6. **Test Infrastructure Monitoring Platform and Configuration Management:**
- a. Check that every critical asset/device with a networking interface on the SCADA network is registered with the infrastructure monitoring software.
 - b. Generate a networking event and demonstrate its capture and subsequent log/record with the system.
 - c. Generate an alarm event and display notification of alarm
 - d. Test notification emails are received by incident responders.
 - e. Demonstrate a configuration change and subsequent alarm notification sent by the Infrastructure Monitoring Platform to incident responders.
7. **Test Software and Signature Updates** – Ensure all critical systems, including (but not limited to); Windows Servers, Windows Workstations, Firewalls and Endpoint Protection are receiving software and signature updates from systems/services located in the DMZ only.
8. **Test Remote Access:**
- a. Terminate a VPN connection with the Fortigate using a Forticlient from the test laptop via an external internet connection and ensure MFA is functioning as required.
 - b. Open the Beyond Trust client and connect to a pre-configured jump client with an authorized user account.
 - c. Attempt to connect to a jump client with a user account that is not authorized to confirm user permissions are correct.
 - d. Once connected to a jump host, open Windows Explorer and a Web Browser and Create and save a text file on the desktop. Review the Beyond Trust admin portal and go through the logs to ensure the system is capturing user activities based on username with the correct date and time stamps.

3.02 OWNER TRAINING

A. General:

1. Provide an integrated training program for Owner's personnel.
2. Perform training to meet specific needs of Owner's personnel.
3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
4. Provide instruction on all working shift(s) as needed to accommodate the Owner's personnel schedule.
5. Owner reserves the right to make and reuse video recordings of all training sessions.

B. OT Network and VM Management Seminar:

1. Length: 2 days.
2. Location: Owner's facility.
3. Presenters: The seminar presenters should include the integrator responsible for configuring the system and representatives from OT application and networking software providers.
4. Objective: Provide an overview for non-operations and maintenance personnel for understanding the OT networking applications software including:
 - a. VMware.
 - b. Domain Configuration.
 - c. Update Procedures.
 - d. Configuration Management.
5. Attended by management, engineering, IT, and other non-operations and non-maintenance personnel.
6. Primary Topics:
 - a. Management-oriented explanation of data management displays and printouts.
 - b. Walk-through of installed systems.
 - c. User access instructions.
 - d. Procedures for using each software type.
 - e. Things to avoid and dangers of changing parameters.
 - f. Best practice and best use.

3.03 O&M MANUALS

A. General: Provide the following:

1. Failure Scenarios:
 - a. Recovery from failures.
 - 1) Recovery Procedure.
 - 2) Contact if recovery procedure fails.

2. Suggested shutdown and startup procedures.
3. Training material.

B. Software: Provide the following:

1. Run Book:
 - a. Licensing Information.
 - b. Configuration Parameters.
 - c. All Credentials.
 - d. Support Contacts.

3.04 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is a part of this Specification:

1. Virtual Servers List – CC Williams.

END OF SECTION

	Y #	VM Host	Name	Desc	Software	SCADA	Network1	Network2	Network3	OS	Procs Physical	Procs Logical	RAM (GB)	HD C: Size (GB)	HD D: Size (GB)	Type
SCADA Virtual Host Cluster (CC Williams)																
Supervisory																
	Y203	CCW-VHC-01	CCWDC01	Domain Controller - Backup Domain Controller	Win2019SRV,AV Agent, NTP Agent	Yes	Supervisory- VLAN20			Windows 2019	1	2	8	120		Server
	Y204	CCW-VHC-01	CCWDC02	Domain Controller - Backup Domain Controller	Win2019SRV,AV Agent, NTP Agent	Yes	Supervisory- VLAN20			Windows 2019	1	2	8	120		Server
	Y205	CCW-VHC-01	CCWHMI01	Primary VTSCADA HMI Server	Win2019SRV,AV Agent, NTP Agent, VT Scada,Adobe,Office	Yes	Supervisory- VLAN20	Control-VLAN10		Windows 2019	1	4	16	500		Server
	Y206	CCW-VHC-01	CCWHMI02	Secondary VTSCADA HMI Server	Win2019SRV,AV Agent, NTP Agent, VI Scada,Adobe,Office	Yes	Supervisory- VLAN20	Control-VLAN10		Windows 2019	1	4	16	500		Server
	Y208	CCW-VHC-01	CCWENG01	Engineering Managemt Server	Win2019SRV,AV Agent, NTP Agent,VT Scada Dev, Office	Yes	Supervisory- VLAN20	Control-VLAN10		Windows 2019	1	2	12	200		Server
	Y230	CCW-VHC-01	CCWWWA01	Wonderware Archestra, Primary Server	P2V-WonderWare	Yes	Legacy Control Network	Legacy Failover Network								
	Y231	CCW-VHC-01	CCWWWA02	Wonderware Archestra, Backup Server	P2V-WonderWare	Yes	Legacy Control Network	Legacy Failover Network								
Management																
	Y221	CCW-VHC-01	CCWvCENTER01	VM Management	VMware vCenter	Yes	Management - VLAN 100			Linux	1	2	8	100		Server
	Y222	CCW-VHC-01	CCWUTIL01	OT Management Server	AV Agent, NTP Agent	Yes	Management - VLAN 100			Windows 2019	1	2	12	250		Server

NOTE: DISTRIBUTE VMS ACROSS ALL NODES TO BALANCE RESOURCES

SECTION 40 99 90
PACKAGE CONTROL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 2. International Society of Automation (ISA): S50.1, Compatibility of Analog Signals for Electronic Process Instruments.
 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
 - c. ICS 2, Industrial Control Devices, Controllers and Assemblies.
 4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 5. Underwriters Laboratories Inc. (UL): 508A, Standards for Safety, Industrial Control Panels.

1.02 SYSTEM DESCRIPTION

- A. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer's factories.
- B. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer's factory.

1.03 SUBMITTALS

- A. Action Submittals:
1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system and equipment.
 2. Catalog information on electrical devices furnished with system.
 3. Shop Drawings, catalog material, detailed wiring diagrams, and dimensional layout drawings for control panels and enclosures.

4. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.
5. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.
6. Communications and Digital Networks Diagrams showing connections to a telephone system, Ethernet network, remote I/O, and Fieldbus including passive and active interconnected devices, device names and tag numbers, terminal numbers, communication media (type of cable), connection type, node and device address, and wire and cable numbers.
7. Factory Test plan: Submit test plan before scheduling a factory test.
8. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
 - a. Required voltages, currents, and phases(s). Include calculations and list assumptions.
 - b. Maximum heat dissipations Btu per hour. Include calculations and list assumptions.
 - c. Maximum permissible internal temperature based on operating range of internal components.
 - d. Computed maximum internal temperature. Include calculations and list assumptions. Include the impacts of internal heat generation, solar radiation and shielding.
 - e. Use the ambient parameters listed in this section for the applicable service condition.
9. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.
10. Programmable Automation Controller (PAC) Submittals:
 - a. Hardware Documentation:
 - 1) Provide the following for all elements of the PAC:
 - a) Block Diagram: A diagram showing all major system components. Identify components by manufacturer and model number. Show interconnecting cables diagrammatically.
 - b) Bill-of-Materials: A list of all PAC components. Group components by type and include:
 - c) Component manufacturer, model number, and part number.
 - d) Component description.
 - e) Quantity supplied.
 - f) Reference to component catalog information.
 - g) Descriptive Information: Catalog information, descriptive literature, performance specifications, internal wiring diagrams, power and grounding requirements, power consumption, and heat dissipation of all elements of the PAC system. Clearly mark all options and features proposed for this Project.

- h) Interconnecting Wiring Diagrams: Diagrams shall show all PAC elements, their interconnecting cables and wiring terminations, and all terminations to all interacting elements and subsystems. Terminations shall be numbered. Terminations for circuits extending outside PAC assemblies and/or leaving panels shall be labeled with circuit names corresponding to the Circuit and Raceway Schedule. The external circuit portion of this diagram shall be coordinated with the Electrical Subcontractor and shall bear his mark showing that this Work has been done.
 - i) Outline Drawings: Equipment envelope Drawings showing external dimensions, enclosure materials, conduit connections, and installation requirements.
 - j) Installation Details: Any modifications or further details as may be required to supplement the Contract Documents and adequately define the installation of the PAC elements.
 - k) Input/Output List: For each I/O point, list point type, tag number of the source or final control element, equipment description, PAC number, PAC terminal identification, rack number, module slot number, and PAC address.
- b. Software Design Submittal: Provides a detailed description on the application program during applications program development and well before submission of the Preliminary Software Documentation. Include all PAC and OIU applications software.
- c. Preliminary Software Documentation: Here the term "preliminary" refers only to the timing of this submittal, not the level of detail to be provided. Provide a fully detailed version of all the material described hereinafter except that electronic copies are not required at this time. Provide information including, but not limited to the following:
 - 1) Prior to programming the PAC, submit a control narrative detailing all control functions including all software functions, software switches, alarms, failures, resets, etc.
 - 2) Prior to programming the HMI, submit draft graphics including, but not limited to, draft overview screens, draft motor faceplates, draft control faceplates, draft analog faceplate, alarm summary, and trend screens. Also include the proposed objects (pumps, analog displays, etc) and planned color schemes (including On/Off colors, alarm colors, etc).

- d. Application Software Documentation:
- 1) Provide PAC and operator interface documentation in electronic (i.e. viewable in programming package software) and hard copy format.
 - 2) Fully documented ladder logic listings.
 - 3) Function listings for function blocks not fully documented by ladder logic listings.
 - 4) Cross-reference listing.
 - 5) Programmable Automation Controller Data Exchange List:
 - 6) Provide a data exchange list where data is exchanged across a network connection.
 - a) Include a hard copy and an electronic file using Microsoft Excel 2007. List and describe each analog and discrete input or output point to the PAC along with all internally calculated variables including discrete variables.
 - b) Define all list parameters in enough detail that the plantwide PAC and HMI software developer can completely and accurately configure and program the plantwide PACs and HMI computers.
 - c) Provide documentation for PAC to PAC and HMI data exchange for coordination with the plant process control system applications programmer. Reflect the tag numbering and engineering unit ranges agreed on with the plant process control system applications programmer.
 - d) Once accepted, promptly updated and deliver to the plantwide software developer any changes made to the data exchange list during any phase of Work.
 - e) Package system vendor programs may require tag changes or network update timing changes to optimize data exchange communications.
 - f) Include, as a minimum, the following data fields on the list:

Field Name	Field Description
TAG	Coordinate with process control system applications programmer.
DESCRIPT	A brief description of the function and location of the point

Field Name	Field Description
SGNLTYPE	Input or output signal type. Signal types include: AI = Analog Input AO = Analog Output DI = Discrete Input DO = Discrete Output IDO = Relay Output
IOADDR	The particular input or output address in the PAC. Applicable to Division 11, Equipment, supplier only: When a point is generated in the PAC software and is truly not a physical input/output point, the IOADDR entered will be "PAC."
RACKNO	The rack number or address at which the I/O point is located. This field will be left blank when IOADDR is PAC.
SLOTNO	The slot number in the rack at which the I/O point is located. This field will be left blank when IOADDR is PAC.
POINTNO	The point number in the slot at which the I/O point is located. This field will be left blank when IOADDR is PAC.
PACNUM	The PAC number (or station number) that owns the I/O address.
PACADDR	Internal PAC address for I/O mapping and communication between PAC and PMCS.
LORANGE	For analog point: The lowest value of the data point in engineering units. This typically corresponds to a 4 mA dc signal. For discrete point: This field will be left blank.
HIRANGE	For analog point: The highest value of the data point in engineering units. This typically corresponds to a 20 mA dc signal. For discrete point: This field will be left blank.

Field Name	Field Description	
LOALARM	The value in engineering units of the point at which a low value alarm is initiated. For discrete points, this field will be left blank.	
LOLOALARM	The value in engineering units of the point at which a low low value alarm is initiated. For discrete points, this field will be left blank.	
HIALARM	The value in engineering units of the point at which a high value alarm is initiated. For discrete points, this field will be left blank.	
HIHIALARM	The value in engineering units of the point at which a high high value alarm is initiated. For discrete points, this field will be left blank.	
EU	The engineering units that the ranges and alarms are specified in. For discrete points, this field will be blank.	
STATUS	For discrete points: A word to describe what the status of the point is when the data point is set high (true). STATUS words include:	
	ON OFF STRT (Start) STOP OPND (Opened) CLSD (Closed) FWD (Forward) REV (Reverse) AUTO (Automatic) MAN (Manual) CASC (Cascade)	REM (Remote) LOC (Local) HI (High) HIHI (High-High) LO (Low) LOLO (Low-Low) FAIL (Fail) TRBL (Trouble) ALM (Alarm) For analog points, this field will be left blank.

B. Informational Submittals:

1. Programmable Controller Submittals:
 - a. Complete set of user manuals.
 - b. Fully documented ladder logic listings.
 - c. Function listing for function blocks not fully documented by ladder logic listings.
 - d. Cross-reference listing.
2. Operations and Maintenance Manuals in accordance with Section 01 78 23, Operation and Maintenance Data.
3. Manufacturer's list of proposed spares, expendables, and test equipment.
4. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufactures' Field Services.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

1.05 EXTRA MATERIALS

- A. Spares, Expendables, and Test Equipment:
1. Selector Switch, Pushbutton, and Indicating Light: 20 percent, one minimum, of each type used.
 2. Light Bulb: 100 percent, 2 minimum, of each type used.
 3. Fuse: 100 percent, 5 minimum, of each type used.
 4. Surge Suppressors: 20 percent, one minimum, of each type used.
 5. PAC I/O Modules: One minimum of each type used.

PART 2 PRODUCTS

2.01 SIGNAL CHARACTERISTICS

- A. Analog Signals:
1. 4 to 20 mA dc, in accordance with compatibility requirements of ISA S50.1.
 2. Unless otherwise specified or shown, use Type 2, two-wire circuits.
 3. Transmitters: Load resistance capability conforming to Class L.
 4. Fully isolate input and output signals of transmitters and receivers.

- B. Pulse Frequency Signals: dc pulses whose repetition rate is linearly proportional to process variable over 10:1 range. Generate pulses by contact closures or solid-state switches.

- 1. Power source: Less than 30V dc.

- C. Discrete Signals:

- 1. Two-state logic signals.
 - 2. Utilize 120V ac sources for control and alarm signals.
 - 3. Alarm signals shall be normally open, close to alarm isolated contacts rated for 5-ampere at 120V ac and 2-ampere at 30V dc.

2.02 CORROSION PROTECTION

- A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

- 1. Northern Instruments; Model Zerust VC.
 - 2. Hoffmann Engineering; Model A-HCI.

2.03 CONTROL PANEL

- A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.
- B. Conform to NEMA ratings as specified in individual equipment sections.
- C. Minimum Metal Thickness: 14 gauge.
- D. NEMA 250, Type 4X Panels: Type 316 stainless steel construction unless otherwise specified.
- E. Doors: Three-point latching mechanisms in accordance with NEMA 250 panels with doors higher than 18 inches.
- F. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.
- G. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

H. Temperature Control:

1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
2. Cooling fans with air filters to dissipate heat are not acceptable.
3. Furnish a panel side-mounted air conditioner for indoor/outdoor installations where heat dissipation cannot be adequately accomplished such that the panel enclosure internal temperature exceeds the panel equipment operating temperature ranges or where shown on Contract Drawings. Include the calculations for sizing the air conditioner unit in the submittal. Air conditioner shall be suitable for a humid and corrosive environment, rated NEMA 4X, closed-loop type, 120V ac power, manufactured by Thermal Edge C-Level Protection, ICEcube Cooling Solutions, or approved equal.
4. For panels outdoors or in unheated areas, furnish hygrostatically (humidistat) controlled heaters to maintain temperature above 40 degrees F.

I. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

J. Lighting: Minimum of one hand switch controlled internal LED light for panels 12 cubic feet and larger.

K. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.

L. Finish:

1. Metallic External Surfaces (Excluding Aluminum and Stainless Steel): Manufacturer's standard gray unless otherwise specified.
2. Internal Surfaces: White enamel.

M. Panel Manufacturers:

1. Hoffman.
2. Coxline.
3. Saginaw.

N. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.

1. Manufacturer and Product:
 - a. Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.
 - b. Hoffman; H2Omit Stainless Steel Vent Drain.

2.04 CONTROL PANEL ELECTRICAL

- A. UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A or UL698A.
- B. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.
- C. Control Panels without Motor Starters and/or Adjustable Frequency Drives:
 - 1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
 - 2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
 - 3. Circuit Breakers:
 - a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
 - b. Branch Circuit Breakers: 15 amps at 250V ac.
 - c. Provide UL 489 breakers.
 - d. Breaker Manufacturers and Products:
 - 1) Square D; Multi 9 Series.
 - 2) Allen-Bradley; 1489-A Series.
 - 3) Or approved equal.
- D. Control Panels with Three-Phase Power Supplies and Motor Starters/AFDs:
 - 1. Interlock main circuit breaker with panel door.
 - a. Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.
 - b. Mount operator controls and indications on front access door.
 - 2. Circuit Breakers:
 - a. In accordance with NEMA AB 1.
 - b. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
 - c. 65,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified in package system equipment specification sections.
 - d. Tripping: Indicate with operator handle position.
 - 3. Magnetic Motor Starters:
 - a. Full voltage, NEMA ICS 2, Class A, Size O minimum.
 - b. Include three-pole bimetallic or eutectic alloy thermal overload relays sized for each motor.
 - c. Manual reset type with reset button mounted on panel door.

4. Motor Control: 120V ac (except intrinsically safe circuits where applicable).
 - a. Power Control Transformer:
 - 1) Sufficient capacity to serve connected load, including 200VA for duplex outlet plus 100VA (minimum).
 - 2) Limit voltage variation to 15 percent during contact pickup.
 - 3) Fuse one side of secondary winding and ground the other.
 - 4) Furnish primary winding fuses in ungrounded conductors.
5. Power Monitoring Relay:
 - a. Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
 - b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
 - c. Transient Voltage Protection: 10,000 volts.
 - d. Manufacturer and Product: Furnas; Class 47.
6. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not "leap frog" power conductors.
7. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Wiring:

1. ac Circuits:
 - a. Type: 600-volt, Type MTW stranded copper.
 - b. Size: For current to be carried, but not less than 14 AWG.
2. Analog Signal Circuits:
 - a. Type: 300-volt, Type 2 stranded copper, twisted shielded pairs.
 - b. Size: 18 AWG, minimum.
3. Other dc Circuits.
 - a. Type: 600-volt, Type MTW stranded copper.
 - b. Size: 18 AWG, minimum.
4. Separate analog and other dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
5. Enclose wiring in sheet metal raceways or plastic wiring ducts.
6. Color Code:

Type	Color
Line and Load Circuits, AC or DC Power	Black
AC control circuits less than line voltage	Red
Interlock control circuit, from external source	Yellow
Equipment grounding conductor	Green
Current carrying ground	White
Hot with circuit breaker open	Orange

7. Wire Identification: Numbered and tagged at each termination.
 - a. Wire Tags: Machine printed, heat shrink.
 - b. Manufacturers:
 - 1) Brady PermaSleeve.
 - 2) Tyco Electronics.

F. Wiring Interface:

1. For analog and discrete signal, terminate at numbered terminal blocks.
2. For special signals, terminate power (240 volts or greater) at manufacturer's standard connectors.
3. For panel, terminate at equipment on/with which it is mounted.

G. Terminal Blocks:

1. Quantity:
 - a. For external connections.
 - b. Wire spare or unused panel mounted elements to their panels' terminal blocks.
 - c. Spare Terminals: 20 percent of connected terminals, but not less than 10.
2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
 - a. Connection Type: Screw connection clamp.
 - b. Compression Clamp:
 - 1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
 - 2) Guides strands of wire into terminal.
 - c. Screws: Hardened steel, captive, and self-locking.
 - d. Current Bar: Copper or treated brass.
 - e. Insulation:
 - 1) Thermoplastic rated for minus 55 to plus 110 degrees C.
 - 2) Two funnel shaped inputs to facilitate wire entry.
 - f. Mounting:
 - 1) Rail.
 - 2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - 3) End Stops: One at each end of rail, minimum.
 - g. Wire Preparation: Stripping only.
 - h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
 - i. Marking System:
 - 1) Terminal number shown on both sides of terminal block.
 - 2) Allow use of preprinted and field marked tags.
 - 3) Terminal strip numbers shown on end stops.
 - 4) Mark terminal block and terminal strip numbers as shown.
 - 5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.

3. Spare Fuse Holder:
 - a. Provide spare fuse holder(s) for all enclosures containing fuses.
 - b. Quantity: As required to hold all spare fuses for each enclosure.
 - c. DIN Rail Mountable.
 - d. Manufacturer and Product: Weidmuller, 7914760001.
4. Terminal Block, General-Purpose:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 30 amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Grey body.
 - f. Spacing: 0.25 inch, maximum.
 - g. Test Sockets: One screw test socket 0.079-inch diameter.
 - h. Manufacturers and Products:
 - 1) Weidmuller; 1020100000 with 0280600000.
 - 2) Entrelec; Type M4/6.T.
 - 3) Phoenix Contact.
5. Terminal Block, Ground:
 - a. Wire Size: 22 AWG to 12 AWG.
 - b. Rated Wire Size: 12 AWG.
 - c. Color: Green and yellow body.
 - d. Spacing: 0.25 inch, maximum.
 - e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
 - f. Manufacturers and Products:
 - 1) Weidmuller; 1010100000.
 - 2) Entrelec; Type M4/6.P.
 - 3) Phoenix Contact.
6. Terminal Block, Blade Disconnect Switch:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 10-amp.
 - c. Wire Size: 22 AWG to 12 AWG.
 - d. Rated Wire Size: 12 AWG.
 - e. Color: Grey body, orange switch.
 - f. Spacing: 0.25 inch, maximum.
 - g. Manufacturers and Products:
 - 1) Weidmuller; 7910210000.
 - 2) Entrelec; Type M4/6.SN.T.
 - 3) Phoenix Contact.
7. Terminal Block, Diode:
 - a. Rated Voltage: 24V dc.
 - b. Rated Current: 30 ma.
 - c. Wire Size: 16 AWG.
 - d. Manufacturers and Products:
 - 1) Weidmuller.
 - 2) Phoenix Contact ST-IN.

8. Terminal Block, Fused, 24V dc:
 - a. Rated Voltage: 600V dc.
 - b. Rated Current: 16-amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Grey body.
 - f. Fuse: 0.25 inch by 1.25 inches.
 - g. Indication: LED diode 24V dc.
 - h. Spacing: 0.512 inch, maximum.
 - i. Manufacturers and Products:
 - 1) Weidmuller 1880410000.
 - 2) Entrelec; Type M10/13T.SFL.
 - 3) Phoenix Contact.
 9. Terminal Block, Fused, 120V ac:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 16-amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Grey body.
 - f. Fuse: 0.25 inch by 1.25 inches.
 - g. Indication: Neon Lamp 110V ac.
 - h. Leakage Current: 1.8 mA, maximum.
 - i. Spacing: 0.512 inch, maximum.
 - j. Manufacturers and Products:
 - 1) Weidmuller 1880420000.
 - 2) Entrelec; Type M10/13T.SFL.
 - 3) Phoenix Contact.
 10. Terminal Block, Fused, 120V ac, High Current:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 35 amps.
 - c. Wire Size: 18 AWG to 8 AWG.
 - d. Rated Wire Size: 8 AWG.
 - e. Color: Grey.
 - f. Fuse: 13/32 inch by 1.5 inches.
 - g. Spacing: 0.95 inch, maximum.
 - h. Manufacturers and Products:
 - 1) Weidmuller 7940029428.
 - 2) Entrelec; Type MB10/24.SF.
 - 3) Phoenix Contact.
- H. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.

I. Relays:

1. General:
 - a. Relay Mounting: Plug-in type socket.
 - b. Relay Enclosure: Provide dust cover.
 - c. Socket Type: Screw terminal interface with wiring.
 - d. Socket Mounting: Rail.
 - e. Furnish holddown clips.
2. Signal Switching Relay:
 - a. Type: Dry circuit.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 0 to 5 amps at 28V dc or 120V ac.
 - d. Contact Material: Gold or silver.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 0.9 watts (dc), 1.2VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Seal Type: Hermetically sealed case.
 - k. Manufacturers and Products:
 - 1) Weidmuller; Series RCM.
 - 2) Potter and Brumfield; Series KH/KHA.
 - 3) IDEC.
3. Control Circuit Switching Relay, Nonlatching:
 - a. Type: Compact general-purpose plug-in.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 240V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Push to test button.
 - k. Manufacturers and Products:
 - 1) Weidmuller; Riderseries II.
 - 2) Potter and Brumfield; Series KUP.
 - 3) IDEC.
4. Control Circuit Switching Relay, Latching:
 - a. Type: Dual coil magnetic latching relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 120V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 2.7 watts (dc), 5.3VA (ac).

- g. Expected Mechanical Life: 5,000,000 operations.
- h. Expected Electrical Life at Rated Load: 500,000 operations.
- i. Manufacturer and Product:
 - 1) Potter and Brumfield; Series KUL.
 - 2) IDEC; Series RR2KP.
- 5. Control Circuit Switching Relay, Time Delay:
 - a. Type: Adjustable time delay relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 240V ac.
 - 1) Contact Material: Silver cadmium oxide alloy.
 - d. Coil Voltage: As noted or shown.
 - e. Operating Temperature: Minus 10 to 55 degrees C.
 - f. Repeatability: Plus or minus 2 percent.
 - g. Delay Time Range: Select range such that time delay set point fall between 20 to 80 percent of range.
 - h. Time Delay Set Point: As noted or shown.
 - i. Mode of Operation: As noted or shown.
 - j. Adjustment Type: Integral potentiometer with knob external to dust cover.
 - k. Manufacturers and Products:
 - 1) Weidmuller; 8647700000.
 - 2) Potter and Brumfield:
 - a) Series CB for 0.1 second to 100 minute delay time ranges.
 - b) Series CK for 0.1 to 120 second delay time ranges.
 - 3) IDEC.
- J. Intrinsic Safety Barriers:
 - 1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
 - a. Manufacturer and Product: MTL, Inc.; Series MTL 5000 or approved equal.
 - 2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
 - a. Manufacturer and Product: MTL, Inc.; Series MTL 5000 or approved equal.
- K. Control Panels with PACs and OIUs:
 - 1. Programmable Automation Controller (PAC):
 - a. Provide a minimum of 20 percent spare PAC program memory available upon completion of startup of the equipment.
 - b. Provide additional communication modules, if required, to support data transfer rates.

- c. Firmware: CompactLogix: Firmware version 31 or latest.
Confirm version with Owner.
- d. Manufacturer and Models:
 - 1) Allen-Bradley CompactLogix L3 series.
 - 2) Product performance and features shall conform to MAWSS Hardware Standards, unless otherwise noted.
 - 3) Manufacturers and Models are further identified in the MAWSS Hardware Standards, unless otherwise noted.
 - 4) See Specification 40 91 00, Supplement 1, MAWSS Hardware Standards.
- 2. Ethernet Switch:
 - a. Provide an Ethernet switch for connection of the manufacturer-supplied PAC and the OIU. Provide Ethernet switch with a minimum of two spare RJ-45 ports once all Ethernet equipment is connected.
 - b. Manufacturer and Models:
 - 1) Product performance and features shall conform to MAWSS Hardware Standards, unless otherwise noted.
 - 2) Manufacturers and Models are identified in the MAWSS Hardware Standards, unless otherwise noted.
 - 3) See Specification 40 94 13, Supplement 2, MAWSS OT Hardware Standards, Component Code Y108.
- 3. Uninterruptible Power Supply (UPS):
 - a. Provide UPS derived power for the Ethernet switch and PAC.
 - b. UPS shall provide a minimum of 20 minutes battery runtime.
 - c. Manufacturer and Models:
 - 1) See Specification 40 91 00, Instrumentation and Control Components, Component Y40.
- 4. Operator Interface Unit (OIU):
 - a. Color, touchscreen.
 - b. Minimum Size: 10.4 inches.
 - c. Manufacturer and Models:
 - 1) Allen Bradley PanelView Plus.
 - 2) Product performance and features shall conform to MAWSS Hardware Standards, unless otherwise noted.
 - 3) Manufacturers and Models are further identified in the MAWSS Hardware Standards, unless otherwise noted.
 - 4) See Specification 40 91 00, Supplement 1, MAWSS Hardware Standards, Component Y331.
- 5. Fiber Optic Patch Panel:
 - a. Suitable for 50/125 micron or 62.5/125 micron multimode fiber optic cable with SC connectors.
 - b. Panel Manufacturer and Model: Corning, WIC-024 with Corning WIC-CP-1-15 adapter modules.

- L. Front-of-Panel Devices in Conjunction with NEMA 250, Type 1 and 12 Panels:
1. Potentiometer Units:
 - a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
 - b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
 - c. Include legend plates with service markings.
 - d. Manufacturers and Products:
 - 1) Allen-Bradley; Model 800T.
 - 2) Eaton/Cutler-Hammer; Model 10250T.
 2. Indicating Lights:
 - a. Heavy-duty, push-to-test type, LED, oiltight, industrial type with integral transformer for 120V ac applications.
 - b. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
 3. Pushbutton, Momentary:
 - a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V ac.
 - b. Standard size legend plates with black field and white markings for service legend.
 - c. Manufacturers and Products:
 - 1) Square D; Class 9001, Type K.
 - 2) Eaton/Cutler-Hammer; Type T.
 - 3) General Electric; Type CR-2940.
 4. Selector Switch:
 - a. Heavy-duty, oiltight, industrial type with contacts rated for 120V ac service at 10 amperes continuous.
 - b. Standard size, black field, legend plates with white markings, for service legend.
 - c. Operators: Black knob type.
 - d. Single-hole mounting, accommodating panel thicknesses from 1/16 inch to 1/4 inch.
 - e. Manufacturers and Products for Units with up to Four Selection Positions:
 - 1) Eaton/Cutler-Hammer; Type T.
 - 2) Square D; Type K.
 - f. Manufacturers and Products for Units with up to 12 Selection Positions:
 - 1) Rundel-Idex; Standard Cam Switch.
 - 2) Electroschick; 31.

M. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:

1. Potentiometer, Watertight:
 - a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
 - b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
 - c. Include engraved legend plates with service markings.
 - d. Manufacturer and Product: Allen-Bradley; Bulletin 800H.
2. Indicating Lights, Watertight:
 - a. Heavy-duty, push-to-test type, NEMA 250, LED, Type 4X watertight, industrial type with integral transformer for 120V ac applications and corrosion-resistant service.
 - b. Screwed on prismatic lenses and factory engraved legend plates for service legend.
3. Pushbutton, Momentary, Watertight:
 - a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
 - b. Standard size, black field, legend plates with white markings for service legend.
 - c. Manufacturers and Products:
 - 1) Square D; Type SK.
 - 2) Allen-Bradley; Type 800H.
4. Selector Switch, Watertight:
 - a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
 - b. Standard size, black field, legend plates with white markings, for service legend.
 - c. Operators: Black knob type.
 - d. Single-hole mounting, accommodating panel thicknesses from 1/16 to 1/4 inch.
 - e. Manufacturer and Products:
 - 1) Square D; Class 9001, Type SK.
 - 2) Allen-Bradley; Type 800H.

2.05 APPLICATION SOFTWARE REQUIREMENTS

- A. Provide all application software (programming) for the PAC and panel mount OIU.
- B. Provide all application software consistent with Owner's existing color scheme: RED is ON/OPENED and GREEN is OFF/CLOSED.
- C. Configure all Ethernet networked equipment (PACs, OIUs, etc) with Owner provided IP addresses prior to shipment to the site. Default IP addresses or IP addresses not consistent with the Owner's standard are not acceptable.

2.06 INSTRUMENT TAG NUMBERS

- A. A shorthand tag number notation is used. For example:

#-AI-12-*[pH]

<u>Notation</u>	<u>Explanation</u>
------------------------	---------------------------

#	Unit Process Number (Area)
AI	ISA designator for Analysis Indicator
12	Loop number
*	Number of same component types in a given loop.
[pH]	Same notation shown at 2 o'clock position on ISA circle symbol on Process and Instrument Diagram

- B. Refer to contract drawing P&IDs for designated tag numbers for equipment, panels, and instruments.

2.07 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

- A. Nametags: Permanently mounted bearing entire equipment tag number.
 - 1. Panel Mounted: Plastic, mounted to instrument behind panel face.
 - 2. Field Mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.
- B. Service Legends (Integrally Mounted with Instrument) and Nameplates:
 - 1. Instruments: Engraved, rigid, laminated Type 316 stainless steel secured. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
 - a. Letter Height: 3/16 inch.
 - 2. Panels: Face mounted Type 316 stainless steel nameplate inscribed with the panel name and tag number. Adhesive backing is not acceptable.

C. Control Panel Nameplate: Control Panel nameplate shall include the following information:

1. Equipment serial number.
2. Control Panel Short Circuit Rating.
3. Supply voltage, phase, and frequency.
4. Current rating of the minimum main conductor.
5. Electrical wiring diagram number.
6. Motor horsepower and full load current.
7. Motor overload heater element (if applicable).
8. Motor circuit breaker trip current rating.
9. Name and location of equipment manufacturer.

D. Standard Light Colors and Inscriptions: Unless otherwise specified in individual equipment specifications, use the following color code and inscriptions:

Tag	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow
FORWARD	FORWARD	Red
REVERSE	REVERSE	Blue

1. Lettering: Black on white and amber lenses; white on red and green lenses.

2. Standard Pushbutton Colors and Inscriptions:
 - a. Use following unless otherwise noted in individual Equipment Specifications:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

- b. Lettering Color:
 - 1) Black on white and yellow buttons.
 - 2) White on black, red, and green buttons.

2.08 ELECTRICAL SURGE AND TRANSIENT PROTECTION

- A. Equip control panels with surge-arresting devices to protect equipment from damage as a result of electrical transients induced in interconnecting lines from lightning discharges and nearby electrical devices.
- B. Suppressor Locations:
 1. At point of connection between an equipment item, including ac powered transmitters, and power supply conductor (direct-wired equipment).
 2. On analog pairs at each end when the pair travels outside of building.
 3. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.

C. Suppressor Design:

1. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
2. Response: 5 nanoseconds maximum.
3. Recovery: Automatic.
4. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
5. Enclosure Mounted: Encapsulated inflame retardant epoxy.

D. Suppressors on 120V ac Power Supply Connections:

1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
2. First-Stage Clamping Voltage: 350 volts or less.
3. Second-Stage Clamping Voltage: 210 volts or less.
4. Power Supplies for Continuous Operation:
 - a. Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
 - b. All Other Applications: Minimum 30 amps at 130V ac.

E. Suppressors on Analog Signal Lines:

1. Test Waveform: Linear 8-microsecond rise in current from 0 amp to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
 - a. dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
 - b. dc Clamping Voltage Tolerance: Plus or minus 10 percent.
 - c. Maximum Loop Resistance: 18 ohms per conductor.

F. Manufacturers and Products:

1. Analog Signals Lines (Panel mounted): Emerson Edco PC-642 or Phoenix Contact 2838228 (plug) with 2839224 (base).
2. 120V ac Lines: Emerson Edco HSP-121 or Phoenix Contact 2907918.
3. 480-Volt, Three-Phase Power Supplies: Square D, Model SDSA3650 or approved equal.
4. Field Mounted at Two-Wire Instruments:
 - a. Encapsulated in stainless steel pipe nipples.
 - b. Emerson Edco SS64 series or Phoenix Contact PipeTrab series.

5. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistor on signal line, all in enclosure.
 - a. Enclosure:
 - 1) NEMA 4X Type 316 stainless steel with door.
 - 2) Maximum Size: 12 inches by 12 inches by 8 inches deep.
 - b. Emerson Edco SLAC series or Phoenix Contact BoxTrab series.

G. Grounding:

1. Field Instrumentation:
 - a. Shielded Instrumentation Cables:
 - 1) Ground shield to ground bus at power supply for analog signal.
 - 2) Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
 - 3) Do not ground instrumentation cable shield at more than one point.
 - b. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.
2. Surge Protection:
 - a. Connect surge arrestor ground terminals to equipment ground bus.
 - b. Install and ground according to arrestor manufacturer's requirements.
3. Provide control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.

PART 3 EXECUTION

3.01 ELECTRICAL POWER AND SIGNAL WIRING

- A. Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.
- B. Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.
- C. Use manufacturer's recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs may be installed on a single screw terminal.
- D. Do not splice or tap wiring except at device terminals or terminal blocks.

3.02 PROTECTION

- A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.
- B. During Work, periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules at Substantial Completion.

3.03 SOURCE QUALITY CONTROL

A. General:

- 1. Engineer may actively participate in many of the tests.
- 2. Engineer reserves right to test or retest specified functions.
- 3. Engineer's decision will be final regarding acceptability and completeness of testing.
- 4. Procedures, Forms, and Checklists:
 - a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
 - b. Describe each test item to be performed.
 - c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
- 5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
- 6. Conducting Tests:
 - a. Provide special testing materials and equipment.
 - b. Wherever possible, perform tests using actual process variables, equipment, and data.
 - c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
 - d. Define simulation techniques in test procedures.
 - e. Test Format: Cause and effect.
 - 1) Person conducting test initiates an input (cause).
 - 2) Specific test requirement is satisfied if correct result (effect), occurs.
 - f. For PIC systems for which Engineer provides applications software, provide sufficient temporary software configuring to allow FDT and SSDT testing of these subsystems.

B. General Factory Test Requirements:

1. Provide factory test of all Package Control system components before shipment to the Site.
2. Engineer and Owner's Consultant reserve the right to actively participate in and witness Factory Testing.
3. Notify Engineer and Owner of Factory Testing 4 weeks in advance.
4. Provide testing in accordance with general testing procedures listed above for the following:

Control Panel Tag No.	Location/Description	Specification Section
20-VCP-20-2	Belt Filter Press 2	44 46 16, Belt Filter Press Dewatering Equipment
20-VCP-20-3	Belt Filter Press 3	44 46 16, Belt Filter Press Dewatering Equipment
20-VCP-20-4	Belt Filter Press 4	44 46 16, Belt Filter Press Dewatering Equipment
20-VCP-20-5	Belt Filter Press 5	44 46 16, Belt Filter Press Dewatering Equipment

5. At a minimum, test the following control system features:
 - a. Internal panel wiring and field and panel devices to the PAC.
 - b. Signal inputs and outputs from the PAC.
 - c. PAC control strategies.
 - d. Interface with OIU, panel mounted controls, and PAC.
 - e. Ethernet communication for Ethernet connected control panels.
6. Provide test documentation to the Engineer.

C. Factory Demonstration Tests (FDT):

1. Notify Engineer of test schedule 4 weeks prior to start of test.
2. Scope: Test entire PAC control system, or skid where applicable, to demonstrate it is operational.
3. Location: System Supplier's facility.
4. Correctness of wiring from panel field terminals to PAC system input/output points and to panel components.
 - a. Simulate each discrete signal at terminal strip.
 - b. Simulate correctness of each analog signal using current source.
5. Operation of communications between PACs and remote I/O and between PACs and computers.
6. Operation of communications between the PAC system, single loop controllers (SLC).
7. Loop-Specific Functions: Demonstrate all control functions of the system including the functions specified in the individual package equipment specifications:
 - a. One of each type function; for example, if there are filter backwash sequence control for several identical filters, demonstrate controls for one filter.

- b. One of each type of function in each panel; for example, but not limited to annunciator operation, controller operation, and recorder operation.
 - c. All required functions for 100 percent of loops.
- 8. Nonloop-Specific Functions:
 - a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
 - b. Timing: Include tests for timing requirements.
 - c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
- 9. Correct deficiencies found and complete prior to shipment to Site.
- 10. Failed Tests:
 - a. Repeat and witnessed by Engineer.
 - b. With approval of Engineer, certain tests may be conducted by PIC System Integrator and witnessed by Engineer as part of Functional Test.
- 11. Make following documentation available to Engineer at test site both before and during FDT:
 - a. Drawings, Specifications, Addenda, and Change Orders.
 - b. Master copy of FDT procedures.
 - c. List of equipment to be tested including make, model, and serial number.
 - d. Approved hardware Shop Drawings for equipment being tested.
 - e. Approved preliminary software documentation Submittal.
- 12. Daily Schedule for FDT:
 - a. Begin each day with meeting to review day's test schedule.
 - b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.

3.04 FIELD QUALITY CONTROL

A. Function testing prior to Facility Startup:

- 1. System Integration Testing:
 - a. Participate in Performance and Functional Tests prior to Facility startup to ensure proper system operation and interactions with the Plant Control System.
 - b. Prepare Package System PAC and OIU, instruments, and equipment for testing.
 - c. Participate in testing, correcting any interface problems due to Package System PAC and/or OIU programming or Ethernet communications.
 - d. Assist the Plant Control System Applications Software Programmer with HMI integration into the Plant Control System.

- e. Schedule: To be completed once facility completed and all systems are installed.
- f. Test Start date will be determined during construction.
- g. Provide a minimum of 3 consecutive days, not including travel time, scheduled with the Applications Software Programmer, to correct problems or troubleshoot data exchange between the Package System Supplier and the Plant Control System.

B. Performance Acceptance Testing (PAT) During and After Facility Startup:

- 1. Package System Services:
 - a. Participate in Performance Test During and After Facility Startup to ensure proper system operation and interactions with the Plant Control System PAC and HMI.
 - b. Prepare Package System PAC, OIU, instruments, and equipment for testing.
 - c. Participate in testing, correcting interface problems due to Package System PAC programming, OIU programming, or Ethernet communications.
 - d. Provide a minimum of three consecutive days of support, not including travel time, to be scheduled with the Plant Control System Application Software Programmer. Provide additional days of support as required to correct problems or errors found to be caused by package system supplied equipment or programming.

END OF SECTION

**SECTION 41 22 13.13
OVERHEAD CRANES**

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Society of Mechanical Engineers (ASME):
 - a. B30.2, Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist).
 - b. B30.10, Hooks.
 - c. B30.11, Monorails and Underhung Cranes.
 - d. B30.17, Overhead and Gantry Cranes (Top Running, Single Girder).
 - e. HST 1M, Performance Standard for Electric Chain Hoists.
 - f. HST 2M, Performance Standard for Hand Chain Manually Operated Chain Hoists.
 - g. HST 4M, Overhead Electric Wire Rope Hoists.
 2. Crane Manufacturer's Association of America (CMAA):
 - a. 70, Electric Overhead Traveling Cranes.
 - b. 74, Top Running & Under Running Single Girder. Electric Overhead Traveling Cranes.
 3. National Electrical Manufacturer's Association (NEMA):
 - a. MG 1, Motors and Generators.
 - b. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
 4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 5. Occupational Safety and Health Act (OSHA).
 6. UL: 674, Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.02 DESIGN REQUIREMENTS

- A. Top-Running Multiple-Girder Overhead Traveling Crane: CMAA No. 70 and ASME B30.2 and B30.17.
- B. Top-Running and Underhung Single-Girder Overhead Traveling Cranes: CMAA No. 74, and ASME B30.11.
- C. Trolley Service Class: CMAA No. 70.

- D. Wire Rope Hoist Service Class: ASME HST 4M and CMAA No. 70 or CMAA No. 74.
- E. Chain Hoist Service Class: ASME HST 1M and CMAA No. 70 or CMAA No. 74.
- F. Hook: ASME 30.10.
- G. Building Clearances: CMAA No. 70 and CMAA No. 74. Where bridge span exceeds 40 feet, increase clearance to 6 inches.
- H. Stress and Safety Factors: CMAA No. 70 and CMAA No. 74. Properly select materials of construction for stresses to which subjected.
- I. Safety of Operation, Accessibility, Interchangeability, and Durability of Parts: ASME B30.2.0 and OSHA requirements. Design equipment for environment operated.
- J. Provide system, equipment, and components, including supports and anchorages, designed in accordance with Section 01 61 00, Common Product Requirements.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Make, model, weight, and horsepower of each equipment assembly.
 - b. Complete catalog information, descriptive literature, materials of construction, and specifications on bridge drive system, end trucks, weight of underhung crane assembly, maximum wheel loads, runway stops, footwalks and platforms, wheels, shafting, drive motor, gears and bearing, steel framing, trolley drive system, hoist motor and assemblies, hook, brakes, starting system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
 - c. Detail Shop Drawings of crane runways, brackets, hangers, and their attachments to precast concrete members and panels.
 - d. Power and control wiring diagrams, including terminals and numbers.
 - e. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
 - f. Factory finish system.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer's printed installation instructions.
3. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.
4. Factory Functional Test Report.
5. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
8. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
9. Structural calculations for bridge crane signed and sealed by an engineer registered in the State of Alabama.

1.04 ENVIRONMENTAL REQUIREMENTS

- A. Temperature: Maximum 100 degrees F; minimum 45 degrees F.
- B. Humidity: 95 percent.
- C. Atmosphere: Mildly corrosive.
- D. Ventilation: 2 cubic feet per minute per square foot, continuous.

PART 2 PRODUCTS

2.01 GENERAL

- A. Crane manufacturer to coordinate equipment requirements with steel structures, panels, drive motor, control panel, trolley and hoist, hoisting cable or chain, hook, crane mounted conductors, rails, stops, and electrical equipment controls.
- B. Where adjustable speed drives or remote control systems are required, crane manufacturer to furnish a coordinated operating system.

2.02 SUPPLEMENTS

- A. See supplements to this section for additional requirements.

2.03 RUNWAY

- A. Furnish runway beams, brackets, and associated framework in accordance with Section 05 50 00, Metal Fabrications and Drawings.
- B. Suspension assembly and bracing for runway beams shall be Type 316L stainless steel.
- C. See 20-S-Series Drawing for designation of runway beams. Note that width of bottom flange is in excess of 6-inches.
- D. Support underhung crane runway rails from suspension framing shown on Drawings.
 - 1. Crane manufacturer may propose adjustments to the detailing shown on Drawings to facilitate erection or improve serviceability and operation of underhung crane assembly.
 - 2. Coordinate proposed adjustments (if any), with precast manufacturer, Contractor, and Owner.
 - 3. Provide miscellaneous appurtenances for fully operational underhung crane assembly.
 - 4. Furnish slotted holes and shims for lateral and vertical rail adjustment.

2.04 BRIDGE

- A. Furnish girders from structural shapes proportioned to resist vertical, lateral, and torsional forces.
- B. Construct bridge end trucks in accordance with CMAA No. 70 or CMAA No. 74. For Class D and E cranes, designed for impact loading and repeated duty cycle. Furnish end trucks with rail sweeps and impact-absorbing bumpers.
- C. Furnish runway stops attached to resist force applied when contacted and locate at limit of travel of bridge. Runway stops shall not engage the wheels.
- D. Provide bridge travel limit switches, located approximately 10 feet to 15 feet from each end of bridge runway, or as required such that bridge travel speed is reduced to low speed prior to bridge engaging runway end-stops. Bridge drive speed past the limit switch locations shall be limited to low speed.
- E. Wheels: Rolled or forged steel with treads and flanges heat treated, or cast iron wheels with chilled tread. Minimum tread hardness 200 Brinell. Clearances, wheel loads, and tolerances in accordance with CMAA No. 70 or CMAA No. 74. For under-running cranes provide fixed axles with wheels accurately machined and ground to receive inner bearing races.

- F. Bridge driving machinery consisting of a cross shaft driven by an electrical motor through a gear speed reducer unit. Cross shaft, high-grade steel, turned, ground, polished, and adequately supported with self-aligning bearings. Shaft diameter to resist torsional strains when bridge is traveling under full load, or when stopped suddenly. Furnish oil-tight speed reducer gear case and support on common base with bridge brake.
- G. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.
- H. Bearings: Combination radial and thrust type, double row, spherical ball, either prelubricated and sealed or fitted for pressure lubrication. Pressure lubrication fittings for maintenance accessibility.
- I. Brakes: Electrically operated, adjustable, suitable for the service class indicated, with rated torque capacities as specified in CMAA No. 70 or CMAA No. 74.

2.05 TROLLEY

- A. Frame: Welded steel, cast steel, or ductile iron construction, or a combination thereof. Design to control deflection of trolley assembly while transmitting the carrying load to bridge rails.
- B. Drive shall consist of trolley drive shaft, driven by an electric motor through a gear reduction unit.
- C. Wheels: Rolled or forged steel, accurately machined and ground to receive inner bearing races. Furnish alloy steel axles. Rotating axles with wheels mounted press fit and keys, or with keys alone. Minimum tread hardness 210 Brinell.
- D. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.
- E. Bearings: Combination radial and thrust type, double row, angular contact ball bearings or single-row tapered roller bearings. Bearings prelubricated and sealed, or fitted for pressure lubrication. Locate pressure lubrication fittings for accessibility during maintenance.
- F. Brakes: Suitable for service class and rated torque capacities as specified in ASME B30.11. Furnish stops on trolley rails or beams.
- G. For bridge spans greater than 40 feet provide trolley travel limit switches, located approximately 6 feet to 8 feet from each end of trolley rails/beams, or as required such that trolley travel speed is reduced to low speed prior to trolley engaging the trolley end-stops. Trolley drive speed past the limit switch locations shall be limited to low speed.

2.06 HOIST

- A. Hoisting machinery shall consist of rope drum driven through gear reductions, load blocks, hook, hoisting rope, sheaves, and hoist braking. Drum size and length sufficient for minimum two turns of cable remaining on drum when hook is at lowest position. Furnish reeving as specified on supplement located at end of section. Provide right and left-hand grooved drum when two-part double reeving is specified.
- B. Rope drum and surrounding members constructed to minimize abrasion, crushing or jamming of hoist rope. Load blocks enclosed type. Hoisting rope extra flexible, improved plow steel wire rope, made especially for hoist service.
- C. Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load and positively held in place with locknuts, collars or other devices.
- D. Brakes: Mechanical and electric load brake and controls, designed in accordance with ASME 4M, and adjustable to compensate for wear.

2.07 ELECTRICAL

- A. Furnish electrical equipment including motors, motor starters, pendant control, control systems, wire, and conduit. Bridge conductors may be removed for shipment. Crane wiring by crane supplier.
- B. Electrical: In accordance with NFPA 70, NEC Article 610.
- C. Furnish motors compatible with adjustable frequency, variable speed, drive system, 40 to 1 speed range, suitable for hoist, trolley, and bridge drive applications. Controls with 120-volt ac, microprocessor based, pulsed width modulation design, withstand 45 degree C temperatures, housed in NEMA 250, Type 4 enclosure, and supplied with 200 percent overcurrent protection.
 - 1. Manufacturers and Products:
 - a. P & H Smartorque.
 - b. Ace Industries; 800 Series.
 - c. Or approved equal.

- D. Bridge and trolley conductor voltage drops from runway supply taps shall permit the crane motors to operate within voltage tolerances of plus or minus 10 percent, when building supply voltage is at plus or minus 5 percent of design voltage.
- E. Festooned Flat Cable Conductors: Flexible cable, carried by heavy-duty roller, permanently lubricated roller bearings, with monorail support system that will dispense and retrieve flexible cable without twisting or tangling, and 20 percent spare conductor in each cable assembly.
- F. Grounding: External in accordance with NFPA 70, NEC Article 250.

2.08 CONTROLS

- A. Furnish electric cranes with pendant control having momentary contact pushbuttons with a device which will disconnect motors from line on failure of power. Device shall not permit any motor to be restarted until controller handle is brought to the OFF position, or a reset switch or button is operated. Furnish with undervoltage protection as a function of each motor controller, or by magnetic main line contactor.
- B. Controls: Fully magnetic, plain reversing type, housed in NEMA 250, Type 12 enclosure, with contactors of sufficient size and quantity for starting, accelerating, reversing, and stopping duty for specified crane service class.
- C. Bridge and Trolley Drives: Soft start controls, 460/230-volt ac series device, installed in between drive motor and motor starter with torque and acceleration rate adjustable, suitable for crane service, and work in conjunction with crane controls.
- D. Pushbutton Control Stations: Heavy-duty, oil-tight, suspended from trolley, with control transformers to supply 120-volt ac power to pushbutton control station. Pushbutton enclosure supported with chain or wire rope. Control wire cable attached to support chain or wire rope at not more than 6-foot intervals. Furnish control station buttons for control of bridge, trolley, and hoist, ON/OFF main line contactor power switch which removes all power from crane and controls.
- E. Remote Control System: Infrared, line-of-sight system, hand held and capable of operating all crane functions.
- F. Control motions indicate direction of resultant crane motion. Furnish spring-loaded switch motions, with return to OFF position when switch is released and designed to prevent runaway crane situations.

- G. Crane motions shall stop automatically when crane can no longer receive remote signals and designed to stop when control signal for any motion becomes ineffective.
- H. Remote Control Crane Motions: Hook raise and lower, trolley movement, bridge movement, and crane power up and power. Furnish an EMERGENCY OFF pushbutton station which will disconnect main line power via a remote switch, and manual reset function to activate all motions after an EMERGENCY OFF event.

2.09 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location. Mounted on separate components of each crane assembly, to facilitate assembly in the field.
- B. Lifting Lugs: Equipment weighing over 100 pounds.

2.10 FACTORY FINISHING

- A. Prepare and prime coat in accordance with manufacturer's standard for the specified installation environment.

2.11 SOURCE QUALITY CONTROL

- A. Factory Inspections: Inspect equipment for required construction, electrical connection, and intended function.
- B. Factory Tests and Adjustments: No-load run test all equipment furnished.
- C. Factory test report shall include Test Data Sheets.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Provide lubrication and lubrication fittings.

3.02 FIELD FINISHING

- A. Equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

- A. Functional Test: Conduct on each crane.
 - 1. Alignment: Test complete assemblies for proper alignment, connection, and quiet operation.
- B. Performance Test:
 - 1. Conduct on each crane.
 - 2. Load tests in compliance with OSHA, ASME B30.11, and ASME B30.16.

3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative:
 - 1. Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
 - a. 2 person-days for installation assistance and inspection.
 - b. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - c. 1 person-day for facility startup.
 - d. 1 person-day for post-startup training of Owner's personnel.
- B. See Section 01 43 33, Manufacturers' Field Services , and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

3.06 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are a part of this Specification.
 - 1. Crane Data Sheet.
 - 2. Crane Dimension Sheet: Building Clearances for Under-Running Cranes.
 - 3. Induction Motor Data Sheet.

END OF SECTION

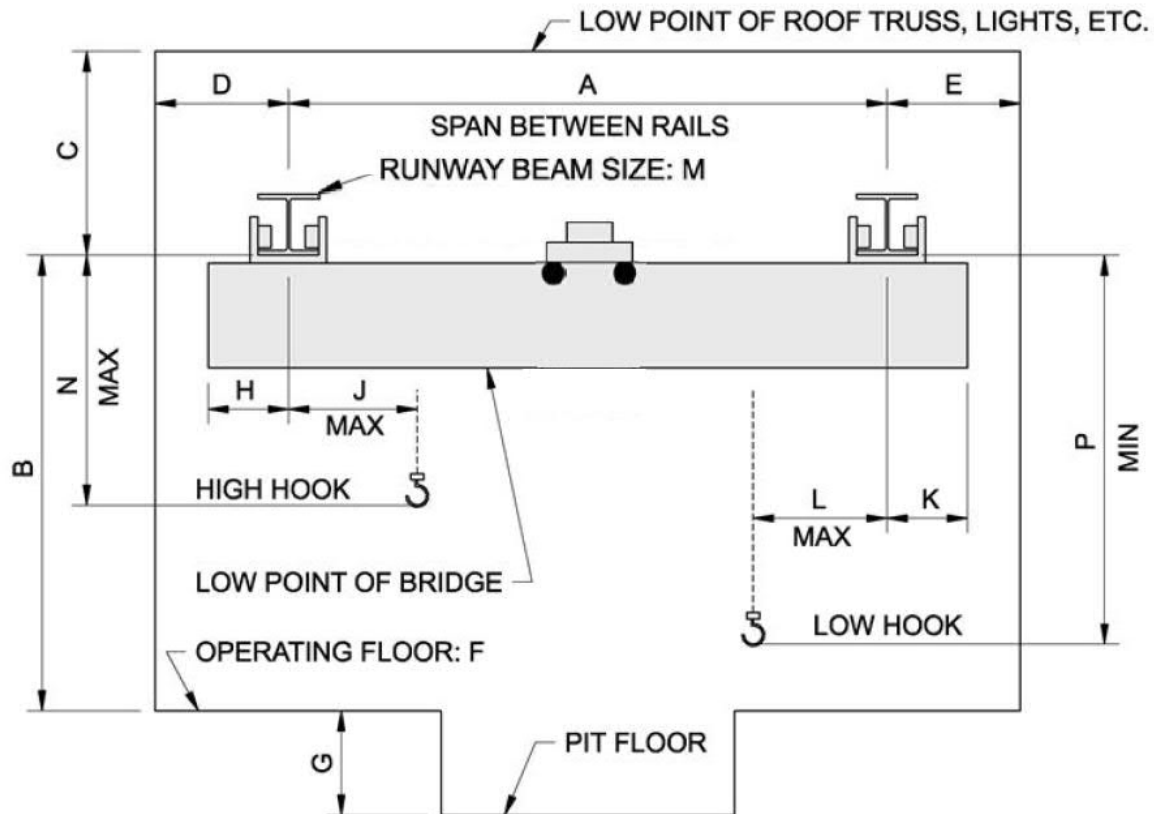
CRANE DATA SHEET		
Project: <u>C. C. Williams WWTP Dewatering Facility & Other Improvements</u>		Manufacturer.: <u>Yale</u>
Owner: <u>Mobile Area Water & Sewer System</u>		Model No.: <u>YKC T10-033S420-2-72</u>
Service: <u>Dewatering and Control Building Belt Filter Press Room Bridge Crane</u>		Number of Units: <u>1</u>
Equip. Tag Number(s): _____		Rev/Date/By: ____/____/____
GENERAL REQUIREMENTS		
Equipment Capacity: <u>10</u> tons	Factory Testing: <input checked="" type="checkbox"/> Required <input type="checkbox"/> Not Required	Power Supply: _____
Method of Control: <u>Radio Remote, Pendant spare</u>		Voltage <u>460</u>
Location of Control: <u>Interior</u>	Field Testing: <input type="checkbox"/> Not required	Phase <u>3</u>
Equipment Location: <input checked="" type="checkbox"/> Indoors <input type="checkbox"/> Outdoors	<input checked="" type="checkbox"/> Required, functional and Performance	Frequency <u>60</u>
BRIDGE	TROLLEY	HOIST
Type: <input type="checkbox"/> Single Girder <input type="checkbox"/> Double Girder <input type="checkbox"/> Top Running <input checked="" type="checkbox"/> Underhung Service Class (ANSI): <input type="checkbox"/> A (standby) <input type="checkbox"/> B (light) <input checked="" type="checkbox"/> C (moderate) <input type="checkbox"/> D (heavy) <input type="checkbox"/> E (severe) <input type="checkbox"/> F (continuous) Speed (fpm): <u>0</u> to <u>115</u> <input type="checkbox"/> Constant Speed <input checked="" type="checkbox"/> Variable Speed <input type="checkbox"/> Hand Operated Motor hp: 4 @ 1 HP _____ Main Runway Electric Conductors: <input type="checkbox"/> Bus Bar <input checked="" type="checkbox"/> Festoon Bridge Drive System (CMAA): <input type="checkbox"/> A1 <input type="checkbox"/> A2 <input type="checkbox"/> A3 <input type="checkbox"/> A4 <input type="checkbox"/> A5 <input type="checkbox"/> A6	Type: <input checked="" type="checkbox"/> Top Running <input type="checkbox"/> Underhung Service Class (ANSI): <input type="checkbox"/> A (standby) <input type="checkbox"/> B (light) <input checked="" type="checkbox"/> C (moderate) <input type="checkbox"/> D (heavy) <input type="checkbox"/> E (severe) <input type="checkbox"/> F (continuous) Speed (fpm): <u>0</u> to <u>80</u> <input type="checkbox"/> Constant Speed <input checked="" type="checkbox"/> Variable Speed <input type="checkbox"/> Hand Operated Motor hp: _____ Electric Conductors: <input type="checkbox"/> Bus Bar <input checked="" type="checkbox"/> Festoon <input type="checkbox"/> _____ <input type="checkbox"/> Cable Reel	Type: <input checked="" type="checkbox"/> Electric, Wire Rope <input type="checkbox"/> Hand Operated, Chain Service Class (ANSI): <input type="checkbox"/> H1 (standby) <input type="checkbox"/> H2 (light) <input checked="" type="checkbox"/> H3 (standard) <input type="checkbox"/> H4 (heavy) <input type="checkbox"/> H5 (severe) Speed (fpm): <u>20</u> to <u>2</u> <input type="checkbox"/> Constant Speed <input type="checkbox"/> Two Speed <input checked="" type="checkbox"/> Variable Speed Motor hp: 15 _____ Hook: See Crane Dimension Sheet Hook Manufacturer: _____ Reeving: _____
SPECIAL REQUIREMENTS		
Accessories: <input type="checkbox"/> Service Platform <input type="checkbox"/> Central Lubrication System <input type="checkbox"/> OSHA Operating and Safety Devices	Remote Controls: <input type="checkbox"/> Infrared, line-of-sight <input type="checkbox"/> Frequency Modulated (FM) Manufacturer: _____ <input type="checkbox"/> Extended Grease Fittings	Special Electrical Requirements:
See Crane Dimension Sheet for clearances, lift distances, and details.		

CRANE DIMENSION SHEET, Belt Filter Press Room

Building Clearances for Under-Running Bridge Cranes and Top-Running Hoist

Project: C.C. Williams WWTP Dewatering Facility & Other ImprovementsOwner: Mobile Area Water and Sewer System

Equip. Tag No.: _____



A: <u>40' 5"</u>	F: <u>Datum</u>	K: <u>manufacturer's recommendation</u>
B: <u>24'</u>	G: <u>12"</u>	L: <u>48"</u>
C: <u>2'</u>	H: <u>manufacturer's recommendation</u>	M: <u>See Drawings</u>
D: <u>2' 2"</u>	I: _____	N: <u>10"</u>
E: <u>2' 2"</u>	J: <u>48"</u>	P: <u>25'</u>

Notes:

1. Runway Length: 136' 2"
2. Bridge Wheelbase, Centered on Bridge, Maximum: 5' 6"

INDUCTION MOTOR DATA SHEETProject: C.C. Williams Dewatering Facility and Other ImprovementsOwner: MAWSSEquipment Name: Dewatering and Control Building Belt Filter Press Room Bridge Crane

Equipment Tag Number(s): _____

Type: Squirrel-cage induction meeting requirements of NEMA MG 1

Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

Motor Horsepower: _____

Guaranteed Minimum Efficiency at Full Load: _____ percent

Bridge Motors – 2@ 1HP each

Trolley Motors – 2@ 1HP each

Hoist Motor - 15HPVoltage: 460

Guaranteed Minimum Power Factor at Full Load: _____ percent

Phase: 3Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15Frequency: 60

Enclosure Type: NEMA 4X _____

Synchronous Speed: _____ rpm

☒ Multispeed, Two-Speed: 1800 / 900 rpm☐ Thermal Protection: _____Winding: ☐ One ☐ Two☐ Space Heater: _____ volts,
single-phaseMounting Type: ☐ Horizontal ☐ Vertical☐ Vertical Shaft: ☐ Solid ☐ Hollow☐ Vertical Thrust Capacity (lb): Up _____ Down _____☐ Adjustable Speed Drive: See Section 26 29 23, Low-Voltage
Adjustable Frequency Drive System.

Operating Speed Range: _____ to _____% of Rated Speed

☐ Variable Torque☐ Constant TorqueAdditional Motor Requirements: ☒ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features:

Crane shall only require a single 480V power feed.



**SECTION 41 22 23.19
MONORAIL HOISTS**

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI): MH27.1, Underhung Cranes and Monorail Systems.
 2. American Society of Mechanical Engineers (ASME):
 - a. B30.10, Hooks.
 - b. B30.11, Monorails and Underhung Cranes.
 - c. HST 1M, Performance Standard for Electric Chain Hoists.
 - d. HST 2M, Performance Standard for Hand Chain Manually Operated Chain Hoists.
 - e. HST 4M, Performance Standard for Overhead Electric Wire Rope Hoists.
 3. National Electrical Manufacturer's Association (NEMA):
 - a. MG 1, Motors and Generators.
 - b. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
 4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 5. Occupational Safety and Health Act (OSHA).
 6. Underwriters Laboratory (UL): 674, Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.02 DESIGN REQUIREMENTS

- A. Monorail System: Specifications for Underhung Cranes and Monorail Systems, ANSI MH27.1 and ASME B30.11.
- B. Hoist: ASME B30.11, Hoist Manufacturers' Institute.
- C. Trolley: ANSI MH27.1.
- D. Wire Rope Hoist Service Class: ASME HST 4M.
- E. Chain Hoist Service Class: ASME HST 1M.
- F. Hook: ASME 30.10.

- G. Stress and Safety Factors: ANSI MH27.1 and ASME B30.11. Properly select materials of construction for stresses to which subjected.
- H. Safety of Operation, Accessibility, Interchangeability, and Durability of Parts: ASME B30.11 and OSHA requirements.
- I. Provide system, equipment, and components, including supports and anchorages, designed in accordance with Section 01 61 00, Common Product Requirements.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Shop Drawings:
 - a. Make, model, weight, and horsepower of each equipment assembly.
 - b. Complete catalog information, descriptive literature, materials of construction, and specifications on hoist, wheels, gears and bearing, trolley drive system, hoist motor and assemblies, hook, brakes, starting system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
 - c. Detail Shop Drawings of monorail runway beams, brackets, hangers, and their attachments to precast concrete framing and panels.
 - d. Power and control wiring diagrams, including terminals and numbers.
 - e. Motor nameplate data in accordance with NEMA MG 1, and include any motor modifications.
 - f. Factory finish system.

B. Informational Submittals:

- 1. Special shipping, storage and protection, and handling instructions.
- 2. Manufacturer's printed installation instructions.
- 3. Structural design calculations for monorail track stamped by a professional engineer registered in the state of Alabama.
- 4. Manufacturer's Certification of Compliance.
- 5. Factory Functional Test Report.

6. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
9. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 ENVIRONMENTAL REQUIREMENTS

- A. Temperature: Maximum 100 degrees F; minimum 45 degrees F.
- B. Humidity: 95 percent.
- C. Atmosphere: Corrosive.
- D. Ventilation: 2 cubic feet per minute per square foot, continuous.

1.05 EXTRA MATERIALS

- A. Provide special tools required to maintain or dismantle.

PART 2 PRODUCTS

2.01 GENERAL

- A. Hoist and trolley manufacturer to coordinate equipment requirements with steel structures, drive motor, hoisting cable or chain, hook, track, stops, and electrical equipment controls.
- B. Where adjustable speed drives or remote control systems are required, crane manufacturer to furnish a coordinated operating system.

2.02 SUPPLEMENTS

- A. See supplements to this section for additional requirements.

2.03 RUNWAY

- A. Furnish runway beams, brackets, and associated framework in accordance with Section 05 50 00, Metal Fabrications and Drawings.
- B. See 50-S-Series Drawing for designation of runway beams.

- C. Support monorail runway from suspension framing shown on Drawings.
 - 1. Suspension assembly and bracing for monorail runway beam shall be Type 316L stainless steel construction, except for the exterior rigid frame assembly above the bottom of column base plates.
 - 2. Monorail manufacturer may propose adjustments to the detailing shown on Drawings to facilitate erection or improve serviceability and operation of monorail assembly.
 - 3. Coordinate proposed adjustments (if any), with precast manufacturer, Contractor, and Owner.
 - 4. Provide miscellaneous appurtenances for fully operational monorail assembly.
 - 5. Furnish slotted holes and shims for lateral and vertical runway adjustment.
- D. Lubricant: Permanent factory prelubricated joints.

2.04 TROLLEY

- A. Frame: Welded steel, cast steel, or ductile iron construction, or a combination thereof. Construct to control deflection of trolley assembly while transmitting the carrying load to running surface.
- B. Drive shall consist of trolley drive shaft, driven by an electric motor through a gear reduction unit.
- C. Wheels: Rolled or forged steel, accurately machined and ground to receive inner bearing races. Furnish alloy steel axles. Rotating axles with wheels mounted press fit and keys, or with keys alone. Minimum tread hardness 210 Brinell.
- D. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.
- E. Bearings: Combination radial and thrust type, double row, angular contact ball bearings or single-row tapered roller bearings. Bearings prelubricated and sealed, or fitted for pressure lubrication. Locate pressure lubrication fittings for accessibility during maintenance.
- F. Brakes: Suitable for service class and rated torque capacities as specified in ASME B30.11.

2.05 HOIST

- A. Hoisting machinery shall consist of rope drum driven through gear reductions, load blocks, hook, hoisting rope, sheaves, and hoist braking. Drum size and length sufficient for minimum two turns of cable remaining on drum when hook is at lowest position. Furnish reeving as specified on Supplements at end of section. Provide right and left-hand grooved drum when two-part double reeving is specified.
- B. Rope drum and surrounding members constructed to minimize abrasion, crushing or jamming of hoist rope. Load blocks enclosed type. Hoisting rope extra flexible, improved plow steel wire rope, made especially for hoist service.
- C. Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load and positively held in place with locknuts, collars or other devices.
- D. Brakes: Mechanical and electric load brake and controls, designed in accordance with ASME 4M, and adjustable to compensate for wear.
- E. Brakes: In accordance with ASME HST 1M and ASME HST 2M, adjustable to compensate for wear, spring set, electric release load brake system, which releases load when drive motor is energized and holds load when the drive motor is de-energized.

2.06 ELECTRICAL

- A. Furnish electrical equipment including motors, motor starters, pendant control, control systems, wire, and conduit.
- B. Electrical: In accordance with NFPA 70, NEC Article 610.
- C. Furnish motors compatible with adjustable frequency, variable speed, drive system, 40 to 1 speed range, suitable for hoist, trolley, and bridge drive applications. Controls with 120V ac, microprocessor based, pulsed width modulation design, withstand 45 degree C temperatures, housed in NEMA 250, Type 4X enclosure, and supplied with 200 percent overcurrent protection.
 - 1. Manufacturers and Products:
 - a. P & H Smartorque.
 - b. Ace Industries; 800 Series.
 - c. Approved Equal.

- D. Monorail conductor voltage drops from monorail track supply taps shall permit the hoist and trolley motors to operate within voltage tolerances of plus or minus 10 percent, when building supply voltage is at plus or minus 5 percent of design voltage.
- E. Festooned Flat Cable Conductors: Flexible cable, carried by heavy-duty roller, permanently lubricated roller bearings, with monorail support system that will dispense and retrieve flexible cable without twisting or tangling, and 20 percent spare conductor in each cable assembly.
- F. Cable Reel Conductors: Flexible cable, housed on a circular wheel, counter-torque spring to dispense and retrieve cable, with sag not more than 3 feet below connection point on hoist or trolley at maximum travel.
- G. Grounding: External in accordance with NFPA 70, NEC Article 250.

2.07 CONTROLS

- A. Hoist and Trolley: Pendant control having momentary contact pushbuttons with a device which will disconnect motors from line on failure of power. Device shall not permit any motor to be restarted until controller handle is brought to the OFF position, or a reset switch or button is operated. Furnish with undervoltage protection as a function of each motor controller, or by magnetic main line contactor.
- B. Pushbuttons: Fully magnetic, plain reversing type, housed in NEMA 250, Type 4X enclosure, with contactors of sufficient size and quantity for starting, accelerating, reversing, and stopping duty for specified hoist service class.
- C. Trolley Drives: Soft start controls, 460/230V ac series device, installed between drive motor and motor starter with torque and acceleration rate adjustable, suitable for trolley drive service, and work in conjunction with crane control and pendant system.
- D. Pendant Pushbutton Control Stations: Heavy-duty, oiltight, suspended from trolley, with control transformers to supply 120V ac power to pushbutton control station. Pushbutton enclosure supported with chain or wire rope. Control wire cable attached to support chain or wire rope at not more than 6-foot intervals. Furnish control station buttons for control of hoist and trolley ON/OFF main line contactor power switch which removes all power from control station.
- E. Control motions indicate direction of resultant monorail motion. Furnish spring-loaded switch motions, with return to OFF position when switch is released and designed to prevent runaway monorail situations.

- F. Monorail motions shall stop automatically when monorail can no longer receive remote signals and designed to stop when control signal for any motion becomes ineffective.
- G. Remote Control Monorail Motions: Hook raise and lower, trolley movement, and monorail power up and power down. Furnish an EMERGENCY OFF pushbutton station which will disconnect main line power via a remote switch, and manual reset function to activate all motions after an EMERGENCY OFF event.

2.08 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
- B. Lifting Lugs: Equipment weighing over 100 pounds.

2.09 FACTORY FINISHING

- A. Prepare, prime coat, and finish coat in accordance with manufacturer's standard for the specified installation environment.

2.10 SOURCE QUALITY CONTROL

- A. Factory Inspections: Inspect equipment for required construction, electrical connection, and intended function.
- B. Factory Tests and Adjustments: No-load run test all equipment furnished.
- C. Factory test report shall include Test Data Sheets.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Provide lubrication and lubrication fittings.

3.02 FIELD FINISHING

- A. Equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

- A. Functional Tests: Conduct on each hoist and monorail system.
 - 1. Alignment: Test complete assemblies for proper alignment and connection, and quiet operation.
- B. Performance Test:
 - 1. Conduct on each hoist and monorail system.
 - 2. Load tests in compliance with OSHA, ASME B30.11, and ANSI MH27.1.

3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
 - 1. 2 person-days for installation assistance and inspection.
 - 2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - 3. 1 person-day for facility startup.
 - 4. 1 person-day for post-startup training of Owner's personnel.
- B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

3.06 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are a part of this Specification.
 - 1. Hoist/Monorail Data Sheet.
 - 2. Hoist/Monorail Dimension Sheet.
 - 3. Induction Motor Data Sheet.

END OF SECTION

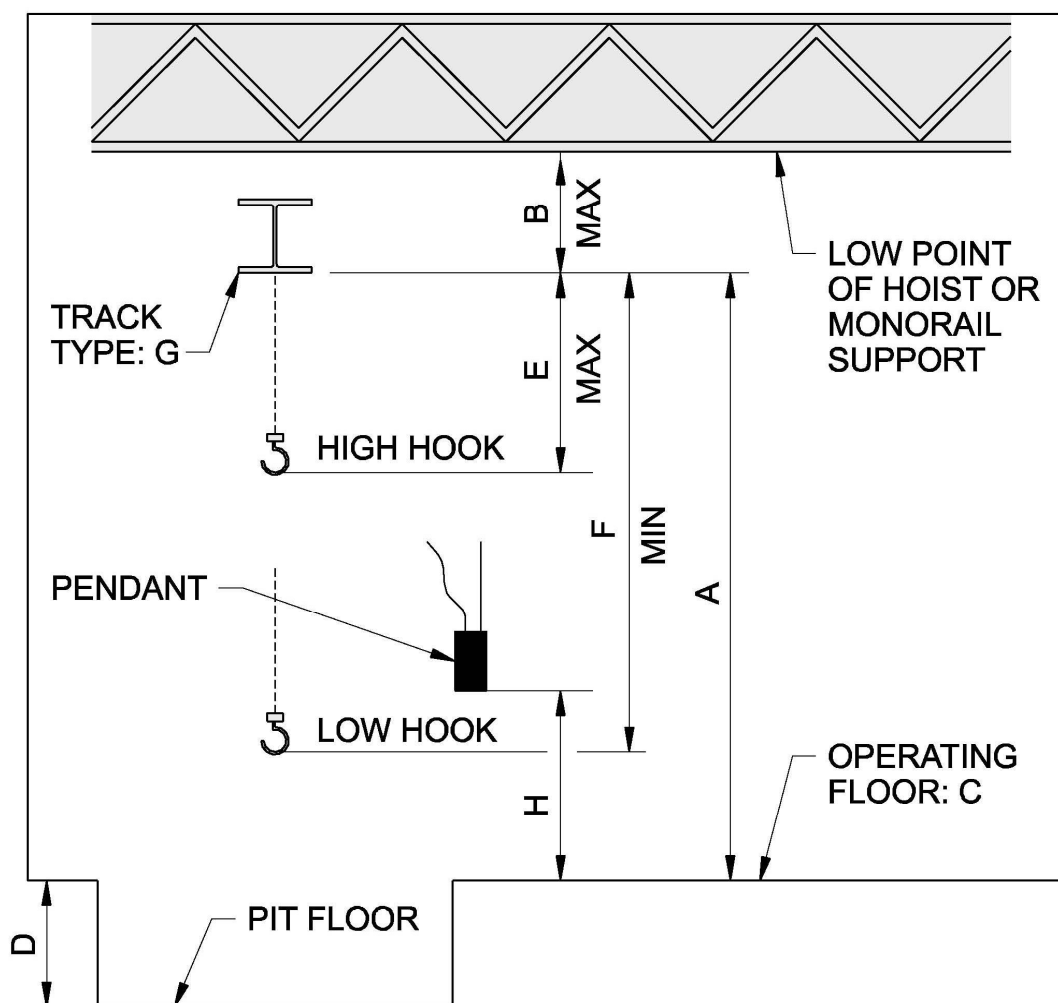
HOIST/MONORAIL DATA SHEET		
Project: <u>C. C. Williams WWTP Dewatering Facility & Other Improvements</u>		Manufacturer.: <u>Yale</u>
Owner: <u>Mobile Area Water & Sewer System</u>		Model No.: <u>80M03-030S18-2</u>
Service: <u>Chlorine and Sulfur Dioxide Ton Container Handling</u>		Number of Units: <u>2</u>
Equip. Tag Number(s): _____		Rev/Date/By: _____ / _____ / _____
GENERAL REQUIREMENTS		
Equipment Capacity: <u>3</u> tons		Factory Testing: _____
Method of Control: <u>Pendant</u>		Power Supply: _____
<input checked="" type="checkbox"/> Required <input type="checkbox"/> Not Required		Voltage <u>460</u>
Location of Control: <u>Interior/Exterior</u>		Phase <u>3</u>
Field Testing: <input type="checkbox"/> Not required		Frequency <u>60</u>
Equipment Location: _____		Frequency <u>60</u>
<input checked="" type="checkbox"/> Required, functional and performance		
<input checked="" type="checkbox"/> Indoors <input checked="" type="checkbox"/> Outdoors		
HOIST	TROLLEY	
Type: <input checked="" type="checkbox"/> Electric, Wire Rope <input type="checkbox"/> Hand Operated, Chain Service Class (ANSI): <input type="checkbox"/> H1 (standby) <input type="checkbox"/> H2 (light) <input type="checkbox"/> H3 (standard) <input checked="" type="checkbox"/> H4 (heavy) <input type="checkbox"/> H5 (severe) Speed (fpm): <u>18 to 9</u> <input type="checkbox"/> Constant Speed <input checked="" type="checkbox"/> Two Speed <input type="checkbox"/> Variable Speed Motor hp: <u>4 / 2</u> Hook: See Hoist/Monorail Dimension Sheet Hook Manufacturer: _____ Reeving: _____	Type: <input type="checkbox"/> Top Running <input checked="" type="checkbox"/> Underhung Service Class (ANSI): <input type="checkbox"/> A1 (standby) <input type="checkbox"/> A2 (infrequent) <input type="checkbox"/> B (light) <input type="checkbox"/> C (moderate) <input checked="" type="checkbox"/> D (heavy) Speed (fpm): <u>0 to 50</u> <input checked="" type="checkbox"/> Constant Speed <input type="checkbox"/> Variable Speed <input type="checkbox"/> Hand Operated Motor hp: <u>0.5</u> Electric Conductors: <input checked="" type="checkbox"/> Bus Bar <input type="checkbox"/> Festoon <input type="checkbox"/> _____ <input type="checkbox"/> Cable Reel	
SPECIAL REQUIREMENTS		
<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> Accessories: <input type="checkbox"/> Central Lubrication System <input type="checkbox"/> OSHA operating and safety devices </div> <div style="width: 30%;"> Remote Controls: <input type="checkbox"/> Infrared, line-of-sight <input type="checkbox"/> Frequency modulated (FM) Manufacturer: _____ <input type="checkbox"/> Extended Grease Fittings </div> <div style="width: 30%;"> Special Electrical Requirements: _____ </div> </div>		
See Hoist/Monorail Dimension Sheet for clearances, lift distances, and details.		

HOIST/MONORAIL DIMENSION SHEET

Building Clearances for Monorail Cranes

Project: C. C. Williams WWTP Dewatering Facility & Other ImprovementsOwner: Mobile Area Water & Sewer System

Equipment Tag Number(s): _____

A: 10.68 feet (bottom of beam)D: 0 feetG: Note 1B: 3 feetE: 2.27 feetH: 3.5 feetC: DatumF: 10 feet

Notes:

1. Monorail Track Length: As shown in Drawings

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MAY 2021

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MONORAIL HOISTS

41 22 23.19 SUPPLEMENT 2 - 1

INDUCTION MOTOR DATA SHEET	
Project: <u>C. C. Williams WWTP Dewatering Facility & Other Improvements</u>	
Owner: <u>Mobile Area Water & Sewer System</u>	
Equipment Name: <u>Chlorination and Dechlorination Hoists</u>	
Equipment Tag Number(s): _____	
Type: Squirrel-cage induction meeting requirements of NEMA MG 1	
Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.	
Hazardous Location: <input type="checkbox"/> Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.	
Motor Horsepower: <u>4</u>	Guaranteed Minimum Efficiency at Full Load: _____ percent
Voltage: <u>460</u>	Guaranteed Minimum Power Factor at Full Load: _____ percent
Phase: <u>3</u>	Service Factor (@ rated max. amb. temp.): <input type="checkbox"/> 1.0 <input type="checkbox"/> 1.15
Frequency: <u>60</u>	Enclosure Type: _____
Synchronous Speed: _____ rpm	<input checked="" type="checkbox"/> Multispeed, Two-Speed: 1800 / 900 rpm
<input type="checkbox"/> Thermal Protection: _____	Winding: <input type="checkbox"/> One <input type="checkbox"/> Two
<input type="checkbox"/> Space Heater: volts, single-phase	Mounting Type: <input type="checkbox"/> Horizontal <input type="checkbox"/> Vertical
<input type="checkbox"/> Vertical Shaft: <input type="checkbox"/> Solid <input type="checkbox"/> Hollow	
<input type="checkbox"/> Vertical Thrust Capacity (lb): Up _____ Down _____	
<input type="checkbox"/> Adjustable Speed Drive: See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.	
Operating Speed Range: _____ to _____% of Rated Speed	
<input type="checkbox"/> Variable Torque	
<input type="checkbox"/> Constant Torque	
Additional Motor Requirements: <input type="checkbox"/> See Section 26 20 00, Low Voltage AC Induction Motors.	
Special Features:	

SECTION 43 22 56.01
SIDE-MOUNTED TANK MIXERS

PART 1 GENERAL

1.01 SUMMARY

- A. Comply with Division 1, General Requirements, Section 01 61 00, Common Product Requirements, and Section 26 05 02, Basic Electrical Requirements.
- B. Section includes the supply, delivery, Site storage, installation, testing and placement into operation of tank mixers and axial-flow pumps, including all appurtenances required to complete an operating system as specified.
- C. Section includes supply and installation of all components necessary to install a two side-entering tankagitators in the Biosolids Holding Tank and the Smith Biosolids Receiving Tank.
- D. Refer to the Grease Trap Waste Treatment Facility Wright Smith, Jr. WWTP, 2012 record drawings for details of the existing storage tanks being relocated.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American National Standards Institute (ANSI).
 - 2. American Water Works Association (AWWA).
 - 3. ASTM International (ASTM).

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. General layout, seal, complete engineering description, and performance characteristics.
 - 2. Size, details, and complete list of materials.
 - 3. Details of wiring schematics.
 - 4. Commissioning reports.
- B. Informational Submittals:
 - 1. Installation Manuals. Submit installation manuals before shipment of any equipment. No payment will be made for equipment delivered before installation manuals.

2. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data. Submit operation and maintenance manuals before requesting initial start-up.
3. Submit Manufacturer's Certificate of Proper Installation as specified in Section 01 43 33 Manufacturer's Field Services.
4. Submit Manufacturer's Certificate of Compliance to guarantee that the supplied mixer meets the design as intended and as specified in accordance with Section 01 61 00 Common Product Requirements.
5. Action and informational submittals in accordance with Section 40 99 90, Package Control Systems.

PART 2 PRODUCTS

2.01 SIDE-MOUNTED TANK AGITATORS

- A. Design the tank mixers for continuous full load duty and guarantee the mixers based on the design conditions specified on the data sheet. Design and construct all units to permit economical maintenance. Select all units to allow as much interchangeability of parts as possible. Unspecified details of design and construction of the mixing unit will be manufacturer's standard.
 1. Tank Dimensions:
 - a. Diameter: 13 feet.
 - b. Straight Side Height: 19 feet.
 - c. Bottom Shape and Depth: Cone; 4 feet.
 - d. Top Shape and Depth: Cone; approximately 14 inches.
 - e. Mixer Mounting Type: Flanged; 20-inch diameter; Type 316 stainless steel.
 - f. Tank Volume: 18,000 gal.
 2. Service Conditions:
 - a. Fluid: Digested Sludge.
 - b. Viscosity: 1.05.
 - c. Temp: 50 – 90 F.
 - d. Percent Solids: 1 – 4 percent.
 3. Mixers:
 - a. Number of Mixers: 2.
 - b. Tags: 20-M-10-1 and 20-M-10-2.
 - c. Location:
 - 1) Biosolids Holding Tank.
 - 2) Smith Biosolids Receiving Tank.
 - d. Motor: 230/460V, 60Hz, 1800 rpm.
 - e. Motor Enclosure Type: TEFC.
 - f. Per NEMA standards.
 - g. Motor: With thermostats.
 - h. Horsepower: 7.5
 - i. Shaft / Impeller Materials: Type 316 stainless steel.
 - j. Shaft / Impeller Design Safety Factor: 3.5.

- k. Impeller Diameter: 18 inches.
- l. Impeller Type: 3-blade Axial flow.
- m. Model:
 - 1) Chemineer; Model 2HSA-7.5.
 - 2) Lightnin, Model 108RSE15.
- 4. Seal: Six ring stuffing box with PTFE packing and with bronze lantern ring FKM (Viton) shutoff.
- 5. Seal Lubrication: Weighted lubrication assembly or approved equal.
- 6. Seal Shut-off System: provide a seal shut-off valve assembly to permit the replacement of the seal packing without damage to the shaft and assures positive shut-off.
- 7. Supports: Provide stainless steel support stand in adequate length to allow base to mount to concrete slab and sized by manufacturer to support the weight of the mixer and prevent movement or vibration. The weight of the mixers shall not be supported from the tank.
- 8. Coatings: In accordance with Section 09 90 00, Painting and Coatings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide stainless steel supports, mounting bolts, washers, and nuts and install the equipment to existing flanged connections on the relocated tanks.
- B. Install the equipment in accordance with the manufacturer's instructions and typical installation detail included in this section.

3.02 START-UP

- A. Before operating equipment, provide the services of a qualified manufacturer's service representative to inspect, operate, test, and adjust the equipment after installation.
- B. Submit the Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturer's Field Services. Provide copies of this report to be included in the installation, operation and maintenance manuals.
- C. Included in the Inspection:
 - 1. Soundness (without cracked or otherwise damaged parts).
 - 2. Completeness of installation as specified and as recommended by manufacturer.
 - 3. Correctness of setting, alignment, and relative arrangement of various parts of system.

- D. Operate, test, and adjust equipment to prove that it is satisfactorily installed to operate under the intended conditions as specified.
- E. Equipment will only be accepted after receipt of the Manufacturer's Certificate of Proper Installation and Certificate of Compliance.
- F. Modify or replace equipment or materials failing required tests.
- G. Perform additional testing required due to changes of materials required by Supplier or as a result of failure of materials or construction to meet specifications.

3.03 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

3.04 SUPPLEMENTS

- A. The supplement listed below, following "End of Section", is part of this Specification.
 - 1. Side-Mounted Tank Mixer Motor Data Sheet.

END OF SECTION

INDUCTION MOTOR DATA SHEETProject: Williams WWTPOwner: MAWSSEquipment Name: Mixer No. 1 and Mixer No. 2Equipment Tag Number(s): 20-M-10-1 and 20-M-10-2

Type: Squirrel-cage induction meeting requirements of NEMA MG 1

Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.Motor Horsepower: 7.5

Guaranteed Minimum Efficiency at Full Load: _____ percent

Voltage: 460

Guaranteed Minimum Power Factor at Full Load: _____ percent

Phase: 3Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15Frequency: 60Enclosure Type: TEFC

Synchronous Speed: _____ rpm

☐ Multispeed, Two-Speed: _____ / _____ rpm☒ Thermal Protection: ThermostatsWinding: ☐ One ☐ Two☐ Space Heater: 120 volts,
single-phaseMounting Type: ☐ Horizontal ☐ Vertical☐ Vertical Shaft: ☐ Solid ☐ Hollow☐ Vertical Thrust Capacity (lb): Up _____ Down _____☐ Adjustable Speed Drive: See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

Operating Speed Range: _____ to _____% of Rated Speed

☐ Variable Torque☐ Constant TorqueAdditional Motor Requirements: ☒ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features:

The motor shall include thermostats which interface directly with the associated motor starter.

SECTION 43 40 01
POLYETHYLENE STORAGE TANK

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Society of Mechanical Engineers (ASME): B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
 2. ASTM International (ASTM):
 - a. C177, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - b. D638, Test Method for Tensile Properties of Plastics.
 - c. D648, Test Method for Deflection Temperature of Plastics Under Flexural Load.
 - d. D746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 - e. D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - f. D833, Standard Definitions of Terms Relating to Plastics.
 - g. D1505, Test Method for Density of Plastics by the Density-Gradient Technique.
 - h. D1525, Test Method for Vicat Softening Temperature of Plastics.
 - i. D1621, Test Method for Compressive Properties of Rigid Cellular Plastics.
 - j. D1622, Test Method for Apparent Density of Rigid Cellular Plastics.
 - k. D1623, Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
 - l. D1693, Test Method for Environmental Stress-Cracking of Ethylene Plastics.
 - m. D1940, Method of Test for Porosity of Rigid Cellular Plastics.
 - n. D1998, Specification for Polyethylene Upright Storage Tanks.
 - o. E84, Test Method for Surface Burning Characteristics of Building Materials.

1.02 DEFINITIONS

- A. XLHDPE: Cross-linked high-density polyethylene.

1.03 DESIGN REQUIREMENTS

- A. Manufacturer shall design 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. Tank manufacturer must be capable of providing UL Listing for Nonmetallic Aboveground Tanks for Chemicals.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Fabricator's catalog information, descriptive literature, specifications, and identification of materials of construction. Provide catalog cuts for all off-the-shelf items.
 - b. 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, access ladders, supports, and tank hold down and support systems. Both plan and elevation views shall be provided. All piping terminal points shall be clearly shown and fully dimensioned.
 - c. Resin used for each tank and all supporting specifications for resins.
 - d. 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.
 - e. 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) shall be indicated for each of the applicable loading combinations found in the attached schedule. Calculations for anchor bolt type, size, and location shall be indicated for the controlling load condition.
 - f. Tank data indicating pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, and details of nozzle designs.
 - g. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.

- h. Certified test data on representative samples of standard materials which demonstrate compliance with the physical properties specified herein.
 - i. Certified copy of all factory test results including gel tests, impact tests, and hydrostatic tests. Provide a listing of procedures used in testing.
 - j. 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.
 - k. All exceptions and any proposed revisions to the requirements of the Specifications shall be included with the Submittals.
- 2. Samples: Representative Samples of the high density cross-linked polyethylene with anti-oxidant resistant linear low density polyethylene liner tank shall be provided.
 - 3. Anchorage and bracing drawings and cutsheets as specified in Section 01 88 15, Anchorage and Bracing.

B. Informational 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 Data: As specified in Section 01 78 23, Operation and Maintenance Data.
- 7. Anchorage and bracing calculations as specified in Section 01 88 15, Anchorage and Bracing.

1.05 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 (such as, ISO9001).

1.06 DELIVERY, STORAGE, AND HANDLING

- A. All materials fabricated to this Specification must be packaged, crated, or protected in such manner so as 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 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 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.

1.07 SPECIAL GUARANTEE

- A. Tanks shall have a minimum 2-year guarantee from substantial completion 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 2 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.

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. Or approved equal.

2.03 SERVICE CONDITIONS

- A. Location: Indoors.
- B. Ambient Air Temperature Range: 50 degrees F to 100 degrees F.
- C. Relative Humidity: Up to 100 percent.
- D. Operating Pressure: Atmospheric.
- E. Stored Materials:

Stored Materials		
Equipment	Chemical	Specific Gravity
Polymer Tank	Emulsion Polymer	1.05
*Wall thickness calculations shall be based on tank contents with a specific gravity of 1.9.		

2.04 TANK DESIGN CRITERIA

- A. Seismic Load: Refer to Structural General Notes or Section 01 61 00, Common Product Requirements.
- B. Live Load: 200 pounds per square foot.
- C. Concentrated Load: 300 pounds.
- D. Special Loads: Design tanks for dead loads from all attached piping.
- E. Hydrostatic Load: For specific gravities of stored materials specified herein. Tanks shall be designed to withstand the hydrostatic pressure resulting from a full tank.

2.05 TANK CONSTRUCTION

- A. Tanks specified herein shall be cross linked high-density polyethylene construction with interior anti-oxidant resistant linear HDPE liner and shall meet or exceed all requirements of ASTM D1998.
- B. Tanks shall be double-walled, vertical, flat bottom, dome top construction.
- C. Tank manufacturer must be capable of issuing gel test results with 1/8-inch inner wall reading no less than 65 percent and outer wall no less than 90 percent gel. Entire thickness must be at least 80 percent gelled.
- D. The XLHDPE tanks shall be constructed using the rotational molding process.
- E. 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*
Polymer Storage Tank (20-T-50-1 and 20-T-50-2)	4,400 gal	10'-2.5"	10'-0"
*Tank sizes are nominal sizes.			

- F. 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 hrs
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 Temp	D648	67 degrees C
Polyethylene Notch Test (PENT)	F1473	>1,000 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, anchor bolts, nuts, and washers for proper anchoring of the tank. Actual number of holddown lugs shall be calculated with the tank full.
- C. All exposed metal surfaces not constructed of stainless steel shall be painted in accordance with and as specified in Section 09 90 00, Painting and Coating.

2.07 FITTINGS

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

Fitting/Opening Schedule		
Service	Type/Location	Diameter
Fill	Flanged/Top	3 inch
Vent	Flanged/Top	4 inch
Level Transmitter	Flanged/Top	4 inch
Manway Opening	Flanged/Top	24 inch
Overflow	Flanged/6" below tank top	3 inch
Drain	Flanged at tank bottom	3 inch
Discharge	Flanged at tank bottom	3 inch
Spare	Flanged/Top	6 inch
Recirculation Outlet	Flanged at tank bottom	2 inch

- 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 to discharge to interior sidewall of tank. Drop leg shall be supported internally by a pipe support. Pipe support shall be a bolted fitting at tank sidewall.
- C. Fittings shall be CPVC compressive 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 materials compatible with the chemical service.
- E. Bolted fittings shall use Hastelloy C bolts with polyethylene-encapsulated heads and CPVC 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.
- G. Level transmitter nozzles are to be are to be a minimum distance away from tank wall or obstruction per the following:
 - 1. Measuring range: 0-10 feet, 10.5-inches.
 - 2. Measuring range: 0-21 feet, 22-inches.

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. Gaskets:
 - 1. Material compatible with chemical service, low torque, full face, ASME 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, ASME B16.1 dimensions.
- C. Pipe Supports:
 - 1. Provide pipe supports for the fill pipe, overflow pipe, and discharge pipe attached to the tank.
 - 2. Spacing of pipe supports shall be as recommended by the fabricator, but shall not be greater than 5 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.
- D. Ladder: Provide an external ladder mounted to tank exterior to access manway opening. Ladder to not extend above top of tank.

- E. 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.
- F. Anchor Bolts: Type 316, stainless steel bolts, sized by fabricator and at least 3/4-inch diameter, or as shown and as specified in Section 05 50 00, Metal Fabrications.

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 ASTM D1998.
 - 2. Gel Tests: A representative sample from each tank provided shall undergo a factory gel test, as prescribed by ASTM D1998.
 - 3. Hydrostatic Leak Tests:
 - a. Perform on each tank.
 - b. Fill to overflow nozzle; allow to stand for 24 hours with no visible leakage.
 - 4. 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.
 - 5. 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 manufacturer or as otherwise recommended by manufacturer and as specified in Section 05 50 00, Metal Fabrications.
- 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. Uniform and level surface contact shall be made between all tank bottoms and the support foundations by means of grouting. Tanks shall be set in wet grout tapered from a point 1 inch higher at tank center to the foundation edges. Initially, grouting shall be finished to leave no voids. Tanks shall be settled down squeezing out excess grout in such a manner as to leave no voids in the tank bottom/foundation interface. The grout shall not be used to support any load, only to fill irregularities in the tank bottoms and foundations. The in-place tanks shall not be exposed to any loads until the grout has hardened.
- F. 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 Job Site and 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 installation.
- 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 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are part of this Specification.

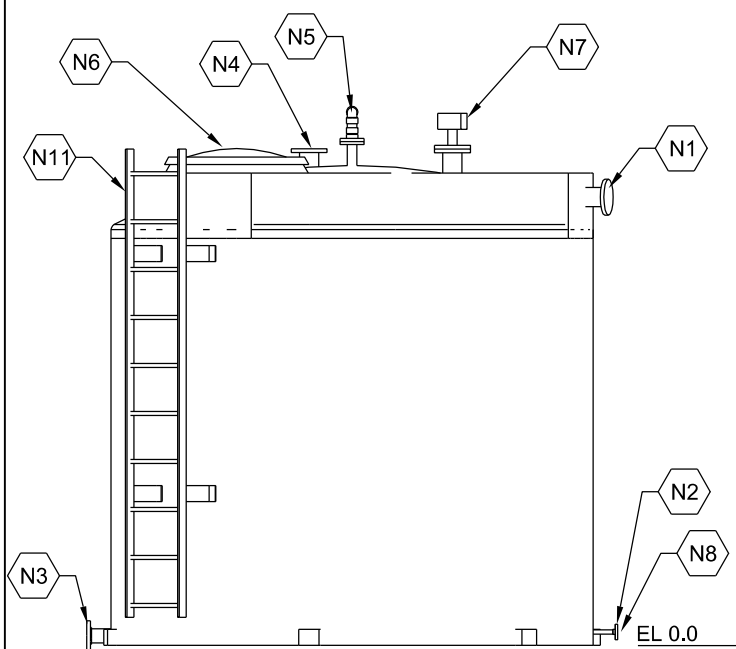
1. Tank Data Sheet: Polymer Storage Tank No. 1.
2. Tank Data Sheet: Polymer Storage Tank No. 2.

END OF SECTION

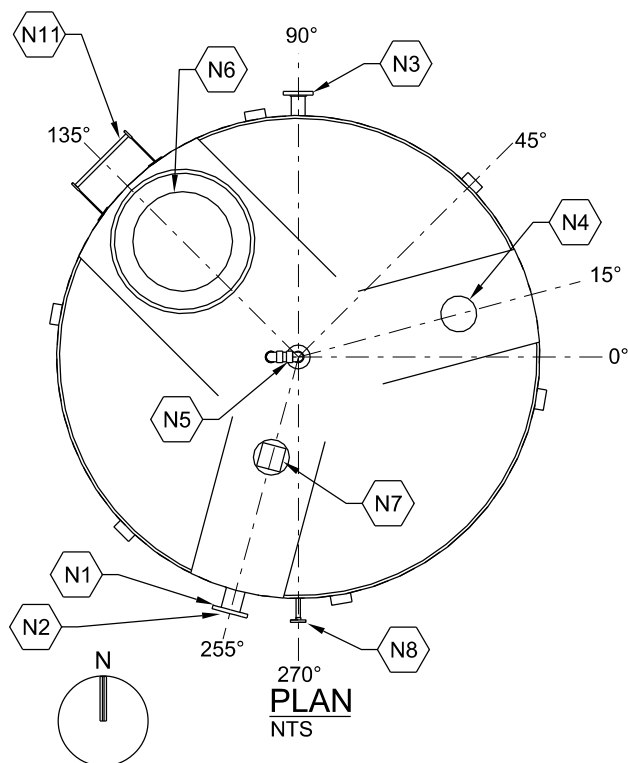
TANK NAME:	POLYMER STORAGE TANK No. 1		
TAG NUMBER(S):	20-T-50-1		
SERVICE:	NEAT EMULSION POLYMER		
QUANTITY:	1	SPECIFIC GRAVITY:	1.05 (USE 1.9 FOR STRUCTURAL DESIGN)
pH RANGE:	5-8	TEMP. RANGE (°F):	50° - 90°F
DIAMETER:	10'-2 1/2"	STRAIGHT SHELL HEIGHT:	10'-0"
CAPACITY:	4,400 GALLONS (MIN.)	STRAIGH SKIRT HEIGHT:	N/A

NOTES:

- HORIZONTAL NOZZLE ELEVATION FROM DATUM TO CENTERLINE OF FITTING.
- TANK MANUFACTURER TO PROVIDE INTERNAL AND EXTERNAL SUPPORTS TOTAL, ONE FOR EACH PIPE.
- TANK ANCHOR LUGS AND ANCHOR BOLT DESIGN BY MANUFACTURER, DESING TO MEET STRUCTURAL DESIGN REQUIREMENTS PER CONTRACT DRAWING 01-G-006.
- TANK MANUFACTURER TO PROVIDE EXTERNA AND INTERNAL ACCESS LADDERS AS SHOWN ON DRAWINGS.



ELEVATION
NTS



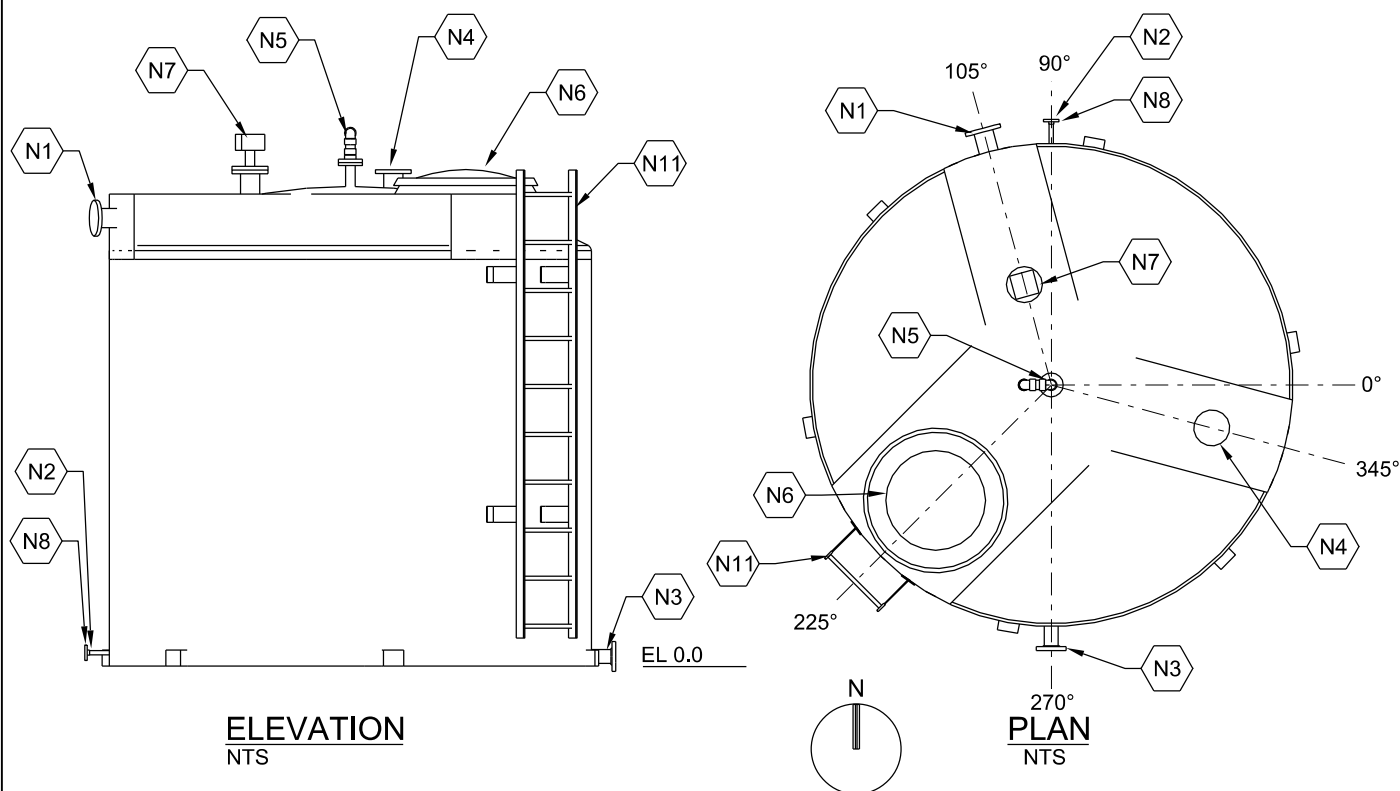
PLAN
NTS

NOZZLES	MARK	QTY	SIZE	ELEV (NOTE 1)	CL RADIUS	APPROX. BEARING ANGLE (<A) (SEE NOTE 3)	DESIGN DATA
OVERFLOW	N1	1	3"	9'-4"	N/A	255°	TANK LOCATION: INDOORS TYPE OF BOTTOM: FLAT LADDER REQUIRED: YES PIPE SUPPORTS FOR INTERIOR PIPING: YES PIPE SUPPORTS FOR EXTERIOR PIPING: YES GRADUATED STANDPIPE: NO INSULATION: NO HANDRAILS: NO TIE DOWN SYSTEM: YES - CLIPS FOR INDOOR INSTALLATION LATERAL RESTRAINT: YES N/A = NOT APPLICABLE
DRAIN	N2	1	3"	0'-2"	N/A	255°	
OUTLET	N3	1	3"	0'-2"	N/A	90°	
FILL	N4	1	3"	TOP	3'-5"	15°	
VENT	N5	1	4"	TOP	0	0°	
MANWAY ACCESS	N6	1	24"	TOP	3'-5"	135°	
LEVEL ELEMENT	N7	1	4"	TOP	2'-3"	255°	
RECIRC OUTLET	N8	1	2"	0'-2"	N/A	270°	
ANCHOR BOLT	N9	4 MIN	-	N/A	N/A	N/A	
LIFTING LUGS	N10	4 MIN	-	N/A	N/A	N/A	
LADDER	N11	1	N/A	N/A	N/A	135°	

TANK NAME:	POLYMER STORAGE TANK No. 2		
TAG NUMBER(S):	20-T-50-2		
SERVICE:	NEAT EMULSION POLYMER		
QUANTITY:	1	SPECIFIC GRAVITY:	1.05 (USE 1.9 FOR STRUCTURAL DESIGN)
pH RANGE:	5-8	TEMP. RANGE (°F):	50° - 90°F
DIAMETER:	10'-2 1/2"	STRAIGHT SHELL HEIGHT:	10'-0"
CAPACITY:	4,400 GALLONS (MIN.)	STRAIGHT SKIRT HEIGHT:	N/A

NOTES:

- HORIZONTAL NOZZLE ELEVATION FROM DATUM TO CENTERLINE OF FITTING.
- TANK MANUFACTURER TO PROVIDE INTERNAL AND EXTERNAL SUPPORTS TOTAL, ONE FOR EACH PIPE.
- TANK ANCHOR LUGS AND ANCHOR BOLT DESIGN BY MANUFACTURER, DESING TO MEET STRUCTURAL DESIGN REQUIREMENTS PER CONTRACT DRAWING 01-G-006.
- TANK MANUFACTURER TO PROVIDE EXTERNA AND INTERNAL ACCESS LADDERS AS SHOWN ON DRAWINGS.



NOZZLES	MARK	QTY	SIZE	ELEV (NOTE 1)	CL RADIUS	APPROX. BEARING ANGLE (<A) (SEE NOTE 3)	DESIGN DATA
OVERFLOW	N1	1	3"	9'-4"	N/A	255°	TANK LOCATION: INDOORS TYPE OF BOTTOM: FLAT LADDER REQUIRED: YES PIPE SUPPORTS FOR INTERIOR PIPING: YES PIPE SUPPORTS FOR EXTERIOR PIPING: YES GRADUATED STANDPIPE: NO INSULATION: NO HANDRAILS: NO TIE DOWN SYSTEM: YES - CLIPS FOR INDOOR INSTALLATION LATERAL RESTRAINT: YES N/A = NOT APPLICABLE
DRAIN	N2	1	3"	0'-2"	N/A	255°	
OUTLET	N3	1	3"	0'-2"	N/A	90°	
FILL	N4	1	3"	TOP	3'-5"	15°	
VENT	N5	1	4"	TOP	0	0°	
MANWAY ACCESS	N6	1	24"	TOP	3'-5"	135°	
LEVEL ELEMENT	N7	1	4"	TOP	2'-3"	255°	
RECIRC OUTLET	N8	1	2"	0'-2"	N/A	270°	
ANCHOR BOLT	N9	4 MIN	-	N/A	N/A	N/A	
LIFTING LUGS	N10	4 MIN	-	N/A	N/A	N/A	
LADDER	N11	1	N/A	N/A	N/A	135°	

SECTION 43 40 05
ABOVE GRADE DOUBLE-WALLED FUEL STORAGE TANK SYSTEM

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the Work necessary to furnish, install, and test, complete a 4,000 gallon above grade, double-walled fuel storage tank system as well as all appurtenant and accessory items specified herein or shown on the Contract Drawings. The storage tank system is to supply fuel to a nearby diesel engine generator.

1.02 GENERAL

- A. See General Conditions and Division 1, General Requirements, which contain information and requirements that apply to the Work specified herein and are mandatory for this Project.

1.03 EQUIPMENT TAG NUMBERS

- A. 60-T-10-1: Bulk Diesel Fuel Storage Tank.
- B. 60-LE/LIT-10-1: Level Element/Transmitter.
- C. 60-LG-10-1: Mechanical Fuel Level Gauge.
- D. 60-XE/XSH/LAHH-10-1: Interstitial Leak Detection Element/Switch.

1.04 GENERAL DESIGN REQUIREMENTS

- A. All-welded steel tank, rectangular in configuration, atmospheric pressure rated, double contained with concrete protective enclosure, for abovegrade installation as shown. Entire unit factory-fabricated. Provide tank supports that can be anchored to a concrete foundation.
- B. Design tank, including, wall thickness, methods and locations of support/bracing, and stiffener requirements per Underwriter's Laboratory (UL) requirements. Structural design shall be prepared and sealed by registered professional engineer licensed in the State of Alabama.

- C. Tank shall be a UL 2085 listed and labeled (i.e., "Special Purpose") double-walled, concrete vaulted, rectangular system consisting of an interior (primary) liquid holding vessel with an exterior (secondary) containment vessel.
- D. System is to include an integral leak detection system with sensor probe designed to detect and annunciate leaks in the interstitial space between the outer and inner walls of the storage tank.
- E. Tank shall have a 30-year warranty that includes concrete vaulting materials as well as the primary and secondary tanks.
- F. All electrical panels and items associated with the fuel storage tank shall be in compliance with UL 508A.

1.05 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01 33 00, Submittal Procedures. In addition, the following specific information shall be provided:
- B. Action Submittals:
 - 1. Drawings showing dimensions, openings, connections, and construction details of the tank. Tank design data submitted shall include, but shall not be limited to:
 - a. Tank size, overall dimensions, and capacity.
 - b. Steel thickness of inner and outer vessels.
 - c. Location and details of nozzle placement and tank connection construction.
 - d. Construction details of tanks plainly identifying materials of construction by ASTM number.
 - e. Description of quality assurance program to be utilized.
 - f. Complete detailed description of coating materials, surface preparation, etc.
 - g. Complete detailed description of all appurtenant/accessory items (e.g. fill station/spill containment cabinet, valves, fittings, tank accessories, leak detection probes, level measurement devices, instrumentation, etc.) including catalog cuts, dimensional drawings, technical specifications, wiring and circuit diagrams, and related information identifying materials of construction, dimensions, etc.
 - h. Installation details in accordance with the manufacturer's recommendations and instructions.

- i. Operation and Maintenance Manuals.
- j. Description of instrumentation and controls, including catalog cuts, wiring diagrams, and interconnecting diagrams.
- k. Anchorage and bracing drawings and cutsheets as specified in Section 01 88 15, Anchorage and Bracing.

C. Informational Submittals:

- 1. Structural design calculations as specified herein.
- 2. Manufacturer's Statement of Conformance to UL 142 and 2085.
- 3. Manufacturer's Certificate of Pressure Testing with results.
- 4. Manufacturer's Certificate of Proper Installation.
- 5. Manufacturer's list of proposed spares, expendables, and test equipment.
- 6. Manufacturer's 30-year warranty for primary and secondary tank system.
- 7. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data, including routine maintenance requirements prior to startup.
- 8. Anchorage and bracing calculations as specified in Section 01 88 15, Anchorage and Bracing.

1.06 STANDARDS, SPECIFICATIONS, AND CODES

A. Tanks and equipment shall be designed, fabricated, tested, inspected, and delivered in accordance with the latest issue of the following Standards:

- 1. Underwriter's Laboratories Standard 508A (UL 508A), 2085 (UL 2085), and 142 (UL 142).
- 2. National Fire Protection Association (NFPA) Standard No. 30 and 30A.
- 3. Petroleum Equipment Institute (PET) Recommended practice (RP) 200-96 "Recommended practices for Installation of Aboveground Liquid Storage Systems."
- 4. Occupational Safety and Health Act (OSHA) Standards for Safety.
- 5. Environmental Protection Agency, Code of Federal Regulations 40 CFR Parts 280 and 281.
- 6. National Electrical Manufacturers Association (NEMA) Section 3R.
- 7. American Petroleum Institute (API) Standard 650.

1.07 QUALIFICATIONS

- A. The tank manufacturer shall be experienced in the design and construction of abovegrade double-walled fuel storage steel tanks, such as the one specified in this section and shall have furnished such similar sized tanks for installations that have been in successful operation for a minimum of 10 years.
- B. All tanks installed under this Specification shall be UL listed and labeled by the manufacturer and for the intended product. Tanks and all related accessory items shall also be EPA and State of Alabama listed and approved.

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. Other manufacturers' equipment will be considered in accordance with the General Conditions of the Contract Documents.

2.02 STORAGE TANK MANUFACTURERS/PRODUCTS

- A. Convault; Model "Above Ground Tank System."
- B. Or Engineer approved equal.

2.03 TANK CONSTRUCTION

- A. General: Tanks shall be in conformance with the following:
 - 1. Underwriter's Laboratories Standard 142 (UL142) and 2085 (UL 2085).
 - 2. NFPA 30, 37, and 110.
- B. Construction:
 - 1. Comply with UL 2085 for protected tanks, minimum 2-hour fire rating, vehicle impact resistant and ballistic projectile resistant with secondary containment. Provide label of conformance.
 - 2. Inner tank ASTM A36 steel, constructed in conformance with UL 142. Provide label of conformance. Cover entire inner tank with 0.25-inch thick Styrofoam.

3. Secondary Containment Vessel: Cover entire outer steel tank and Styrofoam with 0.030-inch thick high density polyethylene sealed membrane.
 4. Concrete Enclosure:
 - a. Shall consist of 6 inches of 4,000 psi minimum concrete.
 - b. Shall be structurally designed to support the filled tank and a top live load of 100 lbs/sq ft.
 - c. Monolithic pour with no cold joints, heat sinks.
 - d. Construct in accordance with ACI standards including concrete placement, vibration, and quality assurance.
 - e. Top of secondary tank shall be sloped to shed rainwater.
 - f. Test for leaks as specified hereinafter in this section. Furnish certificate that inner and outer vessels have been tested and are leak-free and pressure-tight.
- C. Primary Tank: The primary tank walls and bottoms shall be manufactured of minimum 3/16-inch thick carbon steel plates conforming to ASTM A36. Continuous welds shall be used on all sides, inside as well as outside conforming to the American Welding Society Standards.
- D. Secondary Containment with Leak Detection Access:
1. The tank system shall include adequate interstitial space to allow for monitoring of leaks from the primary vessel.
 2. Leak detection access tubes shall be located within the space between the inner tank and the outer vessel. In the event of a leak, a positive space shall be available to permit leaked fluid to flow to the monitoring point.
 3. The secondary containment system outer vessel shall be pressure testable, as specified herein.
- E. Tank Nozzles:
1. Materials of Construction: Black carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B seamless or ERW.
 2. Nozzle Thickness: Nozzles 24 inches and smaller shall be Schedule 40.
 3. Joints: Butt-welded at connections to tank shell. Nozzles 3/4 through 3 inches to be NPT threaded. (Tank supplier is to provide half coupling, bushings, and other pipe fittings necessary to connect to tank piping and all related accessory items.) Nozzle sizes 4 through 24 inches shall be flanged style as specified hereinafter.
 4. Nozzle dimensions for instruments shall be coordinated with the instrument manufacturer's dimensional drawings to assure proper installation and access of all devices to the tank interior.

5. Nozzle Flanges: Forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 weld neck style, flat face; weld neck bore to match pipe internal diameter.
6. Bolting: Type 304 stainless steel, ASTM A193/A193M, BM8.
7. Gaskets for Flanges: 1/8-inch thick, BUNA-N gaskets.
8. Tilt of nozzle flange face shall not exceed plus or minus 1/2 degree from the specified plane. Projection shall be from face of tank shell to face of pipe flange.

F. Miscellaneous Tank Piping:

1. Miscellaneous piping associated with storage tank such as FOS suction tubes, normal vent risers, etc. shall be carbon steel as specified in Section 40 27 00, Process Piping-General and Section 40 27 00.03, Carbon Steel Pipe and Fittings-General Service:
2. Provide the nozzles and tank accessory items on the tank as identified in the following schedule. Note: In some cases accessory items in this schedule are only defined by Tag Numbers, Valve Numbers, or equipment identification numbers for brevity. Detailed specifications for equipment items are provided in subsequent parts of this Specification.

ABOVEGROUND TANK SCHEDULE				
Nozzle Size (Inches)	Number of Nozzles	Nozzle Designation	Nozzle Location	Remarks
4	2	Fuel Oil Supply (FOS)	Primary Tank	FOS nozzles to include the below listed items. Equipment includes: 1. 2-inch by 1-1/2-inch double tap bushing and coupling. 2. 1-1/2-inch carbon steel suction tube. 3. Type V-953 double poppet foot valves for the FOS suction tube bottom.
4	2	Fuel Oil Return (FOR)	Primary Tank	1. 2-inch by 1-1/2-inch double tap bushing and coupling for FOR nozzle. 2. 1-1/2-inch carbon steel drop tube terminating 2 inches above tank invert.

ABOVEGROUND TANK SCHEDULE				
Nozzle Size (Inches)	Number of Nozzles	Nozzle Designation	Nozzle Location	Remarks
4	1	Leak Detection Probe (Tag No: 60-XE/XSH-10-1)	Interstitial Space between Primary and Secondary Containment	Leak detection probe for monitoring of interstitial tank space shall include: 1. Leak Detection Probe shall be Veeder-Root Co. Interstitial Sensor Model 794390-420 with 312020-928 adapter kit, or equal. 2. Suspend level probe by cable within a 4-inch drop tube terminating 1-inch above tank invert.
6	1	Mechanical Direct Reading Fuel Level Gauge (Tag No: 60-LG-10-1)	Primary Tank	Components for mechanically monitoring tank level shall include: 1. Mechanical level indicator as specified in this section.
2	2	Primary and Secondary (Normal) Vents	Primary Tank and Interstitial Space	Normal vents to be pressure-vacuum type vent valve, Morrison Bros.; 2-inch Figure 5483 or equal. Normal tank venting system shall conform to fire codes and requirements of UL 142 and NFPA 30 Standards.
6	1	Emergency Vent	Primary Tank	Emergency vent to be Morrison Bros.; 6-inch Figure 244 or equal. Note: Emergency tank venting system shall conform to fire codes and requirements of UL 142 and NFPA 30 Standards.
4	1	Level Element/ Level Transmitter Mount (Tag No: 60-LE/LIT-10-1)	Primary Tank	Extended height nozzle configured with following components for monitoring tank level: 1. 4-inch blind flange NPT tapped for mounting of level element/transmitter. 2. Tank gauging element/transmitter shall be GEMS Model XM/XT-800 with explosion proof housing. Transmitter to generate a 4-20 mA analog signal for continuous monitoring of tank level.

ABOVEGROUND TANK SCHEDULE				
Nozzle Size (Inches)	Number of Nozzles	Nozzle Designation	Nozzle Location	Remarks
6	1	Emergency Vent	Interstitial Space (Secondary Tank)	Emergency vent to be Morrison Bros.; 6-inch Figure 244, or equal. Note: Emergency tank venting system shall conform to fire codes and requirements of UL 142 and NFPA 30 Standards.
24	1	Access Manway	Primary Tank	Mount gasketed bolt down 24-inch blind flange on nozzle.
4	1	Fuel Supply line connection from Fill Station	Primary Tank	Fuel supply line originates at the Fill Station/Spill Containment Cabinet. Cabinet as specified in this section. Fuel supply line terminates at the fill line connection (top of tank) and includes the following: 1. 2-inch Type V-964 Overfill Prevention valve with features as specified in section 40 27 02, Process Valves and Operators. 2. 2-inch Schedule 40 powder coated carbon steel pipe and fittings. 3. 4-inch by 3-inch threaded, powder coated, carbon steel adapter bushing. 4. 2-inch fill tube and OPW "Tite Fill" Connection Adapter. 5. 2-inch drop tube.
4	2	Spare Nozzles	Primary Tank	

2.04 TAB DESIGN CRITERIA/PERFORMANCE REQUIREMENTS

A. General Service Conditions:

1. Operating Pressure: Atmospheric.
2. Liquid Stored: Standard Diesel Fuel No. 2 Fuel Oil. percent.
3. Liquid Specific Gravity: 0.876 to 0.88 at 68 degrees F.
4. Min. and Max. Site Ambient Temperature: 3 to 105 degrees F.

- B. Tank shall be double wall construction with the containment tank providing 110 percent of the primary tank's maximum liquid volume. The primary tank shall be sized and constructed so as to provide a minimum of 4,000 gallons of useable fuel storage capacity.
- C. Manway, nozzle locations, and overall general layout of piping and other tank accessories shall be as shown on the Contract Drawings and the Tank Data Sheet Supplement drawing attached as a Supplement at the end of this section.

2.05 ADDITIONAL DESIGN REQUIREMENTS

- A. 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 Tank Data Sheet supplement provided at the end of this section.
- B. Tank manufacturer's structural design calculations shall include design of tie down and anchor bolt system to comply with Building Code requirements applicable to the specific Project site. Requirements are identified on the Structural Legend sheet of the Contract Drawings and Section 01 61 00, Common Product Requirements.
- C. Tank access manway shall be manufacturer's standard vapor-tight flanged manway.

2.06 FILL STATION/SPILL CONTAINMENT CABINET

- A. Provide a grade level fill station/spill containment cabinet with integral support as specified herein and shown on the Contract Drawings.
- B. The fill station cabinet shall include the following fittings and features:
 - 1. Type 304 stainless steel weatherproof, lockable box with continuous style hinged door and stainless steel hardware.
 - 2. Main 3-inch FOS supply line with manual Type V-420 isolation valve, angle check valve, wye strainer, and lockable quick connect fitting.
 - 3. External stainless steel ground stud for attachment of delivery truck ground cable.
 - 4. 3-inch quick disconnect coupling for attachment of delivery hose.
 - 5. Inlet spill containment consisting of 16 gallon minimum spill containment volume with hand pump for returning spilled fuel to main supply line. Hand pump discharge line includes a check valve and a ball valve between the pump and main supply line.
- C. Manufacturer/Products:
 - 1. Phoenix Products; "Diesel Director" Fill Port.
 - 2. Or Engineer approved equal.

2.07 APPURTENANCES

- A. Provide the following tank accessory items as part of the fuel system associated with the bulk storage tank:
 - 1. Primary and emergency vents conform to fire codes and requirements UL142 and NFPA 30 Standards.
 - 2. Grounding lugs.
 - 3. Valves as shown on the Drawings and specified herein.
 - 4. Instrumentation including fuel system leak detection sensors, switches, and related items as specified in this section.
- B. Supports:
 - 1. Pipe and Conduit Supports:
 - a. Provide supports for all tank fuel supply, return, and loading pipes, etc. as well as for all electrical conduits serving electrical/instrumentation on top of the storage tank.
 - b. Spacing of supports shall be as recommended by the fabricator, but shall not be greater than 4 feet on center.
 - c. Shall allow removal of the pipe.
 - d. Hot-dipped galvanized steel construction in accordance with ASTM A123 and Section 05 50 00, Metal Fabrications. Support hot-dip galvanized post fabrication.
- C. Free standing, hot dip galvanized carbon steel, end access rung style ladder in accordance with ASTM A123 and Section 05 50 00, Metal Fabrications.
- D. Lifting Lugs: Provide suitably attached lugs for lifting tank on installation.
- E. Anchor Bolts: Type 316, stainless steel bolts, sized by tank manufacturer and (1/2-inch minimum in diameter), based upon manufacturer's engineering calculations, and as specified in Section 05 50 00, Metal Fabrications.
- F. Provide suitably sized Type 304 stainless steel tiedowns for securing tank to concrete pad. Number and location of tiedowns shall be as specified by the tank manufacturer based upon manufacturer's engineering calculations.

2.08 DIRECT MECHANICAL READING FUEL GAUGE (60-LG-10-1)

- A. Direct reading, float type tank gauge for vertical mounting on abovegrade storage tank nozzle. Orient gauge face towards fill connection point.
- B. One inch numerical display on angles face with swivel adapter base.
- C. Materials of construction compatible with Diesel Fuel No. 2.
- D. Manufacturer/Products:
 - 1. OPW; 200TG-ENG.
 - 2. Or Engineer approved equal.

2.09 FACTORY COATINGS

- A. Exterior concrete surfaces of the tank are to be prepared, primed, and finish coated per the requirements of System No. 28 in Specification 09 90 00, Paintings and Coating.
- B. Tank nozzles, couplings, lifting lugs, etc. to be coated with System No. 29 in accordance with Section 09 90 00, Painting and Coating.

2.10 VALVES

- A. Fuel tank system manufacturer/supplier to furnish valves identified on the Contract Drawings for the above grade storage tank system for contractor installation. Valves (e.g., isolation, foot, etc.) are specified by “V” number designation and include the following styles/types:
 - 1. Type V-420, non-lubricated plug valves.
 - 2. Type V-953, foot style check valves.
 - 3. Type V-964, overfill prevention valves.
- B. Refer to Section 40 27 02, Process Valves and Operators for specific requirements of these valves and their installation.

2.11 ACCESSORIES

- A. Identification Plate: Identify each tank with the manufacturer’s name, manufacturer’s location, and capacity in gallons, manufacturer’s model number, and date of manufacture.
- B. UL Label: Include UL File Number, UL Product Classification, and UL Product Serial Number.

C. Manways:

1. Provide flanged access manways with dimensions and at locations indicated on the Drawings.
2. The manways shall be furnished with necessary gaskets and bolts.

D. Tank Connections: All pipe extensions from the top of the primary tank and extending through the secondary tank shall be carbon steel as specified in Section 40 27 00, Process Piping-General and Section 40 27 00.03, Carbon Steel Pipe and Fittings-General Service.

E. Grounding lugs per requirements of NFPA 70.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All components of a storage tank system shall be installed in accordance with the manufacturer's instructions.
- B. All storage tank systems shall be installed according to the applicable provisions of NFPA 30, 30A, and PEI/RP200-96.
- C. A certified Contractor shall perform the installation of storage tank systems containing pollutants, including tanks, integral piping overflow protection, and spill containment equipment.
- D. A tightness test shall be performed on the tank and integral piping before any storage tank system is placed into service.

3.02 FIELD TESTING

- A. Prior to final installation, the tank shall be visually inspected for impact damage, which may have occurred during shipping, unloading, or storage. The primary tank shall then be tested for leaks by pressurizing at a minimum 5 psig gauge pressure for a minimum period of 24 hours. After the primary tank has been successfully tested, the secondary tank shall be tested for leaks by pressurizing at a minimum pressure of 1-1/2 psig and a maximum pressure of 3 psig. During testing of the secondary tank, a minimum pressure of 3 psig shall be maintained on the primary tank. While under pressure, a soap solution shall be applied to all piping connections to aid in the detection of leaks. If any drop in pressure or leaks are detected, the leaks shall be repaired in accordance with the manufacturer's written recommendations. The tank shall be repaired and retested until no leaks are detected. All testing shall be performed in strict accordance with the manufacturer's written procedures. The Contractor, assisted by the manufacturer's representative, shall perform the field

testing. Note: A vacuum test per the manufacturer's written procedures may be performed in lieu of pressure testing. The Contractor shall provide 2 weeks advance written notice of the test date so that the Owner may witness the testing.

- B. Prior to startup, all installed equipment shall be inspected for proper installation and connection by means of a functional test. Such tests shall include a leakage test with the tank full of clean fuel oil to verify that no liquid will leak from the installed tank. If any leaks are detected, the leaks shall be repaired in accordance with the manufacturer's written recommendations. The tank shall be repaired and retested until no leaks are detected. All testing shall be performed in accordance with the manufacturer's written procedures. The Contractor, assisted by the manufacturer's representative, shall perform the functional testing. Contractor to supply all fuel oil for testing.

3.03 FIELD QUALITY CONTROL

- A. Functional Test:
 - 1. Conduct on each tank.
 - 2. Leak test as specified hereinbefore.

3.04 MANUFACTURERS' SERVICES

- A. Manufacturers' services shall be provided in accordance with Section 01 43 33, Manufacturers Field Services. 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 person-day for installation assistance.
 - 2. 1/2 person-day for inspection, functional testing, certification of the installation, and training.
 - 3. 1 person-day for performance testing.

3.05 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is part of this Specification.
 - 1. Tank Data Sheet: Bulk Fuel Storage Tank, 60-T-10-1.

END OF SECTION

TANK NAME: ABOVE GRADE DIESEL FUEL STORAGE TANK - DOUBLE WALLED

TAG NUMBER(S): 60-T-10-1

QUANTITY: 1

SERVICE: PETROLEUM MID-DISTILLATE FUEL OIL NO. 2

SPECIFIC GRAVITY: .88 (H2O = 1) @ 68 °F

pH RANGE: NA

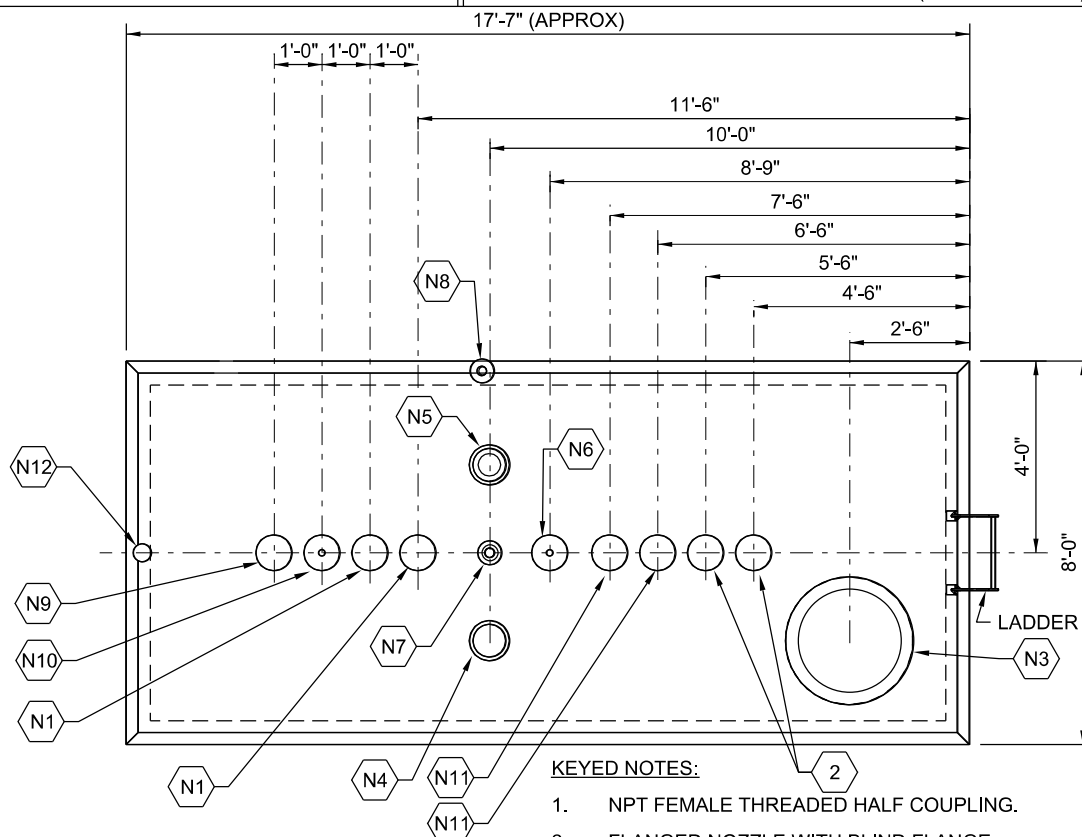
SITE AMBIENT TEMP. RANGE MIN 20°F, MAX 105°F

WIDTH: (EXTERNAL) 8'-0"

HEIGHT: (EXTERNAL) 6'-5" (APPROX)

CAPACITY: 4,000 GALLONS NOMINAL

LENGTH: 17'-7" (APPROXIMATE)



ITEM	MARK	QTY	SIZE	CL ELEV	NOTES	DESIGN DATA
FUEL OIL RETURN (FOR)	N1	2	4"	TOP	3	TANK LOCATION: OUTDOORS, UNCOVERED
FUEL OIL SUPPLY (FOS)	N2	2	4"	TOP	3	TYPE OF TANK: RECTANGULAR
ACCESS MANWAY	N3	1	24"	TOP	2	TANK: HORIZONTAL, RECTANGULAR
PRIMARY EMERGENCY VENT	N4	1	6"	TOP	3	LADDER REQUIRED: YES
SECONDARY EMERGENCY VENT	N5	1	6"	TOP	3	PIPE SUPPORTS FOR INTERIOR PIPING: YES
LEVEL ELEMENT/XMTR.	N6	1	4"	TOP	3	PIPE SUPPORTS FOR EXTERIOR PIPING / INSTRUMENTATION CONDUITS: YES
PRIMARY NORMAL VENT	N7	1	2"	TOP	3	HANDRAILS: NO
SECONDARY NORMAL VENT	N8	1	2"	TOP	3	
FILL STATION SUPPLY CONN.	N9	1	4"	TOP	3	
MECHANICAL LEVEL INDICATOR	N10	1	6"	TOP	3	
SPARE NOZZLES	N11	2	4"	TOP	3	
LEAK DET. SENSOR CONN.	N12	1	4"	TOP	3	
N/A = NOT APPLICABLE						

SECTION 44 42 56.03
PACKAGE WATER BOOSTER SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. American Bearing Manufacturers Association (ABMA):
2. ASTM International (ASTM):
3. Hydraulic Institute Standards (HIS):
4. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
5. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
6. Occupational Safety and Health Administration (OSHA).

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Make, model, weight, and horsepower of each equipment assembly.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions.
 - a. Seismic analysis for discharge head, equipment support and anchors, and column pipe bowl assembly.
4. Detailed structural, mechanical, and electrical drawings showing equipment dimensions, size, and locations of connections and weights of components.

5. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, parts nomenclature, and materials of construction lists.
6. Power and control wiring diagrams, including terminals and numbers.
7. Complete motor nameplate data, as defined by NEMA, motor manufacturer, including motor modifications.
8. Factory finish system.
9. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that factory finish system is identical to requirements specified herein.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Factory Functional and Performance Test Reports and Log. Factory test data for each pump shall be submitted, reviewed, and approved by Engineer prior to shipment of equipment.
6. Suggested spare parts list to maintain equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Manufacturer's Warranty.
9. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
10. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 EXTRA MATERIALS

A. Furnish for this set of pumps:

1. Complete set gaskets and O-ring seals.
2. Complete mechanical seal.
3. Complete set bearings.
4. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

- A. Water booster system with stainless steel vertical multi-stage pumps.
- B. Provide a skid-mounted duplex pump station system complete with pumps, piping, piping accessories, and other appurtenances as required.
- C. The packaged pump system shall be a standard product of a single pump manufacturer. The entire pump system including pumps and pump logic controller, shall be designed, built, and tested by the same manufacturer.
- D. Booster system to be designed to supply dilution water to the polymer blending units across a varying flow range of 30 to 160 gpm.
- E. Booster system to be designed to maintain a constant target downstream water system pressure of 80 psi with varying suction side supply water pressure between 30 and 65 psi. The pump speed shall ramp up and down to maintain the downstream system pressure set point. As the downstream water system pressure increases, the pump speed shall ramp down until the pump shuts down.
- F. The target downstream pressure shall be an operator adjustable parameter in the package control panel.
- G. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20 percent higher than the head at the best efficiency point.
- H. Integrated Adjustable Speed Drives:
 - 1. Furnish coordinated operating system complete with pump, driver, and speed controller.
 - 2. Tags: 20-AFD-53-1, 20-AFD-53-2.
 - 3. Coordinate pump and motor requirements with adjustable speed drive manufacturer and be responsible for the following:
 - a. Torsional vibration of rotating assembly and related stresses.
 - b. Motor thermal rating.
 - c. Structural design of pump and motor assembly.
 - d. Drive capacity for actual motor's nameplate current rating being supplied.

- e. Minimum motor speed rating for required corresponding torque.
- f. Drive type (i.e. variable torque or constant torque) required shall be coordinated by the manufacturer.
- g. Each of the AFDs provided shall include a minimum of a 5 percent input line reactor to aid in mitigating the harmonics that are propagated upstream to the remainder of the electrical distribution system.
- h. The booster system shall be supplied and installed to include a vertical free-standing diaphragm tank, 150 psi working pressure, coated steel construction, heavy duty butyl diaphragm, SST pipe connections. Tank volume shall be as determined by the system supplier to maintain system pressure with not more than six (6) pump starts per hour.

2.02 SUPPLEMENTS

- A. Some specific requirements are attached to this section as supplements.

2.03 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
- B. Lifting Lugs: Equipment weighing over 100 pounds.
- C. OSHA-approved coupling guard for direct coupled pumps.
- D. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

2.04 INSTRUMENTATION AND CONTROLS

- A. Instrumentation, monitoring, and controls included shall interface with the plant SCADA system or AFD, via hardwired signals, as specified and shown on the drawings.
- B. See Section 40 99 90, Package Control Systems, for general instrumentation and control requirements. Instrumentation, control, and electrical components provided under this section shall comply with requirements of Section 40 90 90, Package Control Systems.

C. Control Panel:

1. Tag: 20-VCP-53-1.
2. Material: Type 316 stainless steel, NEMA 4X.
3. Operator Controls and Indicators: Provide the following panel mounted operator and controls and indicating displays:
 - a. Hand/Off/Auto Hand Switch.
 - b. Run Pilot Light.
 - c. Fault Alarm Light.
 - d. Pump Speed Indicator.
 - e. Pump Potentiometer for speed control.
4. External Interfaces:
 - a. Pump Run status, total of two.
 - b. Pump Fault alarm, total of two.
 - c. Pump Station Discharge Pressure, 4 to 20 mA signal.
5. The control panel shall include an appropriately sized, filtered, side panel-mounted air conditioner unit. Air conditioning unit shall be in accordance with and as specified under Section 40 99 90, Package Control Systems. A circuit breaker shall be included within the control panel that uses the incoming 460V, three-phase power to the panel 20-VCP-53-1 as the source of power for energizing the associated air conditioner.
6. The control panel shall include a main circuit breaker rated at 65,000A that is operable from the front face of the control panel.
7. The control panel shall include a surge protection device (SPD) that is located immediately downstream of the main circuit breaker for the control panel.
8. The control panel shall meet all of the requirements outlined in Section 40 99 90, Package Control Systems.

D. Instruments:

1. Inlet and Discharge Pressure Controller:
 - a. Tags: 20PIK-53-1 (Inlet); 20PIK-53-2 (Discharge).
 - b. Range: 0-150 psi
 - c. SPDT relays rated 5 amps, minimum 120V ac.
 - d. NEMA 4X with Type 316 stainless steel wetted metallic parts and 4-digit backlit LCD display.
 - e. Manual or Automatic switch reset with adjustable set points of 0 – 100 percent. External LED switch indication for each relay on the front panel.
 - f. 4 to 20 mA output signal
 - g. Manufacturer: Dwyer EDA Mercoïd Electronic Pressure Controller, or approved equal.

2.05 FACTORY FINISHING

- A. Prepare and prime, and finish coat in accordance with Manufacturer's standard enamel finish.

2.06 SOURCE QUALITY CONTROL

- A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
- B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.
- C. Factory Test Report: Include test data sheets, curve test results, performance test logs, certified correct by a registered professional engineer.
- D. Functional Test: Perform manufacturer's standard, motor test on equipment.
- E. Performance Test:
 - 1. Conduct on each pump at rated speed.
 - 2. Perform under simulated operating conditions.
 - 3. Test for a continuous 3-hour period without malfunction.
 - 4. Test Log: Record the following:
 - a. Total head.
 - b. Capacity.
 - c. Horsepower requirements.
 - d. Flow measured by factory instrumentation.
 - e. Average suction pressure.
 - f. Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
 - g. Calculated velocity head at the discharge flange.
 - h. Driving motor voltage and amperage measured for each phase.
 - 5. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.
- F. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.
- G. Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.

- B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of baseplate when anchor bolts are tightened.
- C. Adjust pump assemblies such that driving units are properly aligned, plumb, and level with driven units and interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
- D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of baseplate and concrete foundation with a poured, nonshrinking grout of the proper category, as specified in Section 03 62 00, Nonshrink Grouting. Remove wedges after grout is set and pack void with grout.
- E. Connect suction and discharge piping without imposing strain to pump flanges.
- F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING

- A. As specified in Section 09 90 00, Painting and Coating.

3.03 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

3.04 FIELD QUALITY CONTROL

- A. Functional Tests: Conduct on each pump.
 - 1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
 - 2. Flow Output: Measured by plant instrumentation and storage volumes.
 - 3. Test Report Requirements: In accordance with HIS 14.6.
- B. Performance Tests: Conduct on pumps.
 - 1. Conduct on each pump and with all pumps in operation.
 - 2. Perform under simulated operating conditions.
 - 3. Test for continuous 3-hour period without malfunction.

3.05 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
 - 1. 1 person-day for installation assistance and inspection.
 - 2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - 3. 1 person-day for facility startup.
 - 4. 1 person-day for post-startup training of Owner's personnel.
- B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.06 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is a part of this Specification.
 - 1. Pump Data Sheet.

END OF SECTION

VERTICAL TURBINE PUMP DATA SHEET, 44 42 56.03-_____

Tag Numbers: 20-P-53-1 and 20-P-53-2

Pump Name: Polymer Water Booster Pumps No. 1, 2

Manufacturers and Product: (1) Grundfos
(2) Goulds
(3) Ebara
(4) WILO-Co-Helix with the model to be determined to meet the contract requirements

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Water

Pumping Temperature (Fahrenheit): Normal 70 Max 80 Min 50

Specific Gravity at 60 Degrees F: 1 Viscosity Range: _____

pH: 6.5 – 8.0

Abrasive (Y/N): N Caused by: _____

Possible Scale Buildup (Y/N): N Caused by: _____

Corrosive (Y/N): N Caused by: _____

Min. NPSH Available (Ft. Absolute): 79

Suction Pressure (Ft): Max 150 Min 69

Altitude (Feet above Mean Sea Level): Min 16

Area Classification: Unclassified

Ambient Temperature (degrees F.): 50 - 100

Location: Indoor (Y/N): Y Outdoor (Y/N): N

PERFORMANCE REQUIREMENTS

Combined Total Pump Station (Rated):

Capacity (US gpm): 2-pumps Rated: 160 Total Dynamic Head (Ft): Rated: 116

Single Pump:

Primary (100% Speed) Capacity: 120 gpm TDH (Ft): 87

Secondary (Reduced Speed) Capacity: 30 gpm TDH (Ft): 45

BHP at Rated Point: 3.3 Secondary: 1

Min. Pump Hydraulic Efficiency at Rated Capacity (%): 71

Max. NPSH Required at Rated Capacity (Ft. Absolute): 5.1

Max. Pump Speed at Rated Capacity (rpm): 3484

Constant (Y/N): N

Adjustable (Y/N): Y

DESIGN AND MATERIALS

ANSI (Y/N) _____ Standard (Y/N) _____ Design: Frame-mounted (Y/N) _____
Close-Coupled Casing (Y/N) _____ Back Pullout (Y/N) _____

Discharge Orientation: Horizontal _____ Rotation (view from end coupling): _____

Casing Materials: Stainless Steel _____

Case Wear Ring (Y/N): Y _____ Material: _____

Impeller: Type: multi-stage _____ Material: Stainless Steel _____

Impeller Wear Ring (Y/N): Y _____ Material: Stainless Steel _____

Shaft Material: Stainless Steel _____ Shaft Sleeve Material: Stainless Steel _____

Shaft Seal: Stainless Steel _____ Packing (Y/N) N _____ Material: _____

Mechanical (Y/N) Y _____ Type: _____

Lubrication: _____

ABMA L-10 Bearing Life (Hrs): 100,000 Lubrication: _____

Coupling: _____ Falk (Y/N) _____ Fast (Y/N) _____
 Spring-Grid (Y/N) _____ Manufacturer Standard (Y/N) Y

Gear Type (Y/N) _____ Spacer (Y/N) _____ Manufacturer _____
 Standard (Y/N) Y _____

Baseplate: Design: Manufacturer Standard _____ Material: Painted Steel _____

Drive Type: Direct-Coupled: X _____ Belt: _____ Adjustable Speed: X _____

Other: _____

Adjustable Speed Drive Range: 50% min to 100% max, See
 Section 26 29 23, Low Voltage Adjustable Frequency Drive System.

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 5 _____ Voltage: 460 _____ Phase: 3 _____

Synchronous Speed (rpm): 3600 _____

Service Factor: 1.0 _____

Motor nameplate horsepower shall not be exceeded at any head-capacity point on
 pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X _____
 CISC-TEFC _____ TEWAC _____ WPI _____ WPII _____

Mounting Type: Vertical Hollow Shaft _____ Nonreverse Ratchet (Y/N) _____
 Vertical Solid Shaft _____

ABMA 9 and ABMA 11, B-10 Motor Bearing Life (hrs): 100,000 _____

REMARKS The motors shall be inverter duty rated. _____

**SECTION 44 42 56.04
SUBMERSIBLE PUMPS**

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. American Bearing Manufacturers Association (ABMA):
 - a. 9, Load Ratings and Fatigue Life for Ball Bearings.
 - b. 11, Load Rating and Fatigue Life for Roller Bearings.
 2. American Society of Mechanical Engineers (ASME): B16.1, Gray Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 150.
 3. ASTM International (ASTM):
 - a. A48, Standard Specification for Gray Iron Castings.
 - b. A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
 4. Hydraulic Institute Standards (HIS):
 - a. 11.6, Submersible Pump Test.
 - b. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
 5. National Electrical Manufacturers Association (NEMA).
 6. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code.
 - b. 497, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.
 7. Underwriters Laboratories Inc. (UL).

1.02 DEFINITIONS

- A. Terminology pertaining to pumping unit performance and construction shall conform to ratings and nomenclature of Hydraulic Institute Standards.

1.03 SUBMITTALS

- A. Action Submittals:
1. Make, model, weight, and horsepower of each equipment assembly.
 2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction, including cable seal details.

3. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.
4. For variable speed motors, provide variable speed curves for every 50 rpm over the operational range.
5. Power and control wiring diagrams, including terminals and numbers.
6. Motor data, in accordance with the requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
7. Adjustable frequency drive data, in accordance with the requirements of Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
8. Factory-finish system.
9. L-10 bearing life calculations per ABMA.
10. If required, wiring for motor protection module.
11. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer's printed installation instructions.
4. Factory and Field Performance Test Reports.
5. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that factory finish system meets requirements specified herein.
6. Suggested spare parts list to maintain equipment in service for period of 1 year and 5 years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
9. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 EXTRA MATERIALS

- A. Furnish for this set of pumps: One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

- A. Submersible, vertical shaft, centrifugal nonclog type, for pumping wastewater.
- B. Designed for continuous operation under submerged or partially submerged conditions, and intermittent operation when totally dry without damage to pump or motor.
- C. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.
- D. Pump and Electrical Driver: Meet requirements for class, group, and division location in accordance with NFPA 70.
- E. Pumps furnished under this section to be provided by a single manufacturer.
- F. Pumps and appurtenances are to be supplied in accordance with MAWSS Standard Specifications.

2.02 ADJUSTABLE FREQUENCY DRIVES:

- A. Provide AFDs in accordance with the requirements of Section 26 29 23, Low Voltage Adjustable Frequency Drive System and as shown on the Drawings.
- B. Tags: 20-AFD-70-1 and 20-AFD-70-2.

2.03 SUPPLEMENTS

- A. Specific requirements are attached to this section as supplements.

2.04 COMPONENTS

- A. Equipment consists of pump complete with motor, control system, guide rail, anchoring brackets, base elbow, power cable, and pump lifting cable.
- B. Characteristics:
 - 1. Motor and rotating parts shall be removable from motor end of pump.
 - 2. Mating surfaces to be watertight and fitted with nitrile O-rings.
 - 3. Pumps fitted with dynamically balanced non-clog impellers designed to pass coarse solids and stringy materials.

C. Lifting Arrangement:

1. Stainless steel chain, 2 feet minimum, and one “grip-eye.”
2. Attach chain permanently to pump and access platform with stainless steel wire rope.
3. “Grip-eye” capable of being threaded over and engaging links of stainless steel chain so pump and motor may be lifted with “grip-eye” and independent hoist.

D. Sliding Guide Bracket:

1. Integral part of pump unit.
2. Pump unit to be guided by no less than two guide bars, or equivalent cable system, and pressed tightly against discharge connection elbow with metal-to-metal contact or through use of profile-type gasket, provided gasket is attached to pump’s flange and can be easily accessed for inspection when pump is lifted out of wetwell.
3. Pump metal parts that come into contact with guide rail or cable system shall be made of nonsparking materials.

E. Motor nameplate horsepower not to be exceeded at head-capacity point on pump curve.

F. Pump motor and sensor cables shall be suitable for submersible pump application and cable sizing shall conform to NFPA 70 specifications for pump motors. Cables shall be of sufficient length to reach junction boxes without strain or splicing.

G. Motor Protection Module:

1. Provide pump with a motor protection module for remote mounting. Each pump module shall be installed inside its respective AFD.
2. Provide dry contacts for High Temperature and Leak/Moisture Alarms for connection to the plant control system.
3. Tags:
 - a. Pump protection module: 20XR-70-1 and 20XR-70-2.
4. Contract Drawings are based on first named submersible pump manufacturer and motor protection module. If pump and motor protection module other than first named manufacturer is provided, provide revised wiring for the motor protection module.

2.05 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in readily visible location.
- B. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.
- C. Sidewalk Door: Size as shown on Drawing or if not shown, sized by equipment manufacturer. As specified in Section 05 50 00, Metal Fabrications, with the following additional requirements:
 - 1. Gasketed and odor tight.
 - 2. Channel drain is not required.

2.06 FACTORY FINISHING

- A. Prepare, and prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

2.07 SOURCE QUALITY CONTROL

- A. Pump:
 - 1. Factory Performance Test:
 - a. In accordance with HIS 11.6, Level A for submersible pump tests.
 - b. Include curve test results.
 - 2. Conduct on each pump.
 - 3. Perform under actual or approved simulated operating conditions.
 - a. Throttle discharge valve to obtain pump data points on curve at 2/3, 1/3, and shutoff conditions.
- B. Submersible Motor Functional Test: In accordance with HIS 11.6.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Mount the discharge elbow to the floor of the wetwell floor with stainless steel bolts.

- C. Connect piping without imposing strain to flanges.
- D. No portion of pump shall bear directly on floor of sump.

3.02 FIELD FINISHING

- A. Equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

- A. Functional Test: Conduct on each pump.
 - 1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
 - 2. Flow Output: Measured by plant instrumentation and storage volumes.
 - 3. Test for continuous 1-hour period.
 - 4. Test Report Requirements: In accordance with Hydraulic Institute Standards for submersible pump tests HIS 14.6 and 11.6.
- B. Pump Test:
 - 1. General:
 - a. Conduct on each pump provided.
 - b. Conduct in accordance with HIS 11.6.
 - 2. Routine Production Tests:
 - a. Check impeller, motor rating and electrical connections for compliance to specification.
 - b. Test motor and cable insulation for moisture content and insulation defects.
 - c. Prior to submergence, run pump dry to establish correct rotation and mechanical integrity.
 - d. Conduct abbreviated three-point operational performance test.
 - e. After operational performance test, perform insulation test again.

3.04 WARRANTY

- A. The manufacturer shall furnish a written warranty for the equipment specified in this section. The warranty shall be for a minimum period of five (5) years from start up. Warranty shall cover all defects or failures of materials or workmanship which occur as a result of normal operation and service except for normal wear parts.

3.05 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
 - 1. 1 person-day for installation assistance and inspection.
 - 2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - 3. 1 person-day for facility startup.
- B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.06 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are part of this Specification.
 - 1. Data Sheets: Pump and Motor.

END OF SECTION

SUBMERSIBLE PUMP DATA SHEET, 44 42 56.04-_____

Tag Numbers: 20-P-70-1; 20-P-70-2

Pump Name: Plant Drain Pump Station Pumps No. 1 and 2

Manufacturer and Model Number: (1) Flygt N3171-434

(2) Wilo EMU FA15.97Z

(3) KSB K150-317

(4) Substitutions: Per MAWSS Standard Spec

SERVICE CONDITIONS

Liquid Pumped (Material and Percent Solids): BFP Filtrate and Raw Sewage

Pumping Temperature (Fahrenheit): Normal: 70 Max 90 Min 50

Specific Gravity at 60 Degrees F: 1 Viscosity Range: 1.05

pH: 6 – 8 typical

Abrasive (Y/N) Y Possible Scale Buildup (Y/N): N

Total Suspended Solids: 2 – 4 % solids

Min. NPSH Available (Ft. Absolute): 35

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 1,800 Secondary: 1,200

Total Dynamic Head (Ft): Rated: 50 Secondary: 43

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 76

Max. Pump Speed at Rated Capacity (rpm): Constant (Y/N): 1760; N
Adjustable (Y/N): Y

DESIGN AND MATERIALS

Pump Type: Heavy-Duty Nonclog (Y/N) Y Other: ____

Volute Material: Cast Iron ASTM A48

Pump Casing Material: Cast Iron ASTM A48

Motor Housing Material: Cast Iron ASTM A48

Wear Rings Case (Y/N):Y Material: _____

Hard Iron (ASTM A-532 (Alloy 111A) 25% chrome cast iron

Wear Ring Impeller (Y/N): N Material: _____

SUBMERSIBLE PUMP DATA SHEET, 44 42 56.04- _____

Tag Numbers: 20-P-70-1 and 20-P-70-2

Pump Name: Plant Drain Pump No. 1 and No. 2

Elastomers: Nitrile Rubber

Fasteners: Stainless Steel

Impeller: Type: Double-Shrouded Non-Clog (Y/N): Other:
Material: Hard Iron (ASTM A-532 (Alloy 111A) 25% chrome cast iron) or
ASTM A-532 II C

Shaft Material: Stainless steel AISI 431 or 420

Base Elbow: Cast Iron ASTM A48

Double Mechanical Seal (Y/N): Y Bearing Life (Hrs): 100,000

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 35 Voltage: 460 Phase: 3 Synchronous Speed (rpm): 1800

Enclosure: Submersible- EXP

CLASSIFICATION: Class 1, Group D, Division 1

Adjustable Speed Drive Range: 50% min to 100% max, See Section 26 29 23,
Low Voltage Adjustable Frequency Drive System.

Other Features:

Moisture Detection Switches (Y/N): Y

Thermal Protection Embedded in Windings (Y/N): Y

REMARKS: Motors shall be inverter duty rated and suitable for installation within a
Class 1, Div 1 area.

SECTION 44 42 56.10
HORIZONTAL END SUCTION CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Bearing Manufacturers' Association (ABMA).
 2. Hydraulic Institute Standards.
 3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
 4. Occupational Safety and Health Administration (OSHA).

1.02 DEFINITIONS

- A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings:
 - a. Make, model, weight, and horsepower of each equipment assembly.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.
 - d. Detailed structural, mechanical, and electrical drawings showing equipment dimensions, size, and locations of connections and weights of associated equipment.
 - e. Power and control wiring diagrams, including terminals and numbers.
 - f. Complete motor nameplate data, as defined by NEMA, motor manufacturer.
 - g. Factory finish system data sheets.
 - h. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Factory Functional Test Reports.
3. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that factory finish system is identical to the requirements specified herein.
4. Special shipping, storage and protection, and handling instructions.
5. Manufacturer's printed installation instructions.
6. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
9. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 EXTRA MATERIALS

A. Furnish for each pump:

1. Complete set gaskets and O-ring seals.
2. Impeller wear ring.
3. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

- A. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.
- B. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 SUPPLEMENTS

- A. Some specific requirements are attached to this section as supplements.

2.03 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
- B. Lifting Lugs: Equipment weighing over 100 pounds.
- C. OSHA-approved coupling guard for direct coupled or belt driven pumps.
- D. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.04 FACTORY FINISHING

- A. Prepare, and prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

2.05 SOURCE QUALITY CONTROL

- A. Factory Tests and Adjustments: Test equipment and control panels actually furnished.
- B. Factory Test Report: Include test data sheets, curve test results, certified correct by a registered professional engineer.
- C. Functional Test: Perform manufacturer's standard, test on equipment.
- D. Performance Test:
 - 1. In accordance with Hydraulic Institute Standards.
 - 2. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.
- E. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.
- F. Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.

- B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of baseplate when anchor bolts are tightened.
- C. Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
- D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, nonshrinking grout of the proper category, as specified in Section 03 62 00, Grouting. Remove wedges after grout is set and pack void with grout.
- E. Connect suction and discharge piping without imposing strain to pump flanges.
- F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING

- A. Finish equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

- A. Functional Tests: Conduct on each pump.
 - 1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
 - 2. Flow Output: Contractor and or Manufacturer to provide means to measure flow output.
- B. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.
- C. Performance Test:
 - 1. Conduct on each pump.
 - 2. Perform under simulated operating conditions.
 - 3. Test for a continuous 3-hour period without malfunction.
 - 4. Test Log: Record the following:
 - a. Horsepower requirements.
 - b. Flow measured.
 - c. Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.

3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative:
 - 1. Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
 - a. 1 person-day for installation assistance and inspection.
 - b. 1 person-day for performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - c. 1/2 person-day for facility startup.
 - d. 1/2 person-day for post-startup training of Owner's personnel.
- B. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

3.06 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is a part of this Specification.
 - 1. Horizontal End Suction Centrifugal Pump Data Sheet.

END OF SECTION

HORIZONTAL END SUCTION CENTRIFUGAL PUMP DATA SHEET

Tag Numbers: 50-P-14-1

Pump Name: Chlorine Algae Control Booster Pump

Manufacturer and Model Number: (1) Goulds 2MC1H5A0

(2) Patterson Pump*

(3) Scott Pump*

(4) Crane (Weinman 100-200 Series)

*model to be determined to meet the contract requirements

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Potable water

Pumping Temperature (Fahrenheit): Normal: 70 Max 80 Min 50

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: _____

pH: 6.5 – 8.5

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Min. NPSH Available (Ft. Absolute): 100

Suction Pressure (Ft): Rated 150

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT

Capacity (US gpm): Rated: 85

Total Dynamic Head (Ft): Rated: 85

Min. Hydraulic Efficiency (%): 58

Maximum Shutoff Pressure (Ft): 113

Max. Pump Speed at Design Point (rpm): 3,500

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS

ANSI (Y/N) _____ Standard (Y/N) _____ Design: Frame-mounted (Y/N) Y
Close-Coupled Casing (Y/N) Y Back Pullout (Y/N) _____

Discharge Orientation: Top Rotation (view from end coupling): Clockwise

Casing Materials: Cast Iron

Case Wear Ring (Y/N) Y Material: Buna

Impeller: Type: Enclosed Material: AISI 316L

Impeller Wear Ring (Y/N): N Material: _____

Shaft Material: Stainless Steel Shaft Sleeve Material: _____

Shaft Seal: _____ Packing (Y/N) _____ Material: _____

Mechanical (Y/N) Y Type: Carbon/ceramic

Lubrication: _____

ABMA L-10 Bearing Life (Hrs): 50,000 Lubrication: _____

Coupling: _____ Falk (Y/N) _____ Fast (Y/N) _____

Spring-Grid (Y/N) _____

Gear Type (Y/N) _____ Spacer (Y/N) _____ Manufacturer _____

Standard (Y/N) _____

Baseplate: Design: Manufacturer standard Material: _____

Drive Type: Closed-Coupled: X Belt _____ Adjustable Speed _____

Other: _____

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 3 Voltage: 460 Phase: 3 Synchronous Speed (rpm): _____

Service Factor: 1.15 Inverter Duty (Y/N) _____

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____ TENV _____
WPI _____ WPII _____ SUBM _____

Mounting Type: Horizontal X Nonreverse Ratchet (Y/N) _____

REMARKS _____

SECTION 44 42 56.12
INDUCED FLOW (RECESSED IMPELLER)
CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Bearing Manufacturers Association (ABMA).
2. Hydraulic Standards Institute (HSI).
3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Make, model, weight, and horsepower of each equipment assembly.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.
 - d. Pump maximum downthrust or upthrust in pounds.
 - e. Detailed structural, mechanical, and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.
 - f. Power and control wiring diagrams, including terminals and numbers.
 - g. Motor information as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
 - h. Factory finish system.
 - i. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that factory finish system is identical to the requirements specified herein.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Factory Functional and Performance Test Reports.
6. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
9. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 EXTRA MATERIALS

A. Furnish for this set of pumps:

1. 1 Complete set upper and lower mechanical seal.
2. 1 Complete set bearings.
3. 1 Complete set gaskets and O-ring seals.
4. 1 Impeller wear ring.
5. Primary wear elements; including casing wear plates, removable suction wear plate, rear casing wear plate, radial wear element, as applicable for pump type.
6. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

- A. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.
- B. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 SUPPLEMENTS

- A. Specific requirements are attached to this section as supplements.

2.03 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
- B. Lifting Lugs: Equipment weighing over 100 pounds.
- C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and in accordance with requirements of Section 01 88 15, Anchorage and Bracing 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

2.04 FACTORY FINISHING

- A. Prepare, and prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

2.05 SOURCE QUALITY CONTROL

- A. Factory Tests and Adjustments: Test all equipment actually furnished.
- B. Factory Test Report: Include test data sheets, curve test results, certified correct by a registered professional engineer.
- C. Functional Test: Perform manufacturer's standard, motor test on equipment Include vibration test.
- D. Performance Test:
 - 1. Conduct on each pump.
 - 2. Perform under simulated operating conditions.
 - 3. Conduct in accordance with Hydraulic Institute Standards.
 - 4. Test for a continuous 3-hour period without malfunction.
 - 5. Test Log: Record the following:
 - a. Total head.
 - b. Capacity.
 - c. Horsepower requirements.
 - d. Flow measured by factory instrumentation and storage volumes.
 - e. Average distance from suction well water surface to pump discharge centerline for duration of test.

- f. Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
 - g. Field head.
 - h. Driving motor voltage and amperage measured for each phase.
 - 6. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.
- E. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for the pump and driver base. Accomplish wedging so that there is no change of level or springing of the baseplate when the anchor bolts are tightened.
- C. Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
- D. After the pump and driver have been set in position, aligned, and shimmed to the proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, nonshrinking grout of the proper category, as specified in Section 03 62 00, Nonshrink Grouting. Remove wedges after grout is set and pack void with grout.
- E. Connect suction and discharge piping without imposing strain to pump flanges.
- F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.
- G. Pipe pump drain(s) to floor drain below associated belt press.

3.02 FIELD FINISHING

- A. Equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

- A. Functional Tests: Conduct on each pump.
 - 1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
 - 2. Flow Output: Measured by plant instrumentation and storage volumes.

3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
 - 1. 1 person-day for installation assistance and inspection.
 - 2. 1 person-day for functional testing and completion of Manufacturer's Certificate of Proper Installation.
 - 3. 1 person-day for facility startup.
 - 4. 1 person-day for post-startup training of Owner's personnel.
- B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

3.06 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are a part of this Specification.
 - 1. Pump Data Sheets.

END OF SECTION

**INDUCED FLOW RECESSED IMPELLER CENTRIFUGAL PUMP DATA SHEET,
44 42 56.12-01**

Tag Numbers: 20-P-20-X (X = 1A, 2A, 3A, and 4A)

Pump Name: Sludge Feed Pumps

Manufacturer and Model Number: (1) KSB, Sewabloc F-80-253G2H

(2) No Substitutions

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Anaerobically Digested Sludge

Pumping Temperature (Fahrenheit): Normal: 85 Max 100 Min 70

Specific Gravity at 60 Degrees F: 1.05

Viscosity Range: _____

pH: 5 - 8

Corrosive (Y/N) N

Nature of Corrosive Conditions: _____

Abrasive (Y/N) Y

Nature of Abrasive Conditions: _____

Possible Scale Buildup (Y/N): N

Total suspended solids (mg/L): 2% - 4% solids

Largest diameter solid pump can pass (inches): 3"

Min. NPSH Available (Ft. Absolute): 30'

Altitude (Feet above Mean Sea Level): 16'

Area Classification: Unclassified

Ambient Temperature (degrees F.): 50 - 100

Location: Indoor (Y/N): Indoor Y Outdoor (Y/N): N

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 300 Secondary (reduced speed): 150
Total Dynamic Head (Ft): Rated: 76' Secondary (reduced speed): 42'
BHP at Rated Point: 10.9 Secondary: 4
Maximum Shutoff Pressure (Ft): 101
Min. Pump Hydraulic Efficiency at Rated Capacity (%): 53
Max. NPSH Required at Rated Capacity (Ft. Absolute): 21
Max. Pump Speed at Rated Capacity (rpm): 1776
Constant (Y/N): N
Adjustable (Y/N): Y

DESIGN AND MATERIALS

Pump Type: Horizontal (Y/N) Y – Closed Coupled_ Frame-Mounted (Y/N) _____
Vertical (Y/N) _____ Other _____
Fully-Recessed Impeller Type: Vortex Material: Hi-Chrome White Iron (G2)
Suction Flange Diameter (in): 4 Discharge Flange Diameter (in): 4
Casing Material: Cast Iron A48 Cast-on Feet (Y/N): _____
Shaft Material: Chrome Steel A276 Shaft Sleeve Material: _____
Shaft Seal: Packing (Y/N) _____ Mechanical (Y/N) Y Type: Double Seal
Seal Water (Y/N) N Seal Lubrication: oil reserve _____
ABMA B-10 Bearing Life (hrs): 100,000 Lubrication: _____

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 20 Voltage: 460 Phase: 3 Synchronous Speed (rpm) 1776

Service Factor: 1.15 Inverter Duty: Y

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____

Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

REMARKS _____

**INDUCED FLOW RECESSED IMPELLER CENTRIFUGAL PUMP DATA SHEET,
44 42 56.12-02**

Tag Numbers: 85-P-11-1 and 85-P-11-2

Pump Name: Digested Sludge Pumps

Manufacturer and Model Number: (1) Aurora 663A 4x4x12

(2) No Substitutions

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Anaerobically Digested Sludge

Pumping Temperature (Fahrenheit): Normal: 85 Max 100 Min 70

Specific Gravity at 60 Degrees F: 1.05 Viscosity Range: _____

pH: 5 - 8

Corrosive (Y/N) N Nature of Corrosive Conditions: _____

Abrasive (Y/N) Y Nature of Abrasive Conditions: _____

Possible Scale Buildup (Y/N): N

Total suspended solids (mg/L): 2% - 4% solids

Largest diameter solid pump can pass (inches): 2.4"

Min. NPSH Available (Ft. Absolute): 27'

Altitude (Feet above Mean Sea Level): 7.5'

Area Classification: Unclassified

Ambient Temperature (degrees F.): 50 - 100

Location: Indoor (Y/N): Indoor Y Outdoor (Y/N): N

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 900 Secondary (reduced speed): 300
Total Dynamic Head (Ft): Rated: 55' Secondary (reduced speed): 19'
BHP at Rated Point: 22 Secondary: 4
Maximum Shutoff Pressure (Ft): 65
Min. Pump Hydraulic Efficiency at Rated Capacity (%): 54
Max. NPSH Required at Rated Capacity (Ft. Absolute): 15
Max. Pump Speed at Rated Capacity (rpm): 1175
Constant (Y/N): N
Adjustable (Y/N): Y

DESIGN AND MATERIALS

Pump Type: Horizontal (Y/N) Y – Closed Coupled_ Frame-Mounted (Y/N) _____
Vertical (Y/N) _____ Other _____
Fully-Recessed Impeller Type: Vortex Material: Cast Iron ASTM A48
Suction Flange Diameter (in): 4 Discharge Flange Diameter (in): 4
Casing Material: Cast Iron A48 Cast-on Feet (Y/N): _____
Shaft Material: Steel SAE 1045 Shaft Sleeve Material: SS ASTM A276
Shaft Seal: Packing (Y/N) _____ Mechanical (Y/N) Y Type: Double
Seal Water (Y/N) Y Seal Lubrication: _____
ABMA B-10 Bearing Life (hrs): 100,000 Lubrication: _____

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 30 Voltage: 460 Phase: 3 Synchronous Speed (rpm) 1175

Service Factor: 1.15 Inverter Duty: Y

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____
TENV _____ WPI _____ WPPI _____ SUBM _____

Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

REMARKS

Motor shall be inverter duty rated. Motor shall include thermostat and 120V space heater.

SECTION 44 42 56.13
PROGRESSING CAVITY PUMPS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Bearing Manufacturers' Association (ABMA).
2. Hydraulic Institute Standards (HIS).
3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Make, model, weight, and horsepower of each equipment assembly.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.
 - d. Detailed structural, mechanical, and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.
 - e. Power and control wiring diagrams, including terminals and numbers.
 - f. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
 - g. Factory finish system.
 - h. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that factory finish system is identical to the requirements specified herein.
3. Factory Functional and Performance Test Reports.
4. Special shipping, storage and protection, and handling instructions.
5. Manufacturer's printed installation instructions.
6. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
9. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 EXTRA MATERIALS

A. Furnish for this set of pumps:

1. Complete set packing.
2. Complete set of bearings.
3. Complete set gaskets and O-ring seals.
4. Complete set rod washers.
5. Complete set keys, dowels, pins, etc.
6. 2 stators.
7. 1 rotors.
8. 1 connecting rods with 1 or 1 pair of universal joint(s), as required by pump type.
9. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

- A. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.
- B. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 SUPPLEMENTS

- A. Some specific requirements are attached to this section as supplements.

2.03 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
- B. Lifting Lugs: Equipment weighing over 100 pounds.
- C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.04 FACTORY FINISHING

- A. Prepare, and prime, and finish coat in accordance with Section 09 90 00, Painting and Coating. Manufacturer's standard enamel finish.

2.05 SOURCE QUALITY CONTROL

- A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
- B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.
- C. Factory Test Report: Include test data sheets, curve test results, certified correct by a registered professional engineer.
- D. Functional Test: Perform manufacturer's standard test on equipment.
- E. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.
- F. Performance Test:
 - 1. Conduct on each pump.
 - 2. Conduct in accordance with Hydraulic Institute Standards.
 - 3. Perform under simulated operating conditions.
 - 4. Test for a continuous 3-hour period without malfunction.
 - 5. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of the baseplate when anchor bolts are tightened.
- C. Adjust pump assemblies such that driving units are properly aligned, plumb, and level with driven units and interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
- D. After pump and driver have been set in position, aligned, and shimmed to the proper elevation, grout space between bottom of baseplate and concrete foundation with a poured, nonshrinking grout of the proper category, as specified in Section 03 62 00, Nonshrink Grouting. Remove wedges after grout is set and pack void with grout.
- E. Connect suction and discharge piping without imposing strain to pump flanges.
- F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.
- G. Pipe pump drain(s) to drain pipe.

3.02 FIELD FINISHING

- A. Equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

- A. Functional Tests: Conduct on each pump.
 - 1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
 - 2. Flow Output: Measured by instrumentation provided by Contractor and storage volumes.
 - 3. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.
- B. Performance Test: In accordance with Hydraulic Institute Standards.

3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
 - 1. 1 person-day for installation assistance and inspection.
 - 2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - 3. 1/2 person-day for facility startup.
 - 4. 1/2 person-day for post-startup training of Owner's personnel.
- B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

3.06 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is a part of this Specification.
 - 1. Pump Data Sheet.

END OF SECTION

PROGRESSING CAVITY PUMP DATA SHEET, 44 42 56.13-__Tag Numbers: 20-P-51-1 and 20-P-51-2Pump Name: Polymer Mixing Pumps (1 and 2)

Manufacturer and Model Number: (1) Moyno; EZ-Strip Z34AC11RMA/E
 (2) Seepex
 (3) Netzsch with the model to be
 determined to meet the contract requirements _____

SERVICE CONDITIONSLiquid Pumped (Material and Percent): Neat emulsion polymerPumping Temperature (Fahrenheit): Normal: 70 Max: 80 Min: 50Specific Gravity at 60 Degrees F: 0.98 – 1.18 Viscosity Range: 500 – 2,000 cpAbrasive (Y/N): N Possible Scale Buildup (Y/N): YInlet Pressure at Pump (psig): 0 to 5Min. Net Positive Inlet Pressure Available (psia): 14**PERFORMANCE REQUIREMENTS**Rated Capacity: 22 US gpm at 7 psi differential pressure.Max. Pump Speed (rpm): 380 Constant (Y/N): Y Adjustable (Y/N): N**DESIGN AND MATERIALS**Pump Body Material: Cast Iron Drive Housing Material: Cast IronPump Stages: 1

Connections:

Suction: Flanged: X Flange Type: _____ Open-Throat: _____ Screwed: _____Discharge: Flanged: X Flange Type: _____ Screwed: _____Seal Type: Mechanical Seal (single)Stator Material: Nitrile Stator Thermal Protection (Y/N): NRotor Material: Alloy Steel Chrome Plated

Joints: Gear Type Universal (Y/N): _____ Pin Type Universal (Y/N): _____ Other: _____

PROGRESSING CAVITY PUMP DATA SHEET, 44 42 56.13-__

Tag Numbers: 20-P-51-1 and 20-P-51-2

Mechanical (Y/N): Y Type: Single

Lubrication: _____

ABMA B-10 Bearing Life (hrs): 100,000 Lubrication: _____

Coupling: Falk (Y/N): _____ Fast (Y/N): _____
Gear Type (Y/N): _____ Manufacturer Standard (Y/N): Y

Baseplate: Design: _____ Material: Painted Carbon Steel

Drive Type: Direct-Coupled: _____ Belt: _____ Hydrostatic Adjustable Speed: _____
Close Coupled Gear Reducer: _____ Other: Split

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 5 Voltage: 460 Phase: 3

Synchronous Speed (rpm): 1200

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP ___ EXP ___ ODP ___ TEFC X CISD-TEFC ___ TENV ___
WPI ___ WPII ___ SUBM ___

Drive Arrangement: In-Line: X Vertical "Z": _____ Piggy Back: _____
Horizontal Offset: _____ C-Face Mounted: _____

Nonreverse Ratchet (Y/N) : _____

REMARKS: _____

**SECTION 44 42 56.16
PERISTALTIC HOSE PUMP**

PART 1 GENERAL

1.01 REFERENCES

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

1. American Bearing Manufacturers Association (ABMA).
2. American Gear Manufacturers Association (AGMA).
3. American National Standards Institute (ANSI).
4. ASTM International (ASTM): A48/A48M, Standard Specification for Gray Iron Castings.
5. Hydraulic Institute Standards.
6. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction conforms to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - b. Detailed mechanical and electrical drawings showing equipment dimensions, size, and locations of connections and weights of associated equipment.
 - c. Make, model, weight, and horsepower of each equipment assembly.
 - d. Performance data curves showing head, capacity, and horsepower demand over entire operating range of pump, from shutoff to maximum capacity. Indicate head, capacity, and horsepower demand required at guarantee point.
 - e. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
 - f. Control panel elevation drawings showing construction and placement of operator interface devices and other elements.
 - g. Power and control wiring diagrams, including terminals and numbers.

- h. Listing of extra materials supplied for this section.
- i. Factory finish system.
- j. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

- 1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, signed by an authorized representative of manufacturer that equipment and factory-applied coating system(s) meet requirements specified herein.
- 2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
- 3. Factory test reports.
- 4. Special shipping, storage and protection, and handling instructions.
- 5. Manufacturer's printed installation instructions.
- 6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup, and for future maintenance.
- 7. Suggested spare parts list to maintain equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
- 8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
- 9. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts:

Item	Quantity
Gasket Kit	One complete set per pump
Hoses	One per pump
Hose Lubricant Refill	One per pump

PART 2 PRODUCTS

2.01 GENERAL

- A. Coordinate pump requirements with motor manufacturer and be responsible for pumps and motors.
- B. Where adjustable speed drives are required, furnish and be responsible for a coordinated operating system complete with pump, motor, and adjustable speed drive.
- C. Design Requirements: In accordance with Section 01 61 00, Common Product Requirements.

2.02 SUPPLEMENTS

- A. Specific product requirements are attached to this section as supplements.

2.03 ACCESSORIES

- A. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.
- B. Equipment Identification Plates: Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location with 3/8-inch high engraved block type black enamel filled equipment identification number indicated in this Specification and as shown.
- C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.
- D. Leak Detection Switch:
 - 1. Locate near top of pump to detect leakage of pumped product into pump housing.
 - 2. Mount sensor on rear of pump housing.
 - 3. Supply sensor Normally Closed with ability for field adjustment to Normally Open.
 - 4. Float Switch Rating: Vmax equals 240V ac, Imax equals 1 amp, Pmax equals 50VA.
- E. Controls: In accordance with general control requirements and component qualities specified in Section 40 99 90, Package Control Systems.

2.04 FACTORY FINISHING

- A. Prepare, and prime and finish coat in accordance with Section 09 90 00, Painting and Coating.

2.05 SOURCE QUALITY CONTROL

- A. Factory Tests:
 - 1. Pumps: Assemble, check, and shim all pumps for the specific application prior to shipment.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Adjust pump assemblies such that driving units are properly aligned, plumb, and level with driven units and interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
- C. Connect suction and discharge piping without imposing strain to pump flanges.
- D. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING

- A. As specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

- A. Perform preoperational checks in accordance with manufacturer's printed instructions.
- B. Functional Tests:
 - 1. Conduct on Each Pump: Test complete assemblies for correct rotation, proper connections, and normal operational characteristics.
- C. Performance Tests:
 - 1. Conduct on Each Pump:
 - a. Perform under simulated or actual operating conditions.
 - b. Test for a continuous 30-minute period for each pump.

- c. Test and Test Log: Record the following:
 - 1) Pump suction head relative to suction flange centerline.
 - 2) Pump discharge head relative to pump discharge flange centerline.
 - 3) Pump flow using pump rpm and gallons per revolution.
 - 4) Pump flow using plant flowmeter instrumentation, if available.
 - 5) Motor voltage and amperage measured for each phase.

3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
 - 1. 2 person-days for installation assistance and inspection.
 - 2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - 3. 1 person-day for facility startup.
 - 4. 1 person-day for post-startup training of Owner's personnel.
- B. See Section 01 43 33, Manufacturers' Field Services , and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

3.06 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is a part of this Specification:
 - 1. Peristaltic Hose Pump Data Sheet.

END OF SECTION

PERISTALTIC HOSE PUMP DATA SHEET 44 42 56.16-_____

Tag Numbers: 20-P-12-1

Pump Name: Smith Sludge Pump #1

Manufacturer and Model Number: (1) Watson Marlow; Brede1100

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Anaerobically Digested Sludge

Pumping Temperature (Fahrenheit): Normal: 80 Max 90 Min 70

Specific Gravity @ 60 Degrees F: 1.05 Viscosity Range: _____

pH: 6 - 8

Abrasive (Y/N): Y Possible Scale Buildup (Y/N): Y

Inlet Pressure at Pump (psig): 2

Min. Net Positive Inlet Pressure Available (psia): 14

Area Classification: Unclassified

PERFORMANCE REQUIREMENTS

Rated Capacity (gpm): 150 Rated Differential Pressure (psi): 11

Maximum Pump Speed at Rated Condition (rpm): 30

Constant Speed (Y/N): Y Adjustable Speed (Y/N): N

Speed Range: ____% to ____% of Rated Speed: 28 rpm

DESIGN AND MATERIALS

Pump Type: Heavy-duty, horizontal, peristaltic hose pump

Pump Configuration: Direct coupled internal bearing frame

Pump Housing Material: Cast, ASTM A48/A48M, Class 25

Cover Material: Carbon steel or cast iron, with inspection window

Cover Seal Material: EPDM or Buna N (NBR)

C.C. Williams WWTP Dewatering

Rotor Material: Cast iron

Rotor Shoes: Aluminum

No. of Rotor Shoes (Minimum): 2

Rotor Shoe Shim Material: Type 316 stainless steel

Hose Size, Millimeters: 100

Maximum Number of Hose Occlusions per 100 Gallons Pumped: 38

Hose Material: Buna-N (NBR)

Hose Pressure Rating (psig): 230

Hose Inserts Material: Type 316 stainless steel

Hose Lubricant: Manufacturer's standard

Flange Rating and Material: ANSI Class 125/150

Bearing Housing Material: Cast iron

Bearing Type: Ball bearings, permanently lubricated

Bearing Life (ABMA L-10) (hrs): 100,000

Gear Drive: Planetary type, AGMA Class II

Baseplate: Steel

High Level Leak Detector (Y/N): Y

Pump Speed Sensor (Y/N): N

Revolution Sensor (Y/N): N

Suction Pulsation Dampener (Y/N): N

Discharge Pulsation Dampener (Y/N): N

DRIVE MOTOR (see Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 20 Voltage: 460 Phase: 3 Synchronous Speed (rpm): _____

Service Factor: 1.15 Inverter Duty (Y/N): N _____

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISC-TEFC _____

TENV _____ WPI _____ WPII _____ SUBM _____

REMARKS _____

SECTION 44 42 56.18
SELF-PRIMING CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Bearing Manufacturers' Association (ABMA):
 - a. 9, Load Ratings and Fatigue Life for Ball Bearings.
 - b. 11, Load Rating and Fatigue Life for Roller Bearings.
 2. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - b. B106.1, Design of Transmission Shafting.
 3. ASTM International (ASTM): A48/A48M, Standard Specification for Gray Iron Castings.
 4. Department of Defense (DoD) Test Method Standard: MIL STD 167, Mechanical Vibrations of Shipboard Equipment.
 5. Hydraulic Institute Standards (HIS):
 - a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
 - b. 11.6, Rotodynamic Submersible Pumps for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests.
 6. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
 7. Occupational Safety and Health Administration (OSHA).
 8. ISO 1940 Balance Quality Requirements of Rigid Rotors.

1.02 DEFINITIONS

- A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings:
 - a. Make, model, weight, and horsepower of each pump assembly.

- b. Complete pump and motor catalog information, descriptive literature, specifications, and identification of materials of construction.
- c. Plan and section dimensional outline drawings of the pumps and motors identifying all components, anchor bolts, external connections, and appurtenances.
 - 1) Include all components identified with quantity, part name and corresponding materials of construction complete with ASTM designation on sectional drawings.
- d. Performance data curves showing head, capacity, horsepower demand, net positive suction head required (NPSH3), and pump efficiency over entire operating range of pump, from shutoff to maximum capacity.
 - 1) Include the pump's preferred operating range (POR) and the manufacturer's defined maximum allowable operating range (AOR) for continuous steady state service on performance curves.
 - 2) Indicate separately head, capacity, horsepower demand, NPSH3, and overall efficiency required at the AOR's minimum and maximum continuous stable flow conditions and at the Rated Conditions and at Secondary Conditions (if applicable).
- e. Certified detail structural, mechanical, and electrical drawings showing equipment dimensions, arrangement, assembly, including locations and type of connections and weights of major equipment and components.
- f. Lateral and torsional critical speed analysis.
- g. Power and control wiring diagrams, including terminals and numbers.
- h. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
- i. Factory finish system.
- j. Bearing life calculation confirming compliance with L10 bearing life requirement.
- k. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

- 1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
- 2. Manufacturer's design analyst qualifications.
- 3. Special shipping, storage and protection, and handling instructions.
- 4. Manufacturer's printed installation instructions.

5. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that factory finish system is identical to requirements specified herein.
6. Factory Functional and Performance Test Reports.
7. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
8. Suggested spare parts list to maintain equipment in service for period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
9. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
10. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.04 EXTRA MATERIALS

- A. Furnish for each set of pumps:
 1. 1 complete set packing.
 2. 1 complete set bearings.
 3. 1 complete set gaskets and O-ring seals.
 4. 1 Set of Impeller wear rings.
 5. One complete set of any special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

- A. Constant speed, self-priming centrifugal pump for the Smith Biosolids Receiving Station.
- B. Provide a complete, coordinated, and fully functional operating system.
- C. Coordinate pump requirements with motor manufacturer and be responsible for pump and motor requirements.
- D. Pumps supplied under this section to be a standard product of manufacturer and to have proven reliability.

2.02 SUPPLEMENTS

- A. Specific service, performance, and design requirements are attached to this section as supplements.

2.03 EQUIPMENT

A. Pump:

1. Horizontal, frame mounted pump with V-belt drive.
2. Frame Mounted Type Pumps: pumps shall meet or exceed all requirements for general purpose type pumps and shall have the following additional requirements:
 - a. The pump and motor shall be mounted to a common base.
 - b. The motor shall be sized to be non-overloading throughout the pump range and the maximum motor speed.
 - c. The pump shaft shall be designed to limit shaft deflection at the stuffing box to no more than 0.002-inch.
3. Each pump shall be suitable for continuous or intermittent operation from the local control panel by means of an ON/OFF/REMOTE switch.
4. See Drawings for pump orientation and rotation.
5. Continuously rising head-capacity curve from runout to shutoff.
6. Designed to operate continuously at any point on specified operating range of performance curve without cavitation, overheating, or excessive vibration.
7. Motor nameplate horsepower rating not to be exceeded by pump brake horsepower required at any point on nominal pump performance curve.

B. Casing:

1. Pump casings shall be constructed of Gray Iron No. 30.
2. Openings and passages of the pumps shall be large enough to permit the passage of a 3 inch diameter sphere. Pump casings shall contain no openings, such as recirculation ports, of a lesser diameter, than the sphere specified.
3. Each pump shall be equipped with two removable cover plates allowing complete access to the pump interior. The cover plates shall be capable of being removed without disturbing the suction or discharge piping.
4. The pump shall have 4 inch flanged suction and discharge ports conforming to ANSI\ASME B16.1, Class 125, with 1/4-inch NPT tapped holes for connecting gauges.
5. Pumps shall be provided with a 120-volt casing heater.

C. Wear Plate and Rotating Assembly:

1. Each pump shall be fitted with an adjustable and replaceable wear plate constructed of ductile iron ANSI 1015 steel. Replacement of the wear plate, impeller and seal shall be accomplished through the removable cover plate. Each rotating assembly, which includes bearings, shafts, seal and impeller, shall be removable as a unit without disturbing the pump casing or piping.

2. The impeller shall be 2-vaned, semi open, non clog design, constructed of Gray Iron No. 30. The impeller shall thread onto a pump shaft and be secured with an impeller back screw.
3. The pump shaft shall be constructed of ANSI 4140 steel and covered and protected with a removable ANSI 4130 steel shaft sleeve. The shaft shall be contained within a bearing pedestal at ample size to contain heavy duty ball thrust bearings and radial bearings of adequate size to withstand all operating loads. Bearings shall be oil lubricated using a constant-level oiler and site gauge with a 100,000 hour ABMFA life.
4. The pump shaft shall be sealed against leakage by an oil lubricated mechanical seal, having a separate dedicated oil reservoir. The same oil shall not lubricate both shaft seal and bearings. Both the stationary sealing member and mated rotary member shall be a tungsten titanium carbide alloy. The stationary seal set shall be double floating and self aligning to insure the seal faces are in full contact during periods of shockloads.

D. Drive Transmission:

1. Power shall be transmitted from the motors to pumps by a sheave, V belt drive assembly. The drive assembly shall be selected to establish proper pump speed to meet the operating conditions shown in the attached supplement.
2. The drive system shall have a minimum safety factor of 1.5 based on performance data published by the manufacturer.

E. Mounting Frame: Each pump and motor shall be mounted on a fabricated steel frame and baseplate. The frame baseplate shall be equipped with lifting eyes so the entire baseplate, frame, pump, and motor assembly can be lifted vertically using an overhead hoist.

F. Valves:

1. Suction Check Valve: The manufacturer shall supply an internal suction check valve made out of molded Neoprene with integral steel and nylon reinforcement. Removal or installation of the check valve shall be accomplished through the cover plate opening, without disturbing the suction piping. The suction check valve should eliminate the need to reprime after each pumping cycle.
2. Air Release Valve: The manufacturer will supply a standard gray iron bodied, automatic air release valve, designed to permit the escape of air to the atmosphere during initial priming or unattended repriming cycles. Valves shall provide visible indication of valve closure and shall operate solely on discharge pressure. Valves which require connection to the suction line shall not be acceptable.

G. Bearing Frame and Bearings:

1. Removable, single-piece construction.
2. Machined for accurate bearing alignment and completely enclosing shaft between bearings.
3. Provide with retainer covers on inboard and outboard ends of frame equipped with lip-type grease seals to prevent entrance of contaminants.
4. Single or double row bearings at inboard and outboard ends designed to take radial, weight, and thrust loads of pump and associated shafting loads. Bearings to be designed for an L10 life per ABMA at best efficiency point.
5. Provide jacking screws for adjustment of impeller.
6. Grease packed at factory and provided with grease fittings for bearing lubrication.

2.04 ACCESSORIES

- A. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.
- B. Equipment Identification Plates: Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number indicated in this Specification and as shown.
- C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.05 FACTORY FINISHING

- A. Manufacturer to prepare, prime and finish coat in accordance with Section 09 90 00, Painting and Coating.

2.06 SOURCE QUALITY CONTROL

- A. Factory Tests and Adjustments:
 1. Factory testing to be in accordance with the standards of the Hydraulic Institute, latest edition.
 - a. Pump Test Acceptance Grade: 1U.
 2. Test all pumps actually furnished. Use manufacturer's standard test motor for factory tests.

3. Factory tests to include the following:
 - a. Performance testing of fully assembled pump, per Hydraulic Institute Standard 1.6. Performance testing to be at rated speed.
 - b. Dynamically balance rotating assembly to ISO 1940 Grade G6.3 or better prior to final assembly.
 - c. Include complete test records certified correct by an authorized representative of the pump manufacturer of each test performed.
 - d. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.
 - e. Make necessary adjustments, realignments, and retest to bring pumps into compliance.
 - f. Witnessing of factory testing shown on supplements at end of this section.

PART 3 EXECUTION

3.01 STORAGE AND PROTECTION

- A. Pumps and accessories shall be stored and protected in accordance with the manufacturer's recommendations and per Section 01 61 00, Common Product Requirements.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Level base by means of steel wedges (steel plate and steel shims). Use double wedges to provide a level bearing surface for the pump and driver base. Accomplish wedging so that there is no change or level or springing of the baseplate when the anchor bolts are tightened.
 1. Adjust pump assemblies such that the driving units are properly aligned, plumb and level with the driven units and all interconnecting shafts and couplings. Flexible couplings shall not be considered to compensate for misalignment.
 2. After the pump and driver have been set in position, aligned and shimmed to the proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured nonshrinking grout.
- C. Connect suction and discharge piping without imposing strain to pump flanges. Any evidence of pump or driver misalignment, noisy operation, or other signs of improper setting shall be corrected by the Contractor.

- D. Pumps and drivers shall be dowelled to the baseplate after final alignment has been checked under operating conditions. Care during storage, installation, and lubrication shall be in strict accordance with the manufacturer's recommendations.
- E. Pipe air release drain pipe using stainless steel according to the manufacturer's recommendations. Supply couplings for easy removal of air release valve, long-radius elbows and support brackets as needed.
- F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.03 FIELD FINISHING

- A. Equipment as specified in Section 09 90 00, Painting and Coating.

3.04 FIELD QUALITY CONTROL

- A. Functional Tests:
 - 1. Conduct on each pump, system, and subsystem as specified in Section 01 91 14, Equipment Testing and Facility Startup.
 - 2. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
 - 3. Flow Output: Measure using plant instrumentation and storage volumes.
 - 4. Use of plant instrumentation is allowed for tests. Provide additional instrumentation required to obtain required test data per the Hydraulic Institute.

3.05 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
 - 1. 1/2 person-day for installation assistance and inspection.
 - 2. 1 person-day for functional testing and completion of Manufacturer's Certificate of Proper Installation.
 - 3. 1 person-day for facility startup.
 - 4. 1/2 person-day for post-startup training of Owner's personnel.
- B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.06 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

3.07 SUPPLEMENTS

- A. The supplements listed below, following “End of Section,” are a part of this Specification.
 - 1. Pump Data Sheet 01 –Smith Sludge Pump 2.
 - 2. Pump Data Sheet 02 – Sludge Feed Pumps 1-4.

END OF SECTION

SELF-PRIMING CENTRIFUGAL PUMP DATA SHEET, 44 42 56.18 - 01__

Tag Numbers: 20-P-12-2

Pump Name: Smith Sludge Pump #2

Manufacturer and Model Number: (1) Gorman Rupp T4-A-B4

(2) Wemco with the model to be determined to meet the contract requirements.

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Anaerobically Digested Sludge

Pumping Temperature (Fahrenheit): Normal: 85 Max: 100 Min: 50

Specific Gravity at 60 Degrees F: 1.05 Viscosity Range: _____

Vapor Pressure at 60 Degrees F: _____ pH: 5 - 8

Abrasive (Y/N) N caused by _____

Possible Scale Buildup (Y/N): N caused by _____

Corrosive caused by N

Min. NPSH Available (Ft. Absolute): 30

Area Classification: Class 1 Division 2

Ambient Temperature (F): 32 - 100

Location Indoor/Outdoor: Outdoor

Altitude: 16 ft

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 200

Total Dynamic Head (Ft): Rated: 30

BHP at Rated Point: 3.6

NPSH Required, Max. (Ft Absolute) at Rated Point: 5

Max. Pump Speed at Rated Capacity (rpm): 1250

Constant Speed: Y

Adjustable Speed: N Minimum Speed: 650 rpm

Maximum Head, Rated Impeller (ft): 55

Maximum Power, Rated Impeller (BHP): 10

Sphere Size Required (to pass through impeller), Min. (in): 3

PUMP CONSTRUCTION DETAILS

Configuration: Horizontal, Frame Mounted: X
Vertical, Close-Coupled: _____
Vertical, Extension Shafting: _____

Size: Suction (in.): 4 Discharge (in.): 4

Casing: Single Volute: X
Tangential Discharge: X Centerline Discharge: _____

Impeller: Manufacturer's Standard

Wear Rings: Suction Cover: _____ Impeller: _____
Axial Type: _____ Radial Type: _____ L Type: _____

Bearings L10 Life: 100,000 Hr: X 50,000 Hr: _____ 25,000 Hr: _____

Shaft Sleeve: Yes X No _____

Pump Base: Heavy Duty Fabricated Steel: X
Cast Iron Combination Base Elbow: _____
Cast Mounting Pads Integral With Casing: _____

Suction Elbow: Yes _____ No X Type: _____
Material: Cast Iron, ASTM A48 Class 30: _____
With 3% Nickel: _____

Coupling: Standard Flexible Type: _____ Spacer Type: _____
Manufacturer: _____ Manufacturers Standard: X

Seal: Packing: _____
Mechanical Seal: X Single: ___x___ Double: _____
Mechanical Seal Manufacturer/Model: _____
Lubrication: _____

Materials: Pump Castings (includes casing, suction cover, stuffing box cover, bearing frame):
Cast Iron, ASTM A48/A48M Class 30 X With 3% Nickel ____
Cast Iron, ASTM A48/A48M Class 35 ____ With 3% Nickel ____

Impeller: Cast Iron, ASTM A48/A48M Class 30 X With 3% Nickel ____

Pump Shaft: High Strength Steel AISI 1045 Steel, HR _____
Type 4140 Alloy Steel X Type 304 Stainless Steel _____

Shaft Sleeve: Hardened Stainless Steel _____ Corrosion-Resistant Bronze _____
 Wear Rings: Hardened Stainless Steel _____
 Mechanical Seal: Buna N _____ Viton _____ EPT _____
 Carbon _____ Tungsten Carbide X Silicone Carbide _____
 18-8 Stainless Steel _____ Type 316 Stainless Steel _____

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 10 Voltage: 460 Phase: 3 Hertz: 60

Synchronous Speed (rpm): 1200

Service Factor (at max. ambient temp.): 1.0 1.15 X

Insulation Class: _____ Temperature Rise: _____

Inverter Duty Rated (Y/N): N Thermal Protection: N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP ODP _____ TEFC X CISD-TEFC _____

TENV _____ WPI _____ WPFI _____ SUBM _____

Mounting Type: Horizontal X Vertical Solid Shaft: _____

REMARKS _____

SELF-PRIMING CENTRIFUGAL PUMP DATA SHEET, 44 42 56.18 - 02__

Tag Numbers: 20-P-20-X (X = 1A, 2A, 3A, 4A)

Pump Name: Sludge Feed Pump #1, #2, #3, and #4

Manufacturer and Model Number: (1) Gorman Rupp T4

(2) Or Approved Equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Anaerobically Digested Sludge

Pumping Temperature (Fahrenheit): Normal: 85 Max: 100 Min: 50

Specific Gravity at 60 Degrees F: 1.05 Viscosity Range: _____

Vapor Pressure at 60 Degrees F: _____ pH: 5 - 8

Abrasive (Y/N) N caused by _____

Possible Scale Buildup (Y/N): N caused by _____

Corrosive caused by N

Min. NPSH Available (Ft. Absolute): 30

Area Classification: Unclassified

Ambient Temperature (F): 50 - 100

Location Indoor/Outdoor: Indoor

Altitude: 16 ft

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 300

Total Dynamic Head (Ft): Rated: 76

BHP at Rated Point: 14

NPSH Required, Max. (Ft Absolute) at Rated Point: 6

Max. Pump Speed at Rated Capacity (rpm): 1657

Constant Speed: N

Adjustable Speed: Y Minimum Speed: 650 rpm

Maximum Head, Rated Impeller (ft): 92

Maximum Power, Rated Impeller (BHP): 20

Sphere Size Required (to pass through impeller), Min. (in): 3

PUMP CONSTRUCTION DETAILS

Configuration: Horizontal, Frame Mounted: X
Vertical, Close-Coupled: _____
Vertical, Extension Shafting: _____

Size: Suction (in.): 4 Discharge (in.): 4

Casing: Single Volute: X
Tangential Discharge: X Centerline Discharge: _____

Impeller: Manufacturer's Standard

Bearings L10 Life: 100,000 Hr: X 50,000 Hr: _____ 25,000 Hr: _____

Shaft Sleeve: Yes X No _____

Pump Base: Heavy Duty Fabricated Steel: X
Cast Iron Combination Base Elbow: _____
Cast Mounting Pads Integral With Casing: _____

Suction Elbow: Yes _____ No X Type: _____
Material: Cast Iron, ASTM A48 Class 30: _____
With 3% Nickel: _____

Coupling: Standard Flexible Type: _____ Spacer Type: _____
Manufacturer: _____ Manufacturers Standard: X

Seal: Packing: _____
Mechanical Seal: X Single: _____ Double: _____
Mechanical Seal Manufacturer/Model: _____
Lubrication: _____

Materials: Pump Castings (includes casing, suction cover, stuffing box cover, bearing frame):
Cast Iron, ASTM A48/A48M Class 30 X With 3% Nickel ____
Cast Iron, ASTM A48/A48M Class 35 ____ With 3% Nickel ____

Impeller: Cast Iron, ASTM A48/A48M Class 30 X With 3% Nickel ____

Pump Shaft: High Strength Steel AISI 1045 Steel, HR _____
Type 4140 Alloy Steel X Type 304 Stainless Steel _____

Shaft Sleeve: Hardened Stainless Steel _____ Corrosion-Resistant Bronze _____

Wear Rings: Hardened Stainless Steel _____

Mechanical Seal: Buna N _____ Viton _____ EPT _____
Carbon _____ Tungsten Carbide X Silicone Carbide _____
18-8 Stainless Steel _____ Type 316 Stainless Steel _____

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 20 Voltage: 460 Phase: 3 Hertz: 60

Synchronous Speed (rpm): 1800

Service Factor (at max. ambient temp.): 1.0 X 1.15

Insulation Class: _____ Temperature Rise: _____

Inverter Duty Rated (Y/N): ___Y___ Thermal Protection: ___Y - Thermostat___

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X _____ CISD-TEFC _____

TENV _____ WPI _____ WPII _____ SUBM _____

Mounting Type: Horizontal X Vertical Solid Shaft: _____

REMARKS: Motor shall be inverter duty rated and shall include a thermostat which interfaces with the belt filter control panel.

**SECTION 44 42 60.01
MACERATORS**

PART 1 GENERAL

1.01 SUMMARY

- A. The work covered by this section consists of furnishing all equipment and materials required to install, test, and place into satisfactory operation the inline macerators at the locations shown on the Drawings.
- B. Each macerator shall be complete with motor, grinder teeth, housing controller, and all accessories necessary for an installation, complete in every detail, whether or not shown on the Drawings or called for in the Specifications.
- C. Comply with Division 1, General Requirements, Section 01 61 00, Common Product Requirements, Sections 26 05 02, Basic Electrical Requirements, and 40 99 90, Package Control Systems.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American National Standards Institute (ANSI).
 - 2. American Water Works Association (AWWA).
 - 3. ASTM International (ASTM).

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Detailed structural, mechanical, and electrical drawings of all equipment provided.
 - 2. Details of wiring and control schematics and panel layout drawings.
 - 3. Catalog information, descriptive literature, specifications. Descriptive literature shall include equipment and electrical control, pilot, or monitoring device.
 - 4. Bill of materials which includes manufacturer, complete model number, description/location, and quantity.
 - 5. Equipment performance data.
 - 6. Special tools and spare parts.
 - 7. Instrumentation and Control Submittals: In conformance with Section 40 99 90, Package Control Systems.

B. Informational Submittals:

1. Installation Manuals. Submit installation manuals before shipment of any equipment. No payment will be made for equipment delivered before installation manuals.
2. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data. Submit operation and maintenance manuals before requesting initial start-up.
3. Submit Manufacturer's Certificate of Proper Installation as specified in Section 01 43 33 Manufacturer's Field Services.
4. Submit Manufacturer's Certificate of Compliance in accordance with Section 01 61 00 Common Product Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. JWC Environmental; Muffin Monster.
- B. Franklin Miller.
- C. Moyno.
- D. Netzsch model 150-I per quote Number B000415366/0010 for unit 20-M-13-1 and model 350-I per quote Number B000415366/0020 for 20-M-14-1 subject to the condition that any piping, control, electrical power feed or other changes as required to accommodate the units shall be included at no additional cost to the Owner. The only approved exceptions to the specification are that the housing may be epoxy-coated cast iron and the pipe-connection sized may differ from those specified.
- E. Vogelsang RotoCut model RC3000 per quote Number 1170901 for unit 20-M-13-1 and model RC10000 per quote Number 11706901 for 20-M-14-1 subject to the condition that any piping, control, electrical power feed or other changes as required to accommodate the units shall be included at no additional cost to the Owner. The referenced proposal's exceptions to the Specification 44 42 60.01 Paragraph 2.06 Paragraphs D and E are excluded from the acceptance of the units as equals.

2.02 MACERATOR

- A. All materials used in the construction of each macerator shall be compatible and shall resist corrosion due to cavitation or galvanic action. Housing shall be cast from ductile iron.

- B. Each macerator shall be of the two shaft design. Shafts shall be fabricated from 4140 steel, hexagonal stock. The shafts shall counter rotate and shall be equipped with spacers and intermeshing cutters. Cutters and spacers shall be cast from 4130 steel, surface ground for uniformity and through hardened to 48 50 Rockwell "C". Units of single shaft design will not be acceptable.
- C. Cutters shall have a minimum of eleven teeth and shall be placed on the shafts in a helical formation. The inside bore of the cutters and spacers shall be hexagon shaped, so that no keys are required to hold the spacers and cutters in position on the shaft.
- D. All seals shall be of the mechanical face type and shall require no external water source. All bearings shall be sealed, oversized, conrad type ball bearings.
- E. Mechanical seals shall be of the tungsten carbide insert design rated for a minimum of 90 psi. The rotating and static braces of the seal shall have facings of tungsten carbide for optimum wear life. Seals not equipped with tungsten carbide facings are unacceptable. Seals requiring an outside water, air, or oil source are unacceptable.
- F. Bearings shall be of the sealed, oversized, conrad type ball bearing. Sleeve bearings requiring external liquids for sealing will not be allowed.
- G. Transitions from the macerator to the pipe flange shall have gasketed clean out covers for access to the cutting chamber. If inlet and outlet sizes differ from those shown on the Drawings or specified herein, the Contractor shall furnish any necessary fittings, per approved shop drawings, at no additional cost to the Owner.

2.03 PERFORMANCE

- 1. Mechanical Grinder associated with the Williams Biosolids Holding Tank: 20-M-14-1.
 - a. Inline pipe diameter: 10-inch.
 - b. Design Flow: 900 gpm.
 - c. Max Flow: 1,500 gpm.
 - d. Fluid: Digested Sludge.
- 2. Mechanical Grinder Associated with the Smith Receiving Station: 20-M-13-1.
 - a. Inline pipe diameter: 4-inch.
 - b. Design Flow: 200 gpm.
 - c. Max Flow: 400 gpm.
 - D. Fluid: Digested Sludge.

2.04 MOTOR

- A. Motor shall meet the requirements of Section 26 20 00, Low Voltage AC Induction Motors and shall incorporate the following:
 - 1. Mechanical Grinder associated with the Williams Biosolids Holding Tank: 20-M-14-1.
 - a. Horsepower: 5.
 - b. RPM: 1725.
 - c. Service Factor: 1.15.
 - d. Continuous Duty.
 - e. TEFC.
 - f. Accessories: Motor temperature switch.
 - 2. Mechanical Grinder associated with the Smith Receiving Station: 20-M-13-1.
 - a. Horsepower: 3.
 - b. RPM: 1725.
 - c. Service Factor: 1.15.
 - d. Continuous Duty.
 - e. TEFC.
 - F. Accessories: Motor temperature switch.

2.05 DRIVE

- A. Speed reducers shall be of the planetary type, grease filled, and shall have a service factor of 1.9. Speed reducer shall have a 29:1 reduction ratio and shall be capable of delivering 8,000-inch pounds of torque to the drive shaft of the macerator. Shaft connections between each component shall be by means of two and three piece couplings.

2.06 CONTROLS

- A. Each macerator shall be supplied with a solid state motor controller. Each controller shall have mechanical and electrical interlock contactors operating on 230/460 volt, 60 Hz, 3 phase power and shall be housed in a NEMA 4X enclosure.
- B. Panel Tag Numbers:
 - 1. 20-LCP-14-1: Local Control Panel for the Mechanical Grinder associated with the Williams Biosolids Holding Tank.
 - 2. 20-LCP-13-1: Local Control Panel for the Mechanical Grinder associated with the Smith Receiving Station.

- C. Operator Controls and Indicators: Provide the following panel mounted operator controls and indicating lights on each local control panel:
1. Hand/Off/Remote selector hand switch.
 2. System (Power) on indicator.
 3. Mechanical Grinder Run (On) indicator.
 4. Mechanical Grinder Fault alarm indicator.
 5. Mechanical Grinder Jam alarm indicator.
 6. Full-voltage reversing motor starter internal to the control panel.
 7. Surge protection device (SPD) internal to the control panel and located immediately downstream of the main circuit breaker.
 8. 65,000A main circuit breaker that is operable from the front of the associated control panel.
 9. 480V-120V control power transformer to provide all 120V controls.
 10. The control panel shall operate from a 20A, 480V, three-phase power feed.
 11. The control panel shall include a thermostatically controlled panel heater.
 12. The control panel shall meet all of the requirements outlined in Section 40 99 90, Package Control Systems.
- D. External Interfaces: Provide hardwired control and monitoring signals to/from the respective Mechanical Grinder Local Control Panel:
1. 20-LCP-14-1: Local Control Panel for the Mechanical Grinder associated with the Williams Biosolids Holding Tank to/from Plant SCADA PLC Panel (20-CP-1):
 - a. Mechanical Grinder In Remote status.
 - b. Mechanical Grinder Run Status.
 - c. Mechanical Grinder Fault Alarm.
 - d. Mechanical Grinder Run command.
- E. 20-LCP-13-1: Local Control Panel for the Mechanical Grinder associated with the Smith Receiving Station to/from Plant SCADA PLC Panel (20-CP-1) and Smith Sludge Local Control Panel (20-LCP-12-1):
1. Mechanical Grinder Run status to 20-LCP-12-1 and to 20-CP-1.
 2. Mechanical Grinder Fault Alarm to 20-CP-1.
 3. Mechanical Grinder Run command from 20-LCP-12-1.
- F. The controller shall provide the following functions:
1. Start and stop the macerator when required.
 2. Sense an overload (jam) condition, momentarily reverse the shaft direction to clear the jam, and return to a forward direction. If the overload has cleared, return the macerator to normal operation.

3. If a second overload (jam) occurs, follow the above procedure to clear the jam.
4. If a third overload (jam) occurs within 30 seconds, the controller shall reverse the shaft directions, shut down the macerator, and energize an overload light and alarm circuit.

2.07 PAINTING AND COATING

- A. Shop prime and coat in accordance with specification Section 09 90 00, Painting and Coating.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide stainless steel mounting bolts, washers, and nuts and install the equipment at locations indicated on the Drawings.
- B. Install the equipment in accordance with the manufacturer's instructions and typical installation detail included in this section.

3.02 START-UP

- A. Before operating equipment, provide the services of a qualified manufacturer's service representative to inspect, operate, test, and adjust the equipment after installation.
- B. Submit the Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturer's Field Services. Provide copies of this report to be included in the installation, operation and maintenance manuals.
- C. Included in the Inspection:
 1. Soundness (without cracked or otherwise damaged parts).
 2. Completeness of installation as specified and as recommended by manufacturer.
 3. Correctness of setting, alignment, and relative arrangement of various parts of system.
- D. Operate, test, and adjust equipment to prove that it is satisfactorily installed to operate under the intended conditions as specified.
- E. Functional and Performance Testing per Section 01 91 14, Equipment Testing and Facility Startup.
 1. Test to be performed with the associated pumps and final piping arrangement.

- F. Equipment will only be accepted after receipt of the Manufacturer's Certificate of Proper Installation and Certificate of Compliance.
- G. Modify or replace equipment or materials failing required tests.
- H. Perform additional testing required due to changes of materials required by Supplier or as a result of failure of materials or construction to meet Specifications.

3.03 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

3.04 MANUFACTURER FIELD SERVICES

- A. A manufacturer's representative for equipment specified herein shall be present at Job Site and/or classroom designated by WSSC for the minimum person-days listed for services hereunder, travel time excluded:
 - 1. 1 person-day for installation assistance, inspection, certification of installation, and functional and performance testing.
 - 2. 1 person-day for startup services.
 - 3. 1 person-day for classroom training with Owner's plant operators.

END OF SECTION

SECTION 44 44 16
WASTEWATER CHLORINATORS AND SULFONATORS

PART 1 GENERAL

1.01 REFERENCES

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

1. Chlorine Institute, Inc.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
3. National Electrical Manufacturers Association (NEMA): MG 1, Motors and Generators.
4. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SYSTEM DESCRIPTION

- A. Chlorine ton containers will be manifolded in a duty-standby relationship to provide redundant disinfection of wastewater at a duty feed rate of approximately 2,515 pounds chlorine gas per 24 hours. Dechlorination of the chlorinated wastewater will be provided with individual sulfur dioxide ton containers arranged in a duty-standby relationship at a duty feed rate of approximately 1,000 pounds sulfur dioxide gas per 24 hours.
- B. Basis of design for the chlorination/dechlorination components is DeNora. Alternate manufacturers listed throughout this Specification may be acceptable and will be reviewed on a case-by-case basis during the submittal review process. Modifications (including but not limited to, piping, instrumentation, and electrical) necessary to provide the chlorination and dechlorination facility in a manner that strictly conforms to the design intent shall be the Contractor's responsibility and shall be provided at no additional cost to the Owner.

- C. The existing four (4) automatic emergency gas shutoff actuators and controller located in the existing chlorine feed room shall be reused in this project. Contractor shall have the shutoff actuators and controller recertified by the equipment manufacturer prior to reinstallation. Contractor shall sequence tasks necessary to complete the scope of work to ensure continuity of the chlorination and dechlorination processes.
- D. Various components for the chlorine and sulfur dioxide dosing processes, as described herein, shall be provided by a single supplier for single source responsibility.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Shop Drawings:
 - a. Detailed structural, mechanical, instrumentation, and electrical drawings showing interface with equipment and modifications necessary to adapt specified equipment and other products to details as shown.
 - 1) Include dimensions, size, and location of connections to other work, and weight of equipment.
 - 2) Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - 3) Complete bill of materials with description, manufacturer's part numbers, and equipment tag numbers.
 - b. Installation or placing drawings for equipment, drives, and bases.
 - c. Design calculations for equipment and equipment supports specified to be designed.
 - d. Wiring and control diagrams of systems and equipment. Inter-connect diagrams between equipment and control panels.
 - e. Performance data that will show compliance with specification requirements stated herein.
 - f. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
- 2. Samples: Furnish color Samples as specified and for selection.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Certificates of factory testing.
 - a. Manufacturer's Performance Guarantee guaranteeing the performance of each unit meets or exceeds the specified performance. The guarantee shall be based on a shop test and shall include the complete unit assembly.
3. Special shipping, storage and protection, and handling instructions.
4. Routine maintenance requirements prior to plant startup.
5. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
6. Suggested spare parts list.
7. List of special tools required for checking, testing, parts replacement, and maintenance with current price information.
8. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.
9. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
10. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Prepare and protect equipment and materials for shipment in accordance with manufacturer's recommendations.

1.05 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following items:

Qty	Item
2	Auxiliary valve gasket set (12 ea)
2	Gas filter gasket kit (1 gasket, 3 filter pads ea)
2	Chlorinator regular maintenance kit
2	Sulfonator regular maintenance kit
2	Chlorinator preventative kit (3 filters, 3 lead gaskets ea)
2	Sulfonator preventative kit (3 filters, 3 lead gaskets ea)
2	Chlorinator inlet valve repair kit
2	Ton container lead gasket set (25 ea)

Qty	Item
2	3,000 PPD automatic feed rate valve preventative maintenance kit
2	1,000 PPD automatic feed rate valve preventative maintenance kit
2	25 PPD remote meter panel preventative maintenance kit
4	Ejector spare parts kit (2 for each size ejector)
2	Chlorine Institute Emergency Kit B for 1-ton containers
8	Spare vent exhaust gas arrestor with fittings

PART 2 PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
1. DeNora.
 2. Evoqua.
 3. Regal.
 4. Hydro International.

2.03 SULFUR DIOXIDE DOSING EQUIPMENT

- A. Sulfonators (Equipment Tags 50-M-31-1, -2, -3, -4): Container-mounted, vacuum operated with integral vacuum regulator, solution feed type with manual dosage adjustment suitable for intermittent START/STOP control. Provide the following with each sulfonator:
1. Minimum Capacity: 500 pounds of sulfur dioxide gas per 24 hours.
 2. Drip leg and heater to trap and vaporize liquid sulfur dioxide.
 - a. 120V, 25 watts, 60Hz, 1 phase.

3. Manual flow rate meter: Capacity of 500 pounds per day.
 - a. Accuracy within 4 percent of indicated flow rate over feeding range of 20:1.
 4. Pressure gauge with a diaphragm seal, 0-200 psig (Equipment Tags 50PE/PI-31-1, -2, -3, -4).
 5. Built-in pressure relief valve (Equipment Tags 50PRV-31-1, -2, -3, -4) to vent possible buildup of pressure within control unit. Provide with flexible tubing to route vent gases to vent arrestor.
 6. Visual indicator to signal exhausted or interrupted gas supply.
- B. Vent Gas Exhaust Arrestors:
1. Provide one per sulfonator with bi-functional media to neutralize vented sulfur dioxide or chlorine gases.
 2. Provide with visual indication of spent media.
 3. Spent media shall not require neutralization prior to disposal in residential waste landfill.
- C. Manifold Connection: Provide flexible tubing and auxiliary shutoff valves for connecting each sulfonator individually to a common manifold.
- D. Automatic Flow Controller: Provide as a wall-mounted assembly with a manual flow rate meter, vacuum monitor (Equipment tags 50-M-32-1, -2), and automatic feed rate valve (Equipment tags 50-FV-32-1, -2) suitable for wall or panel mounting. Each assembly shall include the following:
1. Automatic feed rate valve suitable for automatic control from 4 to 20 mA dc input signal transmitted from the plant control system PLC panel, 50-CP-1, as specified in Section 40 90 00, Instrumentation and Control for Process Systems.
 2. Manual feed rate adjustment capability from the automatic feed rate valve.
 3. Manual feed rate adjustment capability from the manual flow rate meter.
 4. Vacuum monitor with vacuum switches and diaphragm seals (Equipment tags 50PE/PSH-32-1, -2 and 50PE/PSH-32-1, -2) to transmit high and low vacuum alarms to the plant control system PLC panel, 50-CP-1, as specified in Section 40 90 00, Instrumentation and Control for Process Systems.
 5. Vacuum gauge and diaphragm seal (Equipment tags 50PE/PI-32-1, -2) with range per manufacturer's recommendations.
 6. 120V, 60 Hz, 1 phase power requirement.
- E. Ejectors:
1. Remote-mounted suitable for direct pipe mounting.
 2. Design to feed 1,000 pounds per day of sulfur dioxide gas against back pressure of 25 psig with water supply available at 65 psig.

3. Valves:
 - a. Provide double-check arrangement consisting of ball checks, diaphragm checks, or combination thereof, to positively prevent water from leaking into sulfur dioxide gas supply piping when injector is not in operation or under intermittent OFF/ON control.
 - b. Provide drain valve.
4. Pressure Gauges and Diaphragm Seals: Provide pressure gauges with diaphragm seals (Equipment tags 50PE/PI-33-1, -2 and 50PE/PI-34-1) with ranges per manufacturer's recommendations.

F. Components: Construct of corrosion-resistant material.

G. Sulfonator Manufacturer and Model:

1. DeNora; Series 200.
2. Evoqua; S10K.
3. Or equal.

2.04 CHLORINE DOSING EQUIPMENT

- A. Chlorinators (Equipment Tags 50-M-12-1, -2): Remote, wall-mounted, vacuum operated with integral vacuum regulator, solution feed type with manual dosage adjustment suitable for intermittent START/STOP control. Provide the following with each chlorinator:
1. Minimum Capacity: 3,000 pounds of chlorine gas per 24 hours.
 2. Drip leg and heater to trap and vaporize liquid chlorine.
 - a. 120V, 25 watts, 60Hz, 1 phase.
 3. Built-in automatic changeover function.
 - a. Automatically switches chlorine gas supply source from exhausted duty containers to standby containers, integral to chlorinator, complete with trap and filter units.
 - b. System shall not require external power for its operation and shall not require resetting after exhausted supply is replaced.
 - c. System Capacity: 3,000 pounds of chlorine gas per day.
 4. Manual flow rate meter:
 - a. Minimum capacity of 3,000 pounds per day.
 - b. Accuracy within 4 percent of indicated flow rate over feeding range of 20:1.
 5. Pressure gauge, 0-200 psig.
 6. Built-in pressure relief valve to vent possible buildup of pressure within control unit. Provide with flexible tubing to route vent gases to vent arrestor.
 7. Visual indicator to signal exhausted or interrupted gas supply.

B. Vent Gas Exhaust Arrestors:

1. Provide one per chlorinator with bi-functional media to neutralize vented sulfur dioxide or chlorine gases.
2. Provide with visual indication of spent media.
3. Spent media shall not require neutralization prior to disposal in residential waste landfill.

C. Manifold Connection: Provide 650 psig flexible tubing with expansion loop and auxiliary shutoff valves for connecting each of eight chlorine ton containers individually to a common manifold.

D. Chlorine Gas Filters:

1. Dual chamber with trap and removable filter cartridge, rated at minimum 560 psi working pressure. Provide wall mounting bracket. Locate as shown in the Drawings.
2. Painting and coating in accordance with Specification Section 09 90 00, Painting and Coating.

E. Automatic Flow Controller: Provide as a wall-mounted assembly with a manual flow rate meter, vacuum monitor (Equipment tags 50-M-15-1, -2), and automatic feed rate valve (Equipment tags 50-FV-15-1, -2) suitable for wall or panel mounting. Each assembly shall include the following:

1. Automatic feed rate valve suitable for automatic control from 4 to 20 mA dc input signal transmitted from plant control as specified in Section 40 90 00, Instrumentation and Control for Process Systems.
2. Manual feed rate adjustment capability from the automatic feed rate valve.
3. Manual feed rate adjustment capability from the manual flow rate meter.
4. Vacuum monitor with vacuum switches (Equipment tags 50PSH-15-1, -2 and 50PSH-15-1, -2) to transmit high and low vacuum alarms via 4-20 mA output signal to the plant control as specified in Section 40 90 00, Instrumentation and Control for Process Systems.
5. Vacuum gauges (Equipment tags 50PE/PI-15-1C, -2C) with range per manufacturer's recommendations.
6. 120V, 60 Hz, 1 phase power requirement.

F. Algae and Foam Control Chlorine Gas Flow Meter:

1. Remote wall-mounted meter panel with minimum capacity of 25 pounds of chlorine gas per 24 hours.
2. Manual feed rate adjustment capability.

G. Ejectors:

1. Remote mounted suitable for direct pipe mounting.
2. Disinfection service:
 - a. Design to feed 2,500 pounds per day of chlorine gas against back pressure of 25 psig with water supply available at 65 psig.
3. Algae and Foam Control service: Design to feed 25 pounds per day of chlorine gas against back pressure of 25 psig with water supply available at 65 psig.
4. Valves:
 - a. Provide double-check arrangement consisting of ball checks, diaphragm checks, or combination thereof, to positively prevent water from leaking into sulfur dioxide gas supply piping when injector is not in operation or under intermittent OFF/ON control.
 - b. Provide drain valve.
4. Pressure Gauges and Diaphragm Seals: Provide pressure gauges with diaphragm seals (Equipment tags 50PE/PI-15-1A, 2A and 50PE/PI-15-1B, 2B).

H. Components: Construct of corrosion-resistant material.

I. Chlorinator Manufacturer and Model:

1. DeNora; NXT 3000.
2. Evoqua; V2000.
3. Or equal.

2.05 TON CONTAINER WEIGHING SCALES

A. Hydraulic Single Ton Container Weighing Scale (Sulfur Dioxide):

1. Quantity: Four.
2. 4,000 pound capacity.
3. Equipment tags: 50-WE/WIT-30-1, -2, -3, -4.
4. Indicator:
 - a. One per scale.
 - b. 12-inch dial with 4-20 mA transmitter (Equipment tags 50-WIT-30-1, -2, -3, -4) for signal output to plant control.
 - c. 120V, 60Hz, 1 phase power requirement.
 - d. 12 feet long hose with quick disconnect.

B. Hydraulic Dual Ton Container Weighing Scale (Chlorine):

1. Quantity: Four.
2. 8,000 pound capacity.

3. Equipment tags: 50-WE/WIT-11-1, -3, -5, -7.
 4. Indicator:
 - a. One per scale.
 - b. 12-inch dial with 4-20 mA transmitter (Equipment tags 50-WIT-11-1, -3, -5, -7) for signal output to plant control.
 - c. 120V, 60Hz, 1 phase power requirement.
 - d. 12 feet long hose with quick disconnect.
- C. Type: Frame assembly with load cell that transmits the weights of the contents of ton containers.
1. Trunnion-type with bronze-bushed steel trunnion wheels to allow 360-degree rotation of full containers while seated on scale.
 2. Manual adjustment of tare weight of individual cylinders.
- D. Manufacturer and Model:
1. Single Ton Container Scale: Force Flow; 12D40A.
 2. Dual Ton Container Scale: Force Flow; 12D80.
 3. Or approved equal.

2.06 AUTOMATIC EMERGENCY GAS SHUTOFF ACTUATORS AND CONTROLLER

- A. Electrically driven actuator directly attached to the chlorine and sulfur dioxide ton container valve with hand clamping mechanism and valve stem coupling to allow ton container changeout. No tools shall be required to install or remove the actuator. Coordinate with sulfonator manufacturer and provide auxiliary valve adapter assembly to ensure proper installation of the both the container-mounted sulfonators and emergency shutoff actuators.
1. Chlorine ton container actuator equipment tags:
 - a. 50-FV-11-1, -2, -3, -4, -5, -6, -7, -8.
 2. Sulfur dioxide ton container actuator equipment tags:
 - a. 50-FV-31-1A, 50-FV-30-2, -3, -4.
- B. Actuator shall measure and deliver between 40 ft-lbs and 50 ft-lbs of closing torque acting on the container valve stem during an emergency shutdown, as recommended by the Chlorine Institute. Actuator shall measure and deliver between 20 ft-lbs and 30 ft-lbs closing torque to the container valve stem for test closing, as recommended by the Chlorine Institute.
- C. Provide manual override to allow opening or closing of the ton container valve with a wrench via the valve shaft extension. Clutch shall automatically reengage when the motor and gear train are energized.

- D. Installed actuator shall not impede the ability to operate the ton container valve with a standard chlorine wrench and shall not impede the ability to tighten the valve packing nut, yoke, or actuator clamp. Provide an actuator storage rack for each storing each actuator during container changeout.
- E. Actuators shall be constructed of materials suitable for chlorine and sulfur dioxide environments. Valve stem coupling shall be designed to accommodate slight misalignment of the actuator shaft with the axis of the valve stem without restricting rotation.
- F. Emergency Shutoff Controllers (Equipment tags: 50-FP-1, -2, -3):
 - 1. Each controller shall be wall-mounted and capable of operating four electric actuators simultaneously.
 - 2. Capable of receiving leak input signals from gas detection devices, emergency pushbutton switches, and plant control system PLC panel, 50-CP-1, to automatically close each ton container valve within one second.
 - 3. Output relays to plant control system PLC panel, 50-CP-1, for alarm and error conditions and shutdown control as shown on drawings.
 - 4. Integrated battery backup, up to three days, 8.5 amp hour.
 - 5. 120V, 60Hz, 1 phase power requirement.
 - 6. Controller shall have 2-line, 40-character backlit LED display.
 - 7. Wall-mount, NEMA 4X enclosure with 3-year warranty.
 - 8. Provide junction box by manufacturer with sealed fittings as required.
 - 9. Relay contacts and relay modules (Three relay contacts per module, 5A at 120V ac) for the required I/O as shown on the Drawings.
- G. Manufacturer/Model: Halogen Valve Systems, Inc.; Eclipse electric actuators and Hexacon Model III controller, No Substitutions.

2.07 CHLORINE AND SULFUR DIOXIDE GAS DETECTOR

- A. See Section 40 90 00, Instrumentation and Control for Process Systems.

2.08 ACCESSORIES

- A. Manufacturer's standard that meet Chlorine Institute requirements and are necessary for complete installation and preventative maintenance activities:
 - 1. Lead gasketed, positive yoke, cylinder clamp isolation valves.
 - 2. Chlorinator and sulfonator inlet valve filters, lead gaskets, tubing connectors, piping reducers, wrenches, lubricants, and insect screens.

3. Air mask, 30-minute air-tank type, pressure demand, self-contained with alarm and clear view faceplate.
 - a. Provide a quantity of four (4).
 4. Spare air tank with valve, 30-minute capacity, for use with air masks provided above.
 - a. Provide a quantity of four (4).
 5. Storage cabinet, NEMA type weatherproof for outdoor use with locking handle, wall mounted, single door of size required to house air mask and spare canister.
 - a. Provide a quantity of four (4) and locate as shown in the Drawings.
 6. Piping unions, suitable for chlorine and sulfur dioxide gas application.
- B. Lifting Lugs: Provide on equipment and equipment components over 100 pounds.
- C. Equipment Identification Plates: Provide identification plate securely mounted on each separate equipment component and control panel in a readily visible location. See Specification Section 10 14 00, Signage for equipment label requirements.
- D. Anchor Bolts: Type 316 stainless steel 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

2.09 FABRICATION

- A. Shop Finishing: In accordance with and as specified in Section 09 90 00, Painting and Coating.
- B. Factory Finishing: Manufacturer's standard baked enamel finish.

PART 3 EXECUTION

3.01 INSTALLATION

- A. In accordance with manufacturer's written instructions and onsite representative's recommendations and Chlorine Institute Standards.

3.02 FIELD QUALITY CONTROL

- A. Installation shall be approved by equipment manufacturer's representative in writing prior to startup.

3.03 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

3.04 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative for the following services at Job Site or classroom as designated by Owner, for minimum person-days listed below, travel time excluded:
 - 1. 1 person-day for installation assistance, inspection, and certification of installation.
 - 2. 1 person-day for functional and performance testing.
 - 3. 1 person-day for plant startup.
 - 4. 1 person-day for post-startup training.

END OF SECTION

SECTION 44 44 63.01
POLYMER FEED SYSTEM, LIQUID

PART 1 GENERAL

1.01 SUBMITTALS

- A. Contractor's Drawings in accordance with Section 01 33 00, Submittal Procedures.
- B. Action and informational submittals in accordance with Section 40 99 90, Package Control Systems.
- C. Make, model, and weight of equipment item.
- D. Schematic of piping layout showing all equipment, valves, and other accessories.
- E. P&ID of system showing all equipment, valves, instrumentation, and other accessories. Equipment tagging scheme should be in coordination with the Contract Drawings.
- F. Manufacturer's catalog information, descriptive literature, specifications, and materials of construction.
- G. Information on rotameters and mixer chamber shaft seals indicating pressure rating and service requirements specified herein.
- H. Retention time and Gt (mean velocity gradient multiplied by retention time) values for polymer mixing chamber.
- I. Dimensions for system components.
- J. Electrical control schematic and wiring diagrams that clearly show alarms, shutdowns, and contact closures for plant SCADA control system.
- K. Control Panel elevation drawings, including bill of materials.
- L. Installation requirements.
- M. Interconnection wiring diagrams showing 460-volt power distribution, 120-volt control interconnection, instrument connection, wire sizes and quantities, wire identification per control diagrams, and terminal block locations.

- N. Test procedures.
- O. Factory test report and certifications.
- P. Manufacturer's installation instructions.
- Q. Installation requirements for equipment and instruments.
- R. Detailed mechanical and electrical drawings showing equipment fabrications and interface with other items. Include dimensions, size and locations of connections to other Work, and weights of associated equipment.
 - 1. Record Drawings in accordance with Section 01 33 00, Submittal Procedures.
- S. Operation and Maintenance Manuals in accordance with Section 01 78 23, Operation and Maintenance Data.
- T. Manufacturer's Certificates for the following in accordance with Section 01 43 33, Manufacturers' Field Services.

1.02 QUALITY ASSURANCE

- A. The polymer feed systems shall be furnished, coordinated, and tested by one supplier. The system shall be completely shop assembled, skid mounted, and shop tested prior to shipment.
- B. All components shall be the standard product of a manufacturer regularly engaged in the production of required materials and equipment.
- C. All equipment and material shall be designed and constructed in accordance with applicable standards as indicated.

1.03 PREPARATION FOR SHIPMENT

- A. Insofar as is practical, equipment specified herein shall be factory assembled and tested in the factory. Refer to section 40 99 90, Package Control System specification section the unwitnessed and witnessed factory test requirements. Parts and assemblies that are of necessity shipped unassembled shall be packaged and tagged in a manner that will protect equipment from damage and facilitate final assembly in the field. Machined and unpainted parts shall be protected from damage by elements with application of a strippable protective coating.

1.04 SPARE PARTS AND SPECIAL TOOLS

- A. Spare parts shall be shipped in a wooden box and shall be protected from damage, from moisture and dirt accumulation. Parts shall be protected as for an extended storage period. The box shall be heavily constructed with hinged cover, hasp and lock, and designed as a permanent storage enclosure for the spare parts. The spare parts shall, if possible, be enclosed within an airtight membrane. Spare parts supplied in matched sets, such as drive belts, shall be wrapped, bound, or labeled to indicate a set.
- B. Furnish one year supply of lubricants including oil and greases, as recommended by the product manufacturer. The lubricants shall include summer and winter grades along with alternative references to equal products of other manufacturers including specifications such as AGMA numbers, viscosity.

1. Furnish the following:

Item	Quantity
Mechanical seal	1
mixing chamber o-rings	1
injection check valve	1
Stator (pump)	1
Special tools needed for maintenance	1

PART 2 PRODUCTS

2.01 GENERAL

- A. The polymer feed systems shall be skid mounted assemblies consisting of one metering pump, mixing chamber, and all piping, valves, and controls capable of delivering required minimum and maximum gallons per hour of polymer solution as shown on attached schedule. Included with each polymer feed system shall be a pressure relief valve, back pressure valve, and calibration chamber.

2.02 EQUIPMENT

- A. Manufacturer/Model:
1. UGSI; PolyBlend MM2400-P10A.
 2. Prominent; ProMix-M 1200x2-10.
 3. Velodyne; VM2400.
 4. Or approved equal.

B. General:

1. Polymer feed system shall consist of an integrated equipment package system which shall meter, dilute, activate, mix, and feed liquid polymer and water. System shall not rely upon a static mixer as the means of polymer activation. Polymer shall not be exposed to a rotating centrifugal pump turbine or other machinery that would cause excessive shear.
2. Feed systems shall include a progressing cavity feed pump to provide the capability of pumping emulsion type liquid polymers, with maximum apparent viscosities of up to 40,000 centipoise. At no time shall liquid polymer or polymer solution be exposed to excessive shear, so as to degrade the effectiveness of the polymer molecular chains.
3. Polymer feed system shall be furnished with an integrally mounted control panel.
4. Provide SCR or VFD drive for pump to accept 4-20 mA signal.
5. Each polymer feed system shall be equipped with Type 304 stainless steel side frame and stainless steel base with nonskid feet.

C. Mixing Requirements:

1. Polymer mixing system shall be specifically designed to invert, disperse, and activate in solution emulsion polymers which may vary in specific gravity from 0.98 to 1.18 and vary in viscosity from 80 to 6,000 cp.
2. Polymer and water shall be mixed in a chamber designed to create sufficient mixing energy. This design shall include a motor-driven impeller that will create high fluid shear. Solution shall undergo a tapered mixing intensity slope as it exits the initial shear zone and pass through a second zone, isolated by a baffle. Polymer activation efficiency shall be consistent over the entire dilution water range. Mixing chamber shall be transparent to allow viewing of mixing intensity.
3. Mixing energy shall be provided by a constant speed or variable speed, motor-driven impeller per manufacturer's recommendation. Impeller shall rotate on a stainless steel shaft supported by double sealed ball bearings. Variable speed shall be achieved by variable frequency drive. Impeller shall be adjustable of a range of 900 rpm to 3,450 rpm to ensure complete flexibility in creating mixing energy. Constant speed mixing shall be a minimum of 2,000 rpm.

D. Pump:

1. Type:
 - a. Unit shall have a neat polymer metering pump. Pump shall be positive displacement progressive cavity type.
 - b. Rotor shall be Type 316 stainless steel.
 - c. Pump shall have mechanical seal. Pumps supplied with packing seals will not be accepted.
 - d. The metering pump shall have an output range between 0.5 – 10 gph minimum.
 - e. Rotor speed shall not exceed 500 rpm.
2. Motor:
 - a. 1/2 hp, TEFC, AC motor.
 - b. Variable speed with VFD controller.
 - c. Direct-coupled
3. The pump shall be designed with a high viscosity wet end pump capable of pumping neat polymer solution to the mixing chamber.
4. Pump to be provided with a pressure gauge and pressure relief valve located on the discharge side of the pump and is piped back to the pump suction.
5. Include a calibration cylinder mounted to the skid frame with PVC isolation ball valve. Cylinder to be calibrated in mL and constructed of clear PVC with slip on cap and 1/2-inch NPT vent connection.

E. Dilution Water System

1. Polymer feed system shall have a solenoid valve for automatic OPEN/CLOSE control of dilution water supply. Solenoid valves shall be NEMA 4X with 120V ac coil. Solenoids shall be internally controlled.
2. Dilution water system shall contain primary dilution and post dilution assemblies. Dilution system shall have a rotameter type flow indicator equipped with integral rate adjusting valves. Total water flow rate into unit shall be adjustable.
3. Dilution water shall feed into the motorized mixing chamber and be capable of 2,400 GPH. Primary and secondary dilution water feeds into the mixing chamber shall be capable of 120 – 1200 gph each.
4. Water supply pressure will be approximately 80 psig. All components in the system shall be designed for at least 100 psig working pressure.
5. Units shall have a dilution water loss of flow sensor to detect when water flow has been interrupted for any reason.

2.03 CONTROL SYSTEMS

- A. General: See Section 40 99 90, Package Control Systems, for general instrumentation and control requirements. Instrumentation, control, and electrical components provided under this section shall comply with requirements of Section 40 99 90, Package Control Systems.
- B. Commission-Supplied Controls: Commission shall provide programming and controls for interface between the polymer systems and belt filter press systems.
- C. Panels:
 - 1. Provide a skid mounted control panel.
 - 2. Material: FRP.
 - 3. NEMA Rating: 4X.
 - 4. Tags: 20-VCP-52-1, 20-VCP-52-2, 20-VCP-52-3, and 20-VCP-52-4.
- D. Operator Controls and Indicators: Provide the following panel mounted operator controls and indicating displays on the panel mount controller:
 - 1. On/Off/Remote hand switch.
 - 2. Pump Speed LCD Indicator.
 - 3. Potentiometer (to adjust pump speed in Internal Mode).
 - 4. System On Indicator.
- E. External Interfaces: Provide hardwired control and monitoring signals to the respective Belt Filter Press Panels, 20-VCP-20-1, 20-VCP-20-2, 20-VCP-20-3, and 20-VCP-20-4:
 - 1. Pump speed adjustment control.
 - 2. System RUN command.
 - 3. Loss of water flow alarm.
 - 4. System ON status.
- F. Functional Requirements:
 - 1. Blending unit programmable automation controller (PAC) to operate based on ON/OFF/REMOTE control switch.
 - 2. When in Remote:
 - a. Unit runs in response to external System RUN command.
 - b. Pump speed is adjusted in response to external pump speed adjust signal based on programmed setpoint.
 - c. Polymer pump pacing shall be based on a 4-20 mA analog input signal.

3. Monitor for Low Flow of dilution water. If falling Low Flow is sensed, put the polymer pump in standby. Once dilution water flow resumes (rising Low Flow), restart the polymer pump.
4. Activate loss of water flow alarm if Low Flow of dilution water is sensed for a preset time (initial setting, 15 seconds).
5. Controller to include a pre-programmed auto-flush cycle to turn off polymer pump and allow dilution water to flow through the system for a pre-set time at each shutdown.

2.04 ELECTRICAL

A. Wiring:

1. Provide wiring between pump controller's termination enclosure, solenoid valves, pressure switches, and the pumps.
2. Provide circuit breakers and controllers for each pump.
3. One 120V ac, 30-amp power feed will be brought to the polymer unit.
4. Wiring shall be in conduit.
5. Provide device fusing/circuit breakers as required.
6. Drives and solenoid valves shall be powered from the polymer blend unit.
7. Fuses and circuit breakers shall be housed in each respective control panel, which shall be NEMA 4X.

2.05 ACCESSORIES

- A. Equipment Identification Plates: A 16-gauge stainless steel identification plate shall be securely mounted on the equipment in a readily visible location. Plate shall bear 1/4-inch die-stamped equipment identification name indicated in this specification and/or as shown on Drawings.
- B. Lifting Lugs: Equipment over 100 pounds in weight shall be provided with lifting lugs.
- C. Graduated cylinder calibration kits complete with necessary control valves, connective tubing and fittings shall be furnished for each polymer feed system. Calibration columns shall be sized (capacity) as recommended by the polymer feed equipment manufacturer.
- D. Pressure Relief Valve: Adjustable relief valve set at 100 psig for installation on polymer solution pipeline.

2.06 FACTORY TESTS

- A. Shop Test: Each unit shall be shop-tested prior to shipment from the manufacturer's factory prior to installation. WSSC may at its discretion choose to witness the shop performance test.

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

- A. Manufacturer of polymer feed equipment shall furnish a qualified representative who shall supervise installation of equipment, check for proper mounting, assembly, mechanical adjustment, lubrication, proper control sequencing, general functioning of equipment, and quality of workmanship. Polymer feed equipment shall be installed in strict conformance with manufacturer's recommendations.
- B. Polymer equipment shall meet the requirements of applicable industrial standards or specifications as to design, construction, and performance.
- C. Polymer feed system shall be installed to conform to general layout and alignment shown on Drawings.

3.02 PAINTING

All equipment shall be painted with manufacturer's standard painting system for corrosive service.

3.03 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

3.04 MANUFACTURERS' SERVICES

- A. A manufacturer's representative for equipment specified herein shall be present at Job Site and/or classroom designated by MAWSS for the minimum person-days listed for services hereunder, travel time excluded:
 - 1. 2 person-days for installation assistance, inspection, certification of installation, and functional and performance testing.
 - 2. 1 person-day for prestartup classroom or Job Site training.
 - 3. 1 person-day for startup services.

3.05 FIELD TESTING

A. Test in accordance with general requirements in Section 01 91 14, Equipment Testing and Facility Startup.

1. Preliminary Test:

- a. Demonstrate valve operation:
 - 1) Check operation of OPEN/CLOSED indication lights at PLC.
 - 2) Open and close valves through full range and verify valve operation in manual and automatic modes. In remote mode, demonstrate that valves open and close in response to a PLC signal.
- b. Check electrical and operator controls:
 - 1) HAND/OFF/COMPUTER selector switch.
 - 2) Verify indicating lights.
 - 3) Unit responds to 4-20 mA signal.
 - a) Test unit for a continuous 30-minute period without malfunction under simulated operating conditions. During this operating period, the pumps shall obtain suction from the chemical storage tanks, but the Contractor shall direct the discharge to a suitable clean container for collection of the chemical. Chemical shall then be returned to the chemical storage tanks or disposed of at the direction of the Owner. During the test, record the following:
 - b) Neat polymer flow rate.
 - c) Dilution water flow rate.

END OF SECTION

SECTION 44 46 13.02
SCREW CONVEYOR SYSTEM

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Bearing Manufacturers' Association (ABMA): 11, Load Ratings and Fatigue Life for Roller Bearings.
 2. American Gear Manufacturers Association (AGMA).
 3. American Iron and Steel Institute (AISI).
 4. ASTM International (ASTM):
 - a. A36A/36M, Standard Specification for Carbon Structural Steel.
 - b. A153/A153M, Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
 - c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - d. A385, Standard Practice for Providing High-Quality Zinc Coatings (Hot Dip).
 - e. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 5. Conveyor Equipment Manufacturers Association (CEMA): 300, Screw Conveyor Dimensional Standards.
 6. National Electric Manufacturers Association (NEMA):
 - a. MG 1, Motors and Generators.
 - b. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 7. Underwriters Laboratory (UL): 674, Electric Motors and Generators Used in Division 1 Hazardous (Classified) Locations.

1.02 SYSTEM DESCRIPTION

- A. Dewatered Sludge Shaftless Spiral Conveyors.
- B. Performance Requirements: Design conveyor system to meet service conditions outlined in Supplement No. 1, Conveyor Data Sheet. Each conveyor drive unit shall be designed for 100 percent of rated capacity.
- C. Conveyor selection design standards shall be based on the operational experience of the manufacturer with shaftless spiral conveyors. Designs shall not be based on shafted conveyor performance formula or parameters.

- D. Conveyor rotational speeds shall not be greater than specified, unless availability of the reducer ratio requires slight adjustment (+ 3rpm). Deviations from specified speed shall not be utilized to reduce the conveyor trough and spiral size.
- E. Design conveyors without a center shaft for conveying material with minimal maintenance. Spiral flights shall be designed to be self-guiding and aligning in the trough. Guide bearings shall not be permitted.
- F. Prior to fabricating the screw conveyors, determine the requirements for and furnish brackets, chutes, and fitments required.

1.03 EQUIPMENT NUMBERS:

- A. Cake Conveyor(s): 20-CONV-30-(1, 2, 3, 4, 5, 6, 7, 8).

1.04 RELATED SECTIONS

- A. Related sections include the following:
 - 1. Division 1, General Requirements.
 - 2. Division 26, Electrical.
 - 3. Section 40 27 02, Process Valves and Operators.
 - 4. Section 40 99 90, Package Control Systems.

1.05 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Detail drawings and specifications for components of equipment showing all dimensions, parts, construction details, and materials.
 - b. Equipment performance specifications.
 - c. Equipment process schematics.
 - d. Fabricated items, equipment structural supports, platforms, handrails, and associated items.
 - e. Design loadings, for load combinations, to be transmitted to foundations or supports.
 - f. Size, length, and spacing of anchor bolts or attachments to the foundations or supports.
 - g. Specific details of attachment of bracing members to concrete or steel structures.

- h. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
- i. Conveyor support drawings signed and sealed by a professional engineer registered in the state of Alabama.
- j. Motor nameplate data for motors and actuators.
- k. Control station elevation drawings, including complete Bill of Materials:
 - 1) Layout of control station face showing all pushbuttons, switches, instruments, indicating lights, and similar devices.
 - 2) Complete system schematic (elementary) wiring diagrams.
 - 3) Complete system interconnection diagrams between controller, drive motors, related components or controls external to system including wire numbers and terminal board point identification.
 - 4) Other submittals as required by Section 40 99 90, Package Control System.
- l. Test procedures.
- m. Test results, reports, and certifications.

B. Informational Submittals:

- 1. Design calculations for items covered by these Shop Drawings. Calculations shall show design stresses in structural members and connections for loading combinations.
- 2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
- 3. Installation instructions.
- 4. Manufacturer's test reports.
- 5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
- 6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.06 QUALITY ASSURANCE

- A. Qualifications: Shop Drawings shall be stamped by an engineer registered in the state of Alabama.
- B. All shop welding shall conform to the latest standards of the American Welding Society (AWS).

C. Unless otherwise noted:

1. All equipment included in this section shall be furnished by a single manufacturer who shall be responsible for the design, coordination, and the satisfactory operation of the system.
2. Conveyor manufacturer shall have at least twenty-five (25) shaftless spiral conveyor systems and six (6) vertical conveyor systems operating successfully for at least five (5) years in North America. Valid reference installations include only those that were designed and furnished under the suppliers own name. Equipment which was otherwise bought or re-sold, or supplied under a license or marketing agreement, shall not be considered to meet the experience clause.

1.07 EXTRA MATERIALS

- A. All Spare Parts shall be provided in protective packaging for long-term storage.
- B. Manufacturer shall clearly identify and furnish any special tools required for routine service and maintenance of the equipment. Special Tools shall be provided in packaging designed for storage and repeated use.
- C. The following spare parts shall be supplied, as a minimum:
 1. One (1) packing gland set, for each conveyor supplied.
 2. One (1) complete set of liner for all conveyors.
- D. Conveyors shall be supplied by the manufacturer fully and completely lubricated and ready to be placed into operation. No spare lubricant shall be required for the gear reduction units within the warranty period.

1.08 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twenty four (24) months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

- B. The shaftless spiral and replaceable wear liner shall be warranted for a period of three years after the equipment was first placed into operation at the jobsite against wear.
 - 1. Spiral: Excessive wear on the screw shall be indicated by loss of more than 50 percent of the height of the main outer screw section over 30 percent of the total length of the screw. If excessive screw wear is found the conveyor supplier shall provide new screw for installation by the owner to replace the screw in the conveyor that has excessive wear.
 - 2. Liner: For a wear indicator (two color) liner, excessive wear shall be indicated by appearance of the bottom indicator layer (second color) along more than 30 percent of the conveyor length during the first three years of service. If these wear indications occur the conveyor supplier shall provide new formed and banded liner for installation by the Owner to replace all the liner in the conveyor that has excessive wear.

1.09 SCREW CONVEYOR SYSTEM MANUFACTURER / BELT FILTER PRESS
MANUFACTURER COORDINATION

- A. Conveyor manufacturer shall provide chute and conveyor openings to capture sludge cake discharged from belt filter press. Contractor and Conveyor manufacturer shall coordinate opening size and spacing requirements with Belt Filter Press manufacturer.

1.10 CONTRACTOR / SCREW CONVEYOR SYSTEM MANUFACTURER /
CONCRETE MANUFACTURER COORDINATION

- A. Conveyor supports to be sized and designed by conveyor manufacturer. Supports shown on Drawings are representative. Contractor shall coordinate final location of supports to prevent conflicts with nearby utilities and equipment. Contractor shall coordinate conveyor hanger supports with Conveyor manufacturer as well as the Concrete manufacturer supplying the precast concrete building sections for conveyor support anchors as required.

PART 2 PRODUCTS

2.01 SUPPLEMENTS

- A. See supplements to this section for additional product information.

2.02 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. SPIRAC, Inc.
2. Keystone.
3. KWS.
4. Schwing Bioiset.

2.03 COMPONENTS

A. Materials:

1. Steelplate and Shapes: ASTM A36/A36M.
2. Chutes, Troughs, End Plates, and Covers: ASTM A167, Type 304 stainless steel.
3. Supports: AISI 304 stainless steel, minimum 1/4-inch thick, structural shapes.
4. Spiral Flights: Cold-formed high tensile micro alloy steel (HTMAS), minimum hardness 200 Brinell with ability to transmit 32,000 inch-pounds of input torque.
5. Drive Shaft: Heat-treated alloy steel AISI, Grade 4150, of uniform diameter.
6. Wear Liner: Ultra high molecular weight (UHMW) polyethylene, and modified for wear applications. 5/8 inch minimum thickness installed on maximum 12 inch centers and a maximum of 2 inches from the liner top edge. Wear liner bars are not acceptable.
7. Fasteners, except for power transmission or drive components: ASTM A193, Type 316 stainless steel.

B. Fabrication:

1. All welds to be continuous unless otherwise specified. Facing surfaces of field-welded components shall be beveled and match marked.
2. Sharp corners of all cut and sheared edges shall be made smooth by edge grinding.

C. Surface Preparation:

1. All iron and mild steel surfaces to be painted shall be dry abrasive blasted in accordance with SSPC-SP6, and painted in accordance with manufacturer standards. Surfaces shall be painted or hot dip galvanized within 24 hours to prevent rusting and surface discoloration.

2. Stainless steel shall be cleaned with mild abrasive wheels and/or nonferrous blast media to remove heavy scale and welding carbon and passivated with stainless steel cleaner then rinsed.
3. After surface preparation, ferrous metal surfaces, if any, except for the spiral flighting shall receive a minimum of one (1) coat of epoxy primer. Provide a total minimum dry film thickness of 3 mils prior to shipment to Jobsite.
4. The spiral shall be furnished with one coat of shop primer and a finish coat. Finish coat shall be manufacturer standard coating system for use with dewatered sludge.
5. Stainless steel surfaces do not require painting.

D. Chute(s):

1. Minimum #10 gauge ASTM A36/A36M steel.
2. Openings shall be flanged and bolted.
3. Rigidly supported following manufacturer's recommendations.

E. Trough:

1. Fabricated from minimum #10 gauge, ASTM A167, Type 304 stainless steel.
2. A 2-inch drain tap outlet shall be integral to the conveyor trough at the bottom of the low end, in order to facilitate cleaning. The drain outlet shall be piped to a drain.
3. Horizontal conveyors to be sloped to facilitate draining.
4. Flange fittings for filling and discharge chutes.
5. Troughs shall conform to the dimensional standards of CEMA 300 and enclosure Classification IIIE.
6. Troughs shall be constructed with formed upper faces integral to the body of the trough, in order to provide optimum sealing of the gasketed connection between lid and trough. Designs incorporating structural angle welded to the trough body for the upper faces, shall be fully welded and ground smooth on the inside, with stitch welding on no greater than 6 inch centers on the outside.
7. Non-drive ends shall be provided with flanged bolted end plates, where not axially connected to following equipment.
8. Each trough shall be equipped with inlet and/or discharge openings as shown on the Contract Drawings. Each inlet and discharge opening shall be flanged suitable for interconnection to other devices. Any interconnecting devices such as chutes or hoppers shall be fabricated from the same grade of material as the troughs and with a gauge thickness to suit the application requirements.

9. Safety labeling shall be CEMA severe duty style, appropriate for the equipment, and affixed at the factory. In addition to warning of operation without covers, all warning labels shall include a callout for lockout of power before servicing. When indicated on the Contract Drawings, inspection hatches shall be provided with removable finger guards.
10. In order to avoid excessive wear and increased maintenance the conveyors shall be designed without the use of steel hold down bars or structural steel assemblies. Hold down liner segments which do not interfere with the flow of material are acceptable. Acceptable placement shall be limited to the underside of lids. Segments shall be removable without welding, and incorporate leading and trailing beveled edges.

F. Replaceable Wear Liner:

1. Conveyor troughs shall be lined with ultra-high molecular weight polyethylene (UHMW-PE) based material, which has been specifically modified for the reduced friction and wear requirements of the application. The wear liner for a shaftless conveyor system is of primary importance to functionality and maintainability. Unmodified UHMW or material not specifically designed for the application will not be considered.
2. Wear liner shall be supplied in maximum 4-foot sections, in order to provide for ease of replacement during servicing.
3. Each section of liner shall be a single piece, formed and bonded with two (2) layers of the same material, each of a different color, to provide a visible indication when the liner is nearing the end of its useful life.
4. Each layer shall have been modified to have the same properties for reduced friction and wear. Liners which bond a second layer of unmodified UHMW can be readily dislodged after the primary layer is worn through, and will not be acceptable.
5. The liner shall be held in place with stainless steel cleats, permanently welded to the inside of the trough. No fasteners or penetrations through the trough wall shall be allowed.
6. Liner thickness shall be 1/2 inch for spiral up to 14 inch diameter, and 5/8 inches for larger spirals. On all sizes, the wear indicating color shall be at least 1/8 inches thick, in order to provide the strength to be retained in the trough while showing wear.
7. Replacement liner shall be readily available and stocked in the United States by the shaftless spiral conveyor equipment manufacturer.

- G. Spiral Flighting: Design spiral flights with the stability to prevent distortion and jumping in the trough.
1. At its torsional rating, the stress in the spiral flighting shall not exceed 30 percent of the Fy value in the extreme fiber of the flight material.
 2. Brake Horsepower: Produce less torque than the spiral flighting is rated for.
 3. At 250 percent torque of the motor nameplate horsepower rating, the drive train shall not produce more torque than 250 percent of the spiral flighting's torsional rating.
 4. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft or hanger bearings.
 5. Spiral flights shall be formed from corrosion resistant HTMAS (High Tensile Micro Alloy Steel), and shall be concentric to within plus or minus 2mm.
 6. Spiral shapes shall be cold formed from continuous bar, in two distinct stages, in order to achieve optimum hardness. Shaftless spiral flighting shall not be fabricated from plate.
 7. For increased efficiency, a second, inner spiral, concentric with the outside spiral shall also be provided.
 8. Spiral strength calculations shall be supplied by the manufacturer, to show that torsional ratings of completed spirals exceed the torque load produced within the trough at 150 percent of the design load.
 9. Spiral deformation calculations shall supplied by the manufacturer. Calculations shall be based on the formula for cylindrical helical springs of rectangular cross section, found in the latest edition of Marks' Standard Handbook. Calculations cannot rely on use of a correction factor for close coils, and must result in demonstrating a "spring effect" of the completed spiral which does not exceed plus or minus 1/8 inch per linear foot of spiral under conditions of 100 percent through fill.
 10. The minimum outer spiral thickness shall be 0.50 inches.
 11. Spiral flighting shall have full penetration welds at all splice connections, to present a continuous and complete spiral upon installation.
 12. Limit field welds at the jobsite to only those required due to shipping constraints. Field welds are to be performed by the manufacturer's representative and be certified for proper installation as part of the Certification of Proper Installation and Certificate of Compliance.

H. Spiral Mounting:

1. The driveshaft with integral coupling disc, shall penetrate the end plate through a guarded, serviceable, gland packing housing prior to insertion to the gear reducer. The coupling disc shall be machine faced after fabrication, to include centering hub for spiral mounting and alignment.
2. The connection of the spiral to the drive system shall be through fastening of the driveshaft and spiral coupling discs. Fasteners shall be readily accessible and of a corrosion resistant high strength material.
3. The spiral coupling plate, shall be reinforced with a welded gusset, shaped and formed to provide a transition of load forces from the plate to the spiral. Connections which use torsion arms with point load connections to the spiral shall not be acceptable.
4. The drive shaft assembly shall incorporate a grease lubricated labyrinth seal, serviceable from the exterior of the conveyor, which is shaft mounted internally between the back plate and spiral coupling connection.

I. Bearings:

1. ABMA 11, high capacity roller bearings located in the reducing drive housing with an L-10 life rating of 100,000 hours.
2. Designed to support thrust loads and provide angular alignment with the trough.
3. When recommended by the manufacturer, furnish tail and end bearings. If deflection of the spiral flights in the vertical direction exceeds 1 inch, furnish end bearings.
4. End Bearings: Double pillow block or flange and pillow block type mounted outside the trough; completely serviceable from outside the conveyor; no intermediate bearings.

J. Seals: Compression packing gland between the drive shaft and sleeve.

K. Cover:

1. Bolted covers shall be furnished for any portion of each trough that is not covered by the filling chute. Covers shall be manufactured in maximum four (4) foot lengths to allow for ease of access during replacement of the (shorter) sectioned wear liner. Quick opening covers will not be allowed unless they are also bolted, in order to discourage direct access to the shaftless spiral during normal operation.
2. Minimum 12-gauge, ASTM A167, Type 304 stainless steel.
3. Gaskets between trough and cover.
4. Conform to Screw Conveyor Standards CEMA 300.

L. Gear Reducing Drive:

1. Gear reducers, motors, and other ancillary items shall be designed and rated for the severe environment of this application.
2. Design for full thrust loads from spiral flights.
3. Bearings: Operating life of L-10 30,000 hours.
4. Manufacturer shall provide bearing service life calculations compiled by the gear reducer supplier. Results shall be based on the specific design load of the application, as calculated by the manufacturer. Bearing life shall not be based on a modified value from the specific drive manufacturer.
5. AGMA, Class II, single or double reduction helical gears. Constant speed gear reduction units, with high capacity roller bearings.
6. Aircooled, no auxiliary cooling allowed.
7. The gear reducer shall be sized with a torque service factor of 1.5 times the absorbed power or 1.1 times the motor nameplate at the driven shaft speed, whichever is greater.
8. Applied Torque: To allow for system upset, the drive system shall be designed at a minimum, to operate the conveyor with a trough filled to 1.5x the theoretical design load.
9. Close coupled with drive motor.
10. Drive systems incorporating V-belts or separately supported drives and motors, shall not be acceptable.
11. Drives shall be completely supported by direct mounting to a dual flanged bellhousing adapter, providing connection to the drive end plate of the shaftless spiral conveyor.
12. Bellhousing adaptors shall set off the drive from the trough, in order to allow seepage of any material from the conveyor trough to atmosphere rather than onto the output seal of the gear reducer/ motor drive unit. Directly attaching the gear reducer to the drive end plate of the conveyor will not be acceptable.
13. The drive unit mounting to the end of the trough shall require no additional supports, and there shall be no visible "wobble" movement under any operating condition.

M. Conveyor Supports:

1. Minimum 1/4 inch rectangular Type 304 stainless steel shapes and plates.
2. Ratio of unbraced length to least radius of gyration shall not exceed 240 for tensile members and 120 for compression members.
3. Designed to not exceed 1/3 of AISC allowable stresses when loaded to twice the running torque of the motor.
4. Support Loads: Based on completely filled trough, weight of the conveyor, and dynamic loading when operating.

5. Conveyors shall be furnished complete with supports suitable for mounting at a minimum as shown on the Contract Drawings.
6. Coordinate support locations with facility structure. Supports shall not restrict access to other process systems.
7. Supports shall be fabricated, assembled and fit to the conveyor prior to its delivery to the jobsite. Supports and conveyor segments shall be clearly match marked by the manufacturer for ease of installation by the contractor.
8. For design of floor supports with imbedded anchors, manufacturer shall allow for up to 1-inch of grout beneath each support foot pad for the Contractor to compensate for unevenly poured elevations.
9. Coordinate all reinforcing of floor pad and integrate into design of the sump around the belt filter press if there is an overlap between the footprint of the sump and the floor pad.

N. Motion Detector:

1. Detect underspeed or zero speed.
2. Noncontacting motion sensing unit; lid or trough mounted on the conveyor and away from the drive.
3. Adjustable time delay for startup.
4. One (1) SPDT Form C dry relay alarm contact, rated at 5A at 250V ac, fail-safe operation.
5. NEMA 4X rated enclosure with aluminum probe and neoprene gasket. Includes red LED display for verification of pulses.
6. Operate on 120V ac, 60-Hz provided by the associated motor starter.
7. Manufacturer:
 - a. Siemens Sitrans, Model WM100.
 - b. Or approved equal.

O. Multi-Turn Electrically Actuated Slide Gates:

1. Manufacturer will supply 8 multi-turn electrically actuated slide gates to control and divert the flow of sludge cake through the screw conveyors:
 - a. 20-G-30-5A.
 - b. 20-G-30-6A.
 - c. 20-G-30-7A.
 - d. 20-G-30-7B.
 - e. 20-G-30-7C.
 - f. 20-G-30-8A.
 - g. 20-G-30-8B.
 - h. 20-G-30-8C.

2. Shall have minimal leakage of dewatered sludge cake and liquid as specified herein. The requirements of each slide gate include:
 - a. The slide gate shall be designed so that in the full, open position at least one rotation of the spiral is exposed to the opening in the direction of transport. The slide gates shall have an opening at least the full width of the conveyor.
 - b. Welded construction per AWS standards.
 - c. Gate blade supported on stainless steel rollers, located out of the material flow. Rollers shall include bronze bushings which require no lubrication.
 - d. Gate blade leading edge beveled to facilitate its travel through material being handled. Retract blade area shall have expanded metal safety guards above and below the blade.
 - e. Gate wiping seals made of UHMWPE. Seals contact the top of the gate blade along the perimeter of the throat opening. Seals shall be retained by a bolted steel bar which forms the inlet throat lining of the slide gate.
 - f. Includes a drain that allows liquid to drain out when gate is closed.
 - g. To be actuated with "Remote Actuator Control Station" in accordance with the "Actuator".

P. Drive Motors:

1. All motors shall be 460 volt, 60 Hz, 3 phase, comply with the motor specification and be rated for the operational area noted in the Contract Drawings.
2. Motors shall be of energy efficient design meeting or exceeding the most current edition of NEMA MG1-Table 12-10.
3. Motors shall have a 1.15 nameplate service factor, a TEFC enclosure, and be designed with torque characteristics in accordance with NEMA MG1-12.35 and 12.38.
4. See Section 26 20 00, Low-Voltage AC Induction Motors.

Q. Emergency Pull Cord Switch:

1. Pull cords shall activate a dual relay, trough mounted emergency stop switch, intended to provide a signal to immediately stop the conveyor, and any feeding devices, when activated.
2. Pull cords shall run the full length of each conveyor in a straight path, guided through eyebolts spaced on not greater than 12-foot centers. Cording shall be orange colored, nylon coated, corrosion resistant safety cabling.

3. The pull cord switch shall be housed in an enclosure suitable for the environment.
4. Manufacturer:
 - a. Conveyor Components Company, model RS.
 - b. Or approved equal.

2.04 ACTUATORS

A. General:

1. Comply with latest version of AWWA C542.
2. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of gate.
3. Controls integral with actuator and fully equipped as specified in AWWA C542.
4. Stem protection for rising stems.

B. Drive Unit:

1. TENV, 480-volt, three-phase electric motor as specified in Section 26 20 00, Low-Voltage AC Induction Motors, with integral OPEN/STOP/CLOSE weatherproof pushbuttons, reversing motor starter with integral overload protection, 480/120-volt control power transformer, mechanical dial type position indicator, limit switches, and transparent plastic pipe stem cover and cap.
2. Furnish motor enclosure with drainage and breathing holes.
3. Self-locking, a rated running torque equal to 20 percent of the motor starting torque at a rated running time of 15 minutes, without exceeding the allowable NEMA temperature rise for the insulation class used.
4. NEMA 250, Type 4.

C. Actuator Operation—General:

1. Manual override handwheel.
2. Position indication.
3. Operate from FULL CLOSED to FULL OPEN positions or the reverse in 30 seconds.

D. Open-Close (O/C):

1. Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.
2. LOCAL-OFF-REMOTE Selector Switch, padlockable in each position:
 - a. Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control gate in LOCAL position.

- b. Remote OPEN-STOP-CLOSE momentary control dry contact inputs in REMOTE position. Integral seal-in circuits for remote OPEN and CLOSE commands; gate travel stops when remote STOP contact opens.
- c. Auxiliary contact that closes in REMOTE position.
- 3. OPEN and CLOSED indicating lights.

E. Limit Switch:

- 1. Single-pole, double-throw (SPDT) type, field adjustable, with contacts rated for 5 amps at 120 volts ac.
- 2. Each actuator to have a minimum of two auxiliary transfer contacts at end position, one for FULL OPEN and one for FULL CLOSED.
- 3. Housed in actuator control enclosure.

F. Manufacturers and Products: Rotork Controls, Auma, or approved equal.

2.05 LOCAL CONTROL STATIONS

A. Provide for each Cake Conveyors.

1. Control Station nameplates and Operator Control tag numbers:

Control Station No.	Conveyor No.	Operator Control Tag No.
20-LCP-30-1	Conveyor No. 1 Control Station	Hand-Off-Remote Selector Switch: 20-HS-30-1A Forward-Reverse Selector Switch: 20-HS-30-1B
20-LCP-30-2	Conveyor No. 2 Control Station	Hand-Off-Remote Selector Switch: 20-HS-30-2A Forward-Reverse Selector Switch: 20-HS-30-2B
20-LCP-30-3	Conveyor No. 3 Control Station	Hand-Off-Remote Selector Switch: 20-HS-30-3A Forward-Reverse Selector Switch: 20-HS-30-3B
20-LCP-30-4	Conveyor No. 4 Control Station	Hand-Off-Remote Selector Switch: 20-HS-30-4A Forward-Reverse Selector Switch: 20-HS-30-4B
20-LCP-30-5	Conveyor No. 5 Control Station	Emergency Stop Pushbutton: 20-HS-30-5C Hand-Off-Remote Selector Switch: 20-HS-30-5A Forward-Reverse Selector Switch: 20-HS-30-5B

Control Station No.	Conveyor No.	Operator Control Tag No.
20-LCP-30-6	Conveyor No. 6 Control Station	Emergency Stop Pushbutton: 20-HS-30-6C Hand-Off-Remote Selector Switch: 20-HS-30-6A Forward-Reverse Selector Switch: 20-HS-30-6B
20-LCP-30-7	Conveyor No. 7 Control Station	Emergency Stop Pushbutton: 20-HS-30-7C
20-LCP-30-8	Conveyor No. 8 Control Station	Emergency Stop Pushbutton: 20-HS-30-8C

2. Control Station Enclosure NEMA Rating: NEMA 4X, 316 stainless steel.
3. Control Station Operator Indicators and Controls:
 - a. Emergency Stop Pushbutton (Mushroom-style, maintained).
 - b. Hand-Off-Remote selector switch.
 - c. Forward-Reverse selector switch.

2.06 ACCESSORIES

- A. Anchor Bolts: ASTM A193, Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.
- B. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.
- C. Equipment Identification Plates: Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8 inch high engraved block type black enamel filled equipment identification number indicated in this Specification and as shown.
- D. Furnish lubricants required for startup, initial operation, and testing of the equipment until final acceptance by the Owner.

2.07 SOURCE QUALITY CONTROL

- A. Performance Tests: Completely shop assemble prior to shipment and run for a minimum of 2 hours to ensure proper operation.
- B. Factory Tests and Adjustments: Inspect equipment and test for proper alignment, quiet operation, proper connection, and satisfactory performance of components and controls by means of a functional test conducted using material approved by the Engineer.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Anchor Bolts: Accurately place using templates furnished by conveyor manufacturer and as specified in Section 05 50 00, Metal Fabrications.
- B. Install in accordance with manufacturer's recommendations.

3.02 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below and over a minimum of three trips, travel time excluded:
 - 1. 2 person-days for installation assistance and inspection.
 - 2. 2 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - 3. 1/2 person-day for facility startup.
 - 4. 1/2 person-day for post-startup training of Owner's personnel.
- B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.03 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are a part of this Specification.
 - 1. Conveyor Data Sheet.
 - 2. Induction Motor Data Sheet.

END OF SECTION

CONVEYOR DATA SHEET				
	20-CONV-30-(1 and 2)	20-CONV-30-(3 and 4)	20-CONV-30-(5 and 6)	20-CONV-30-(7 and 8)
PERFORMANCE				
Material Conveyed	Sludge	Sludge	Sludge	Sludge
Density (typ) - lbs/ft ³	70	70	70	70
Volume – ft ³ /hr	408	408	408	816
Spiral Speed (max) – rpm	20	20	20	20
Trough fill rate @ Design - %	40	40	40	40
SYSTEM DESIGN				
Length – ft	Per drawings	Per drawings	Per drawings	Per drawings
Incline – degrees	2	34	2	2
Inlet quantity	2	1	1	2
Outlet quantity	1	1	2	4
Discharge Type (axial or vertical)	Axial	Vertical	Vertical	Vertical
Conveyor size, U or OK trough	U420	U420	U420	U500
Trough ID (min) – inches	14	14	14	18
Trough thickness (min) – gauge	11	11	11	11
Lid thickness (min) – gauge	12	12	12	12
Spiral material	HTMAS	HTMAS	HTMAS	HTMAS
Liner (base) material	UHMW-PE	UHMW-PE	UHMW-PE	UHMW-PE
Liner thickness (min) – inches	5/8	5/8	5/8	5/8
Location of drives (push/pull)	Push	Pull	Pull	Pull
Motor Power – Hp (max)	5	7.5	7.5	10

INDUCTION MOTOR DATA SHEETProject: CC Williams Dewatering Facility and Other ImprovementsOwner: Mobile Area Water and Sewer SystemEquipment Name: Conveyor 1, Conveyor 2, Conveyor 3, Conveyor 4,
Conveyor 5, Conveyor 6, Conveyor 7, and Conveyor 8Equipment Tag Number(s): 20-CONV-30-X (X = 1, 2, 3, 4, 5, 6, 7, 8)

Type: Squirrel-cage induction meeting requirements of NEMA MG 1

Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.Motor Horsepower: (1 and 2) 5 hp, (3,
4, 5 and 6) 7.5 hp, (7 and 8): 10

Guaranteed Minimum Efficiency at Full Load: _____ percent

Voltage: 460V

Guaranteed Minimum Power Factor at Full Load: _____ percent

Phase: 3Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15Frequency: 60 HzEnclosure Type: TEFCSynchronous Speed: Manufacturer's
standard _____ rpm☐ Thermal Protection: _____☐ Space Heater: _____ volts,
single-phaseMounting Type: ☐ Horizontal ☐ Vertical☐ ☐ Vertical Shaft: ☐ Solid ☐ Hollow☐ ☐ Vertical Thrust Capacity (lb): Up _____ Down _____☐ Adjustable Speed Drive: See Section 26 29 23, Low-Voltage
Adjustable Frequency Drive System.

Operating Speed Range: _____ to _____ % of Rated Speed

☐ Variable Torque☐ Constant TorqueAdditional Motor Requirements: ☒ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features: Provide Conveyors with Forward and Reverse operation

SECTION 44 46 16
BELT FILTER PRESS DEWATERING EQUIPMENT

PART 1 GENERAL

1.01 WORK OF THIS SECTION

- A. The Work of this section covers the work necessary to provide 3 belt filter press(es) including press accessories, water booster pump, controls, control panels with adjustable frequency drives, and all appurtenances as specified herein.
- B. The Work of this section also covers the work necessary to provide press accessories, water booster pump, controls, control panels with adjustable frequency drive and all appurtenances necessary to facilitate relocating the existing skid-mounted belt press to the new Dewatering and Controls Building.
- C. The belt filter press manufacturers are advised to familiarize themselves with the overall plant process in order to evaluate the compatibility of the manufacturer's equipment to dewater the particular sludge generated.
- D. The system shall consist of an independent gravity belt thickener and a continuous belt press. It shall be designed to receive a blend of primary and secondary anaerobically digested sludge, concentrate it and dewater the sludge by means of three belts of synthetic fiber mesh arranged to perform the conveying, pressing, and dewatering functions. Each belt press, as described in this section, shall have no less than three distinct dewatering zones. The three zones shall be independent gravity drainage at operator level, wedge, and pressure/shear sections.
- E. Standardization of Similar Equipment: Provide belt filter presses that are the end product of one responsible system manufacturer or supplier to accommodate standardization of similar equipment operation and maintenance, spare parts, and replacement and manufacturer's services.

1.02 EQUIPMENT NUMBERS

- A. Belt Filter Press(es): 20-M-20-(1, 2, 3, 4).
- B. Control Panel(s): 20-VCP-20-(1, 2, 3, 4).

- C. Adjustable Frequency Drive(s):
 - 1. Sludge Feed Pump(s): 20-AFD-20-(1A, 2A, 3A, and 4A).
 - 2. Sludge Distributor(s): 20-AFD-20-(1C, 2C, 3C, and 4C).
 - 3. Belt Drive(s): 20-AFD-20-(1D, 2D, 3D, and 4D).
 - 4. Gravity Belt(s): 20-AFD-20-(1E, 2E, 3E, and 4E).
- D. Sludge Distributor(s): 20-T-20-(1, 2, 3, and 4).
- E. Gravity Belt(s): 20-M-20-(1A, 2A, 3A, and 4A).
- F. Belt Drive(s): 20-M-20-(1B, 2B, 3B, and 4B).
- G. Hydraulic Tensioning System(s): 20-M-20-(1C, 2C, 3C, and 4C).
- H. Sludge Feed Pump(s): 20-P-20-(1A, 2A, 3A, and 4A).
- I. Washwater Booster Pump(s): 20-P-20-(1B, 2B, 3B, and 4B).

1.03 GENERAL

- A. Unit Responsibility: Minimum responsibilities of experienced manufacturer named in qualification submittal include:
 - 1. Supply belt filter press (BFP) equipment, complete with all accessories and appurtenances (including, but not necessarily limited to, electric motors, adjustable speed drives, control panels, AFD panels, shafting, safety guards, speed reducers, polymer injection ring/mixer and spare parts).
 - 2. Design, assembly, delivery, installation supervision, startup, and testing of BFP equipment.
 - 3. Furnish all components and accessories of the system to enhance compatibility, provide for ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions.
 - 4. Produce and assemble BFP equipment at a facility owned and operated by BFP manufacturer and under the direct supervision and control of BFP manufacturer.
- B. AC Induction Motor Requirements: Conform to the requirements of Section 26 20 00, Low-Voltage AC Induction Motors.

- C. Adjustable Frequency Drive Requirements: Conform to the requirements of Section 26 29 23, Low-Voltage Adjustable Frequency Drive System. Submit a letter verifying compatibility of AFDs with the associated motor and coordination of AFD sizing requirements. All AFDs provided by the belt filter press manufacturer shall be 6-pulse AFDs with a minimum of a 4 percent input line reactor on each AFD to minimize the harmonics that are propagated upstream to the remainder of the electrical distribution system. All motors that are operated and controlled by an adjustable frequency drive shall be inverter duty rated. Additionally, the only AFD manufacturers that will be considered with this equipment are Eaton, Square D, Allen-Bradley, and Danfoss. Allen Bradley is listed in this section as an acceptable AFD manufacturer, but only for this equipment. Allen-Bradley will not be considered for any other AFDs being provided as part of this Project and are not listed as an acceptable manufacturer in Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
- D. All AFDs that are provided as part of this section shall be rated at a minimum of 1.15 times the motor nameplate FLA. Additionally, all AFD provided as part of this section shall also include a minimum of a 4 percent input line reactor.
- E. Sludge Feed Pump Requirements: Conform to the requirements of Section 44 42 56.12, Induced Flow Recessed Impeller Centrifugal Pumps; or Section 44 42 56.18, Self-Priming Centrifugal Pumps based on manufacturer supplied pump selection. The design drawings are based upon the A-named induced flow recessed impeller pump manufacturer.
- F. Control System Requirements: Conform to the requirements of Section 40 99 90, Package Control Systems.
 - 1. The control functions contained and described herein provide minimum performance requirements. They do not necessarily identify each and every control function, connection, communications, or equipment required by a manufacturer to achieve the specified performance. Reflect components and interfaces required to meet performance criteria in submittals.
- G. System Interfaces: Coordinate the interfaces between the dewatering belt filter press and sludge feed pump, washwater booster pump, screw conveyors and polymer feed system.
- H. Emergency Stop Push Button and Pull Cord control and power interrupting circuits are to be designed in accordance with OSHA and Machinery Safety Standards.

1.04 REFERENCES

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

1. Anti-Friction Bearing Manufacturers Association (AFBMA).
2. American Gear Manufacturers Association (AGMA).
3. American National Standards Institute (ANSI).
4. American Society of Mechanical Engineers (ASME): PTC-36, Measurement of Industrial Sound.
5. American Welding Society (AWS).
6. ASTM International (ASTM): G65, Procedure A, Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests.
7. British Standards Institute (BSI): BS 5490.
8. German Industrial Standards (DIN).
9. Institute of Electrical and Electronics Engineers (IEEE).
10. Instrument Society of American (ISA).
11. National Electric Code (NEC).
12. Occupational Safety and Health Act (OSHA).

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Document modifications to manufacturer's standard design to meet specified requirements and identify elements of manufacturer's standard design that do not comply with performance, features, functions, and materials of construction specified herein.
 - b. Make, model, weight, and horsepower of each equipment assembly.
 - c. List of BFP model reference installations including location, sludge stream, number of units, starting date of operation, and reference contact information.
 - d. Manufacturers:
 - 1) Catalog information, descriptive literature, specifications.
 - 2) Identification of materials of construction for BFP, motors, adjustable speed drives, control panel, AFD panel, power supply, lubrication system, and flexible connectors.
 - a) Listing of materials of construction to confirm compliance with requirements specified herein.

- e. Certification that structural and mechanical calculations have been completed, signed, and sealed by a professional engineer, including:
 - 1) Calculations to indicate all loads and stresses generated in the BFP framework conform to the specified minimum factor of safety.
 - 2) Calculations to indicate that all bearings comply with the specified requirements for minimum L-10 bearing life based on maximum loadings.
 - 3) Calculations to indicate that all roller shaft deflections are less than “or-equal” to specification.
 - 4) Finite element model for rollers and frame with maximum deflection values for each element.
- f. Finalized dimensional plan and sections of the complete equipment.
- g. Proposed dimensional plan and sections of the complete BFP unit mounted on concrete curbs, showing all pipe connections and anchor bolt locations.
- h. Filtrate and washwater collection plans and piping details.
- i. Doctor blade, discharge chute, and details of equipment placement with respect to the downstream conveyor(s).
- j. Detailed descriptive literature and complete specifications on each electrical control, pilot, or monitoring device. Provide detailed description of interlock, control, or protective function provided by each item.
- k. Wiring and interconnection diagrams and control elementaries for all electrical, instrumentation, and control devices.
- l. Electric motor nameplate data for all drives. See Section 26 20 00, Low-Voltage AC Induction Motors, for motor submittal requirements.
- m. Hydraulic or pneumatic control system layout and details, including arrangement drawing, piping diagrams, schematic and wiring diagrams, complete bill of materials, and description of control functions and features.
- n. Bill of materials listing major system components, special tools, and spare parts.
- o. Outside utility requirements such as air, water, power, drain, etc., for each component.
- p. Motor submittals in conformance with Section 26 20 00, Low-Voltage AC Induction Motors.
- q. AFD submittals in conformance with Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
- r. Certificate(s) demonstrating that the BFP production and assembly facilities are currently ISO 9001 certified.

- s. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
- t. Sequential description of operation under various modes of control, describing the complete control circuit and equipment operation and logic, including interlocks and permissives.
- u. Description of all automatic shutdown features and interfaces with the plant instrumentation and control systems, in both word and schematic form. Use Standard Instrument Society of America symbols on all schematics.
- v. Control and AFD Panel interconnection diagrams showing wiring interconnections between all BFP system components and between BFP system components and remote components provided by others.
- w. Control and AFD panel elevation drawings showing construction and placement of operator interface devices and other elements.
- x. Instrumentation and Control Submittals: In conformance with Section 40 99 90, Package Control Systems.
- y. Power and control wiring diagrams, including terminals and numbers.
- z. Shop and Field Painting Systems Proposed: Include manufacturer's descriptive technical catalog literature and specifications, and hazardous communication data sheets.
- aa. Anchorage and bracing drawings and cutsheets as specified in Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

- 1. Factory Quality Control Submittals:
 - a. Obtain Engineer's review and approval of the information listed below prior to equipment shipment.
 - b. Manufacturer's Certificate of Compliance.
 - c. Factory Test Results, Reports, and Certifications: Include:
 - 1) Functional test reports and certificates.
 - 2) For each ac motor, provide a certified copy of a test report for an identical motor tested in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B. The test report shall show full-load efficiency and power factor meeting or exceeding the specified minimum guaranteed values. Motors not as specified will be rejected.
 - d. Submit certified copies of mill test results for the stainless steel castings and abrasion-resistant materials to be used. Certify that the materials supplied are in accordance with the applicable standards.

- e. Test results of the control panels and AFD panels for proper operation, construction, electrical connection, and function.
- f. Shipping, storage and protection, and handling instructions.
- g. Manufacturer's written/printed installation instructions.
- h. Routine maintenance requirements prior to plant startup.
- 2. Anchorage and bracing calculations as specified in Section 01 88 15, Anchorage and Bracing.
- 3. Provide Operation and Maintenance Manual with Maintenance Summary Form in accordance with Section 01 78 23, Operation and Maintenance Data, and the following requirements:
 - a. Operation, maintenance, recommended spare parts, and renewal parts information for all equipment furnished under this section.
 - b. Set of complete as-reviewed Shop Drawing submittals.
 - c. As-built electric and instrumentation and control wiring diagrams and equipment drawings.
 - d. Index of all equipment suppliers listing current names, addresses, and telephone numbers of contacts for service, information, and assistance.
 - e. Detailed operational procedures including step-by-step startup, normal operation, shutdown, and troubleshooting procedures.
 - f. Detailed preventative maintenance requirements and recommended schedule.
- 4. Equipment Testing Procedure Submittals: Submit test procedures for the following tests for review, comment, and approval at least 30 days in advance of the notice to conduct the testing:
 - a. Functional testing.
 - b. Pre-performance testing.
 - c. Performance testing.
 - d. Optimization testing.
- 5. Field Quality Control Submittals:
 - a. Obtain Engineer's review and approval of documents listed below prior to project completion. Submit test reports within 20 days after completing field testing.
 - b. Field Test Results, Reports, and Certifications: Include:
 - 1) Functional test report and certificates.
 - 2) Manufacturer's Certificate of Proper Installation.
 - 3) Pre-performance test report and certificates.
 - 4) Performance test report and certificates.

1.06 EXTRA MATERIALS

- A. Spare Parts and Special Tools: Furnish spare parts and special tools as follows prior to the start of the guarantee period and maintain the spares in full stock during the guarantee period by the manufacturer. Provide and install (except belts as specified) all replacement parts required during the guarantee period. Suitably mark and package the spare parts and tools for shipment and storage.

Item	Quantity
Upper and Lower Belts	1 belt each size for each press
Sensor Paddles	1 set for each press
Doctor Blades	1 complete set for each press
Roller Bearings with seals	1 bearing of each size and type
All seals, Skirts, and Splash Guards shower seals (excluding motor and bearing seals)	1 complete set for each press
Metric Tool Kit with Metal Toolbox	Bearing puller kit, sockets and open ends for each size bolt and bearing
Touchup Paint	One gallon, each type

- B. Replacement Belts:
1. In addition to the spare belts provided, furnish all belts used during the guarantee period. Install the first set of belts. All replacement belts will be installed by Owner.
 2. The replacement belts shall remain the property of Contractor during the guarantee period. Label belts as manufacturer's replacement belts. Package belts to prevent damage or deterioration during prolonged storage. Provide all belts used by the manufacturer and/or Owner prior to the start of the guarantee period.
 3. Owner will discard all used belts after installing spare belts, unless otherwise requested by Contractor. Pay all costs for shipping new spare belts and return of used belts.
 4. Order spare belts only after the optimum filter fabric has been ascertained by the manufacturer. Provide a letter of recommendation from manufacturer for the selected fabric style.

- C. Lubricants: Furnish and install all lubricants for initial belt press startup and testing. Change lubricants upon completion of installation, during test period, and as required in accordance with manufacturer's recommendations prior to final acceptance. Install new lubricants into all components of the equipment at the beginning of the guarantee period (by Contractor). Owner will provide and maintain lubricants during guarantee period.
- D. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

1.07 SAFETY REQUIREMENTS

- A. Construct all equipment with due regard to safety of operation, accessibility, and durability of parts, in compliance with all applicable OSHA, state, and local safety regulations.
 - 1. Provide emergency stop cords around the full perimeter of each BFP.
 - 2. Provide emergency stop push button on the face of each BFP control panel.

1.08 SPECIAL GUARANTEE

- A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or removal and replacement of Work provided under this Specification section (including but not limited to the belt filter press, drive motors, control panel, AFD panel, and adjustable frequency drives) found defective during a warranty period of 3 years. With the exception of warranty period, all other requirements specified in the General Conditions remain in effect. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.
- B. Guarantee equipment provided meets or exceeds all requirements of the Specification at the specified feed conditions. Furnish all equipment and auxiliary items from one equipment manufacturer who shall be wholly responsible for their design, performance, and coordination. Warrant and guarantee the mechanical integrity and engineering design, including but not limited to warranty against defective materials, workmanship, and ordinary wear and tear, of all parts and components of the belt filter presses supplied herein for a minimum period of 2 (industry standard) year from the date the units have been accepted by Owner at substantial completion. Extend additional warranty and guarantee for the following:
 - 1. BFP framework and coating for 8 years; the manufacturer shall repair any defects or corrosion during the warranty period. This shall cover both parts and labor.

2. Bearings for 5 years; replace any bearing that fails during the warranty period provided Owner has lubricated the bearings in accordance with manufacturer's instructions.
3. Rollers for 3 years; replace any roller or roller coating that fails during the warranty period provided the roller has not been damaged by external actions such as fire, weld splatter, etc., beyond the manufacturer's control. This shall cover both parts and labor.
4. Belts for 2,000 operating hours; repair any belt that fails during the warranty period. Splicing of belts does not constitute a belt failure unless excessive splicing is required. Excessive splicing of belts is defined as more than two splices required during the warranty period.

PART 2 PRODUCTS

2.01 GENERAL

- A. Employ Three Distinct Dewatering Zones: A gravity drainage zone, a wedge pressure zone, and a shear-pressure zone in the BFP design. At the end of the shear-pressure zone, use doctor blades to cleanly discharge dewatered cake onto a screw conveyor, provided by others. Completely wash the belts as they return to the head end of the unit, showing no visible cake solids adhering to the belt.
- B. Provide dewatering by the following sequence:
 1. Gravity Zone: Horizontal zone of gravity drainage through the filter belt.
 2. Wedge Zone: Entrain the sludge between two continuous open meshed belts.
 3. Shear-Pressure Zone: Sandwich the cake between the belts and alternately apply compression and shear to the cake as it passes over perforated and solid drums and rollers; provide a belt tensioning system to act on these rollers to provide ever increasing pressure as the sludge advances toward the discharge end.
- C. Provide complete BFP including frames, distribution troughs, drainage and dewatering belts, belt drives, belt tensioning systems, belt alignment systems, hydraulic belt tracking and tensioning system, doctor blades, belt washing systems, control and instrumentation devices, drainage components, drum-roller assemblies and bearings, motors, terminal junction boxes, pneumatic control system, and polymer injector, as specified.
- D. Design and amply proportion all parts of the mechanism for all stresses which may occur during fabrication, erection, and operation.

- E. Allow easy access to internal BFP components and ensure all operating adjustments to be made without interrupting operation of the BFP.
- F. Provide L grade stainless steel for components constructed of stainless steel, if welding is required.
- G. The BFP will be designated as either a right- or left-hand unit as part of the Shop Drawing review process. Right- and left-hand unit shall mean that all piping and maintenance activities can be performed from only one side of the BFP. The other side of the BFP will require minimal visual observation on a periodic basis.

2.02 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
 - 1. BDP; Model-3DP, 70 PLI.
 - 2. No Substitutions.
- B. BFP Manufacturer Qualifications: The belt manufacturer shall have provided heavy duty 70 PLI belt filter presses with a minimum belt width of 2 meters at a minimum of 20 municipal wastewater sludge thickening/dewatering reference installations in North America with units representative of those to be supplied, with each unit operational for a minimum of 5 years. Manufacturers not meeting minimum reference installation requirement shall not be acceptable. Submit list of reference installations including model number, location, sludge stream and characteristics, number of units, starting date of operation, and reference contact information.

2.03 SERVICE CONDITIONS

- A. Suitable for installation indoors or outdoors, for exposure to continuous 100 percent relative humidity conditions, for operation in ambient air temperature from 40 degrees F to 110 degrees F, and for exposure to biological sludge, splash, spill, and washdown conditions.
- B. The material to be dewatered (wastewater sludge) will be a blended anaerobically digested sludge, ranging from 1.0 percent to 4.0 percent solids by mass.
- C. Provisions shall be made to inject one polymer into the BFP sludge feed lines and mix the polymer and sludge prior to discharging of the sludge on the belt filter press gravity deck. The manufacturer shall, therefore, provide one polymer injection ring with an adjustable in-line variable orifice mixer for each BFP.

2.04 PERFORMANCE REQUIREMENTS

- A. Continuously receive, flocculate, condition and dewater the feed sludge specified herein, and neatly discharge the dewatered sludge cake to a screw conveyor.
- B. Operate continuously or intermittently on demand. Suitable for dewatering the specified sludge continuously for 24 hours per day, 7 days a week, and shall perform the required dewatering operations at the loading and operating conditions specified herein without side extrusion of sludge between the belts or spillage of sludge beyond the BFP envelope.
- C. Numeric Performance Requirements:
 1. The required performance standards establish values for each performance parameter which must be guaranteed to be matched or exceeded by the manufacturer, and achieved during Performance Acceptance Testing. All performance standards are based on dewatering liquid sludge under any combination of conditions listed in Article Service Conditions.

BFP Performance Requirements	
Item	Required
Influent Sludge Characteristics (Anaerobically Digested)	Waste Activated and Primary Sludge
Influent Solids Concentration (percent)	1.0% - 4.0%
System Design Point 1	
Design Solids Loading Rate (lb/hr/meter)	750
Minimum cake solids concentration at system design point 1 solids loading rate and design influent solids, dry weight, (percent total solids)	17.0
System Design Point 2	
Design Solids Loading Rate (lb/hr/meter)	1,500
Minimum cake solids concentration at system design point 2 solids loading rate and design influent solids, dry weight, (percent total solids)	16.0

BFP Performance Requirements	
Item	Required
Minimum overall solids capture at both system design point 1 and 2 conditions, (percent)	95
Maximum polymer dose at design conditions at both system design point 1 and 2 conditions (lb Active/ dry ton)	25

2.05 EQUIPMENT

A. General:

1. The equipment covered by these Specifications is intended to be belt filter press dewatering equipment of proven ability as manufactured by reputable concerns having long term experience in the production of such equipment. The equipment shall be designed and constructed in accordance with the best practice and methods.
2. All components of the sludge dewatering equipment shall be engineered for long continuous and uninterrupted service. Provisions shall be made for easy lubrication, adjustment, or replacement of all parts. Corresponding parts of multiple units shall be interchangeable. Except as otherwise specified, steel plates and shapes shall have a minimum thickness of 1/4 inch and bolts shall have a minimum diameter of 1/2 inch.
3. All welding shall be in accordance with the latest acceptable codes of the American Welding Society ANSI/AWS D1.1.
4. All material used in the construction of the sludge dewatering equipment shall be of the best quality and entirely suitable in every respect for the service required. All structural steel shall conform to the ASTM standard specification for structural steel, designation A 500. All iron casting shall conform to the ASTM standard specification for gray iron casting, designation A48-76, and shall be of a class suitable for the purpose intended. Other materials shall conform to ASTM specifications where such specifications exist; the use of such material shall be based on continuous and successful use under the similar conditions of service.
5. Unless otherwise specified herein, all metal parts in contact with polyelectrolyte or sludge shall be Type 316L stainless steel. All fasteners, pins, and anchor bolts shall be Type 316L stainless steel.
6. All fiberglass-reinforced plastics (FRP) shall be manufactured in conformance with NBS standards PS15-69.

B. Frame:

1. Designed to accommodate all operating and static loads plus the specified factors of safety at 70 PLI (pounds per lineal inch of each belt) belt tension without significant deflection, deformation, or vibration during operation; no disassembled components (other than the BFP frame) shall weigh more than 6,000 pounds. Provide lifting lugs as necessary to afford convenient access to maintenance points throughout the BFP.
2. Contain all horizontal loads within the BFP frame. Only vertical loads may be imposed on the BFP supporting structure.
3. Frame Structural Members:
 - a. Type 316L stainless steel with minimum flange thickness of 3/8 inch and minimum web thickness of at least 1/4 inch. Tubular sections are not permitted.
 - b. Provide minimum safety factor under maximum load of five times the design yield strength of any frame member.
 - c. Provide minimum design load for belt tension of 70 PLI which is equivalent to 200 pounds per inch of belt width in the pressure zone.
 - d. Provide load-bearing frame members with moments of inertia not less than 59.9 inches to the fourth power.
 - e. Maximum unsupported frame spans of 8.5 feet.

C. Sludge Conditioning:

1. Furnish an in-line, manually adjustable, 4-inch nonclog venturi mixer for contacting polymer solution with sludge feed for each BFP. Equip each mixer with a vortex polymer injection ring with four tangentially mounted polymer injectors. Locate mixer upstream of the BFP in the sludge feed piping to provide the polymer detention period required. Mixer to include the following features:
 - a. 4-inch diameter flanged, Type 316L stainless steel housing with a weighted, carbon steel hot-dipped galvanized (4 mils to 7 mils).
 - b. Adjustable auxiliary mixing device with shaft and O-ring seal.
 - c. Removable side plate for inspection and cleaning.
 - d. Position indicator which identifies the percent open at the throat. Approximately 3.8 square inches open throat area and infinitely adjustable downward with the auxiliary mixing device.
 - e. Readily accessible parts that require cleaning, maintenance, or operational adjustments.

- f. Tygon tubing with stainless steel fittings for polymer solution piping for interconnection of the four tangentially mounted polymer injectors to the polyethylene distribution manifold. Provide a 1-1/2-inch threaded coupling at the polyethylene manifold to accept the polymer supply line.
- g. Stainless steel ball valve for each polymer injector feed line.
- 2. Inlet Distributor:
 - a. Provide a distribution assembly to gently distribute conditioned sludge onto the gravity dewatering zone, and to prevent spillage or leakage by means of seals against the gravity belt. Include the following features:
 - 1) Design the assembly to minimize turbulence of the conditioned sludge and provide for maximum hydraulic loading of 300 gallons per minute.
 - 2) Extend discharge channel from the full pipe or tank diameter and fan out to a rectangular discharge of the same width as the gravity zone.
 - 3) Design arrangement to minimize velocity and overflow in an even manner onto the gravity zone.
 - 4) Distributed and control flow by a pivoting, transverse mounted leveling plate with means to vary the weight.
 - 5) Fabricate of 12-gauge, Type 316 stainless steel, with adjustable baffles, or similar devices to uniformly distribute the sludge feed across the entire working width of the belt.
 - 6) Provide perimeter of assembly with a skirt to prevent leakage or splashing from the box.
 - 7) Bolts or other members used to mount the assembly shall not protrude into the sludge flow stream. There shall be no vertical edges within the sludge flow stream that could collect material.

D. Gravity Drainage Zone:

- 1. Include a gravity drainage zone to accept sludge from the inlet distributor. Design to prevent spillage or leakage and easy accessibility for operating, viewing, cleaning, and adjusting. Contain sludge within the gravity zone by a barrier or headbox equipped with specially designed seals that prevent sludge leakage and also prevent seal wear and belt wear. Fabricate barrier assembly of 14-gauge, Type 316 stainless steel.

2. To ensure effective free water removal, provide a minimum of 55 square feet of effective gravity drainage zone for each BFP. Inclined (above 2 degrees from the horizontal) or vacuum-assisted gravity zone or rotary gravity zone is unacceptable. Effective gravity drainage zone area is defined as the horizontal area between the belt seals, where sludge is on the belt, and where the belt is supported by a slotted grid. All belt area on rollers shall be excluded from this area computation.
3. Employ a series of plows, or similar devices, to ensure an even distribution of sludge across the entire width of the gravity drainage belt. Size and design the devices such that the entire length of each device rides flat on the belt. Provide a minimum of eight rows of plows, or similar devices to ensure that all of the sludge on the gravity zone contacts the devices to achieve maximum drainage of free water. Design the devices of sufficient strength to prevent the devices from deflecting and breaking under high loadings.
4. Provide a stainless steel tubular lifting handle so that each row of plows can be easily raised for cleaning and balancing and stay in the raised position, if desired. Construct shaft supporting a row of plows of Type 316 stainless steel with bushing mount for lateral movement flexibility. Include locking set screw to firmly attach the plow to the shaft.
5. Support belt in the gravity drainage zone by means of a slotted grid. Construct grid of replaceable high-density polyethylene members, nylon, or ultra-high molecular weight polyethylene and support with a Type 316 stainless steel frame. Size grid minimum 2 inches wider than the width of the belt and designed to reduce belt wear. Rollers for support of the gravity zone are not allowed. Extend grid a minimum of 3 inches upstream at the point of application of sludge on the belt surface. Prevent deflection in any direction along or across the grid at maximum sludge loadings to 0.05 inches. Utilize replaceable support strips. Fabricate Type 316 stainless steel drainage pans for the gravity drainage zone in a manner to enable connection of drain water piping at a single low point on each BFP within the press envelope. Refer to Paragraph Drainage Collection and Paragraph Belt Washing contained herein, for additional requirements.
6. Provide device(s) for positive detection of NO CAKE condition. Utilize adjustable device(s) with SPDT dry contact output.

E. Wedge Zone:

1. After gravity drainage, provide an adjustable wedge zone with a minimum horizontal area of 40 square feet. Design transition from the gravity zone to the wedge zone to evenly distribute sludge across the wedge zone and to prevent spillage or overflow of sludge.

2. Provide upper and lower belts that uniformly converge to squeeze the sludge and exert continuously increasing pressure. A multi-nip roller assembly and/or stationary pipes are not acceptable as a wedge zone. At the maximum BFP performance requirement loading condition, no extrusion or spillage of sludge from the belt is allowed at any point in the wedge zone. Provide splash guards to contain any leakage from the wedge zone within the press envelope. Provide adjustable wedge angle for process flexibility. The effective wedge zone area is the belt surface area in square feet where the sludge is confined between two belts with the width limited to the width of seals in the gravity zone excluding all areas where two belts are not in simultaneous contact with the sludge.
3. Define wedge zone pressure as the transitional pressure between the gravity zone and first high pressure roller (0.1 psi to 2 psi).
4. Fabricate all wedge zone framework or supporting structures of Type 316 stainless steel.

F. Pressure Zone:

1. After the wedge zone, provide a perforated Type 316 stainless steel roll, minimum diameter of 16 inches, as the initial roll in contact with sludge to allow for the gradual buildup of belt pressure. Design to prevent extrusion or spillage of sludge from between the belts at any point in the pressure zone. Provide minimum roll diameter of 12 inches in the remainder of the pressure zone. Use S-shaped roll configuration to apply maximum pressure and shear.
2. To ensure maximum pressure time and shear forces necessary to produce the desired cake dryness under a range of operating conditions, provide a minimum of 128 square feet of effective belt area in the pressure zone. Effective belt area within the pressure zone is defined as the total roller surface area in contact with a medium of belt/sludge sandwich and with the sludge under pressure to remove water. Provide a minimum of eight rollers that apply pressure to the sludge including the perforated roller in the pressure zone. Arrange rollers in decreasing diameter, with no more than four rollers the same diameter.

G. Belt Material:

1. Fabricate and seam belts of monofilament polyester, wear-resistant plastic materials. Select mesh design for optimum dewatering of the sludge to be processed without binding of the filter belt.
2. Base belt selection on the manufacturer's experience at other installations dewatering similar sludge using similar polymer conditioning.

3. Provide belt widths and effective area as hereinbefore specified and with minimum life of 2,000 operating hours at the BFP performance requirement loading condition. Belt life guarantee to include replacement of belts damaged due to defects in the manufacture of the BFP or any of its components, and failure of connecting splice.
4. Design each belt and connecting splice or seam for a minimum tensile strength equal to five times the normal maximum dynamic tension of 50 PLI to which the belt is subjected. Design splice or seam to fail before the belt. Construct belt splice or seam closure of ASTM A167, Type 316 stainless steel. Splice or seam shall not produce interference with doctor blades.
5. Design machine such that belt replacement possible without requiring disassembly of machine components.
6. Material and design of auxiliary systems used in conjunction with the belts as selected by the manufacturer to assure maximum operating life and to minimize maintenance. Chamfer all fixed edges along belt operating surfaces. Provide 1-inch-wide plastic coating on each side of the belts.

H. Belt Tracking and Tensioning:

1. Provide the BFP with an individual, independent hydraulic belt tracking and tensioning system. Use of electrical servos or mechanical take up systems is not acceptable.
2. Size all tubing within the system according to the intended use. Use ASTM A320, Type 316 stainless steel for all piping, tubing, pressure rams, cylinders, and fittings. Connect the pressure rams on each end of the tension roller to each other by a Type 316 stainless steel rack and pinion system to ensure proper alignment of the roller.
3. Continuously and automatically monitor belt positioning by Type 316 stainless steel regulator valves, installed with guide devices. The guide device shall ride the edge of the belt. Utilize regulator valves to continuously sense belt alignment and upon misalignment automatically walk the belt back to the normal operating position by means of an actuator. Design belt tracking system so that all belt position adjustments are performed smoothly without sharp sudden movements of the belt or alignment roller. Incorporate self-aligning pillow block bearings on opposite end of tracking rolls which should conform to the bearing design features as specified under Paragraph Roller Bearings, herein. Limit the angular movement between the bearing centerline and alignment shaft centerline to roller shaft deflection. Automatically operate belt tracking using manufacturers systems.

4. Equip each belt with a system to automatically ensure preset belt tension while dewatering varying sludge concentrations in the pressure zone. Assure parallel and simultaneous movement of the tension rollers. Fabricate all thrust arms and mechanical interconnects of Type 316 stainless steel.
5. Provide a pressure versus bellows extension graph to correlate gauge pressure with bellows position. Provide graph to indicate actual belt tension in pounds per linear inch and normal operating limits. Accommodate at least 3 percent increase in belt length using belt tensioning system. Indicate belt tension on gauges, with manual adjustability at the control system.
6. Provide devices for positive detection of belt misalignment and belt break. Device output shall be SPDT dry contacts.
7. Hydraulic Power Unit: Provide each BFP with a dedicated hydraulic power system to provide pressurized oil for the steering and tensioning. The unit shall consist of a 1-gallon reservoir; variable-displacement pressure compensated hydraulic oil pump and drive motor, hydraulic oil filter, pressure gauges, piping, valves and cylinders to make a complete operational system.
8. Mount the pump, motor, reservoir, oil filter, and valves directly to the belt press frame to minimize excess piping runs, fittings, and hoses. Properly size all hydraulic lines for the pressure and flow of the unit. Construct pressurized hydraulic lines of Type 316 stainless steel tubing and rigidly support the lines on the structural frame of the press. Construct flexible lines to cylinders, low-pressure connections to the reservoir, etc., from hose of the material and construction appropriate to the application. Construct the hydraulic reservoir of translucent high-density polyethylene (HDPE) to allow visual inspection of the oil level.
9. Supply pump motor of 2 hp with maximum noise level of 70 dBA. Utilize cast iron TEFC 1,200 rpm, NEMA B design motor with a "C" face mounting for the hydraulic pump adapter.

I. Drainage Collection:

1. Construct filtrate, washwater, and drainage collection pans of a minimum 14-gauge Type 316 stainless steel. Fiberglass drainage collection pans are not acceptable. Provide separate collection pans and piping for the gravity, wedge, and pressure zones. Use self-venting drain connections to prevent overflow. Pans shall not emit vibration noise. Provide drainage pans to collect all free and spray water under all gravity, wedge, and pressure zones of the BFP. Extend drainage pans a minimum of 3 inches beyond the edge of all belts and include vertical sides with a minimum height of 2 inches.

2. Provide separate drainage piping from each pan to convey all drainage and filtrate flows from the drainage pans to Contractor-furnished filtrate piping. See Drawings for piping interface location. Provide Schedule 10 Type 316 stainless steel or Schedule 40 PVC for all drainage piping from collection pans and belt washing stations.

J. Water Booster Pump:

1. Provide one pressure boosting system per BFP complete with pumps, motors, controls, and appurtenances as specified.
2. Manufacturers:
 - a. Goulds.
 - b. Or approved equal.
3. Components:
 - a. End-suction centrifugal pump; configured as shown on the Drawings.
 - b. Pump shall be supplied with an adjustable frequency drive to maintain programmed washwater flow and pressure at various suction side pressures.
 - c. Domestic water supply pressure: 30 to 65 psi.
 - d. Design pump discharge pressure: 125 psi or per manufacturer's recommendation.
 - e. Design pump flow rate: 100 gpm or per manufacturer's recommendation.
 - f. Motors:
 - 1) 460-volt, 15 horsepower, 3-phase.
 - 2) TEFC enclosed motor.
 - 3) Motor shall be inverter duty rated.
 - g. Pump motor shall be powered and controlled from BFP control panel.

K. Belt Washing:

1. Provide BFP with three separate and integral belt washing stations suitable for cleaning the gravity drainage belt and two dewatering belts as they return to the head of the BFP. Provide separate connections, isolation and control valving, and piping to regulate and divert the belt spray washwater to each wash station within the BFP. Provide electrically actuated ball valves for control.
2. Interconnect all components of washwater system by Type 316 stainless steel piping with the entire washwater system receiving water from a single connection point located at the periphery of the BFP for connection by others to the filtrate drain.

3. Include at each wash station a high pressure spray pipe header, flat jet spray nozzles, nozzle cleaning unit, and containment to eliminate spray from the work area. Cleaning unit shall be a Spraco Showers Washwater Cleaning Unit, Appleton Manufacturing, Menasha, Wisconsin, or approved equal. Construct spray headers and nozzles of ASTM A320, Type 316 stainless steel. Provide built-in nozzle cleaning unit design suitable for cleaning nozzles without disassembly of wash station or interruption of sludge dewatering operations. Fabricate wash station enclosure of ASTM A167, Type 316 stainless steel.
4. Include collection pans and drain piping to prevent spray water from discharging outside of the BFP containment area, if wash station is not totally leakproof.
5. Provide spray header housing that totally encloses the belt, with replaceable seals where the belt enters and exits the housing. Adequately brace the spray piping nozzles and ensure sufficient pressure rating to withstand pressure transients caused by sudden valve closures.
6. Include safety guards over exposed metallic washwater piping to prevent contact as a result of the potential use of high temperature washwater (up to 140 degrees F).
7. Utilize chain operators or servo motors to actuate shower cleaning brush and purge system handwheels (located above a certain height 6).

L. Drum and Roller Assemblies:

1. Roller and Shafts:
 - a. 1045 carbon steel in accordance with ASME Code B17c-1927.
 - b. Shaft Minimum Design Safety Factor: 5.0.
 - c. Minimum Stock Shaft Diameter for Pressure Zone Roller Shafts: 5 inches with a minimum through bearing diameter of 2.95 inches for rollers.
 - d. Minimum Through Bearing Diameter for Other Rollers: 2.18 inches.
 - e. Minimum Wall Thickness: 1/2 inch for all nonperforated rolls less than 14 inches.
 - f. End Plates: ASTM A36 steel with minimum wall thickness of 1.25 inches.
2. Rollers: Concentric to 0.01 inches and balanced to within 5 pounds. Machine all roller surfaces prior to coating. Machine roller coatings to the same tolerance after application and curing.

3. Solid Rollers: Double separated plate stub end shaft type or forged end type construction. Weld the stub end shafts and the roller heads in place. Bolted in-place stub end roller shafts are unacceptable. Design all rollers to have a maximum deflection of 0.05 inches at their center, as measured from the bearing centerline when under maximum loading.
4. Forged Stub Shaft Unit:
 - a. ASTM A572, Grade 50, Type 2, "or-equal".
 - b. Roller Shells: ASTM A53, "or-equal".
 - c. Shell and Radial Vanes: ASTM A36 "or-equal", or stainless steels may be substituted on special order.
5. Maximum Loading: Based on the maximum summation of all forces applied to the roller including, but not limited to, the forces exerted by the tension on the belts from the belt drive and belt tensioning devices (minimum load of 280 PLI of belt width), friction forces, elasticity forces, roller mass forces of the belts caused by the inner belt having shorter travel distance than the other belt as the belt and sludge sandwich travel around the roller, and by motor torque at startup.
6. Coat all nondrive rollers with a minimum 1/4 inch thickness of vulcanized Buna-N rubber or 25 mils or thermoplastic nylon suitable for continuous duty in a wet, corrosive environment (pH 4.0 or higher) with organic oils and grease. The materials shall provide for complete protection of the carbon steel rollers from the wet, corrosive environment.
 - a. Buna-N Rubber Hardness: 92-94 Shore "A".
7. Coat rollers up to the point of insertion into the bearing block, or provide shafts and heads of Type 316 stainless steel. Carbon steel roller surfaces shall not be exposed to sludge or moisture. Rollers constructed entirely of Type 316 stainless steel, in lieu of rollers of carbon steel with protective coatings, shall be considered equivalent.
8. Coat all drive rollers with 1/4-inch-thick vulcanized Buna-N rubber covering. Turn on a lathe drive roller covering after curing to within 0.01 inches concentricity and balance to within 5 pounds.
 - a. Rubber Hardness: greater than 90 Shore "A".
9. Perforated Drum Rollers (Where Used):
 - a. Corrosion resistant with shells fabricated of minimum 0.25 inch thickness, Type 316L stainless steel.
 - b. End Plates and Stiffener Thickness: 0.50 inch.
 - c. Perforation Diameter: Not less than 1.378 inches.
 - d. Total Open Area: 35 percent to 40 percent.
 - e. Through-shaft design.
 - f. Minimum Through Shaft Stock Diameter: Not less than 5 inches.

M. Roller Bearings:

1. Support shafts of all drums and rollers by a greaseable type, high capacity “E” design spherical roller bearing equipped with a brass retainer in sealed, splashproof, horizontal split case pillow block housing. Attach bearings to turned, ground, and polished shaft by direct mounting with an interference fit.
2. Bearings Supporting the Steering Rollers: Nonself-aligning cylindrical roller bearings in pivot-mounted pillow block housings. Support all rollers by 222E series spherical bearings having a minimum self-aligning capability of plus or minus 3/8 of a degree and mounted in expansion and nonexpansion pillow block housings.
3. Bearing Life: Minimum L-10 life of 1,000,000 hours at a minimum belt speed of 15 feet per minute, calculated by using the ANSI/AFBMA latest standard. Base the L-10 life on the summation of all forces applied to the bearings, including, but not limited to, roller mass forces, elasticity forces, drive motor load (50 percent of drive motor load assumed distributed to the drive roller), and belt tension on the rollers. Include a minimum load of 280 PLI of belt width, which equates to a belt tension of 70 PLI for belt tension forces exerted on the pressure zone rollers.
4. Provide certified calculations, based on AFBMA ISO capacity formula demonstrating compliance that all bearings meet the specified requirements for a minimum L-10 life at maximum loadings. Submit to Engineer as set forth in the Contract Documents.
5. Bearing Housings: Class 30 cast iron, conform to ASTM A48 standards and have four cap bolts and two or four mounting bolts. Provide solid outer housing without end caps or filler plugs. Utilize triple lip seal design that rotates with the shaft. Primary seal face will contact a stainless steel solid seal plate.
6. Clean, iron phosphate, and coat housings with a heat-treated thermoplastic nylon to a thickness of 8 mils to 12 mils. Use Type 316L stainless steel hardware unless specified otherwise.
7. Bearings: Manufactured by SKF; Dodge-Master-Reeves, Division of Reliance Electric Industrial Company, Greenville, SC; “or-equal”.
8. BFP Manufacturer-Bearing Warranty: 5 years from date of acceptance of the equipment. Includes all parts and labor for repairing or replacing any bearing that fail during the warranty period, providing that Owner has properly lubricated the bearings.
9. Provide capability to grease all bearings while BFP is operating.
 - a. Bearing Lubrication Frequency: Maximum of two times per year.

N. Doctor Blades:

1. Equip each BFP with two doctor blades for assisting in removal of adherent sludge cake from each belt at the upper and lower discharge rolls.
2. Independently operate each blade and equip each blade with devices to enable quick release from the belt for rag removal.
3. Mount doctor blades so that the cake is continuously removed from the belt.
4. Extend each blade at least 3 inches wider than the belt.
5. Bottom Blade Angle: At least 60 degrees from the horizontal plane to prevent cake buildup on the blade.
6. Doctor Blade Assemblies: Adjustable counter-weighted or spring-loaded design, fabricated with sufficient stiffness so that blades do not warp, distort, or bow in the middle under normal service conditions, or in the event sludge sticks to the belts or rollers.
7. Leading Edges of Blades: Easily replaceable and constructed of high-density polyethylene. Fiberglass reinforced polyester is unacceptable.
8. Doctor Blade Support Frames, Fastener and Hardware: Type 316L stainless steel.

O. Belt Filter Press Sludge Feed Pumps:

1. The press manufacturer shall provide as a part of this dewatering equipment package, one centrifugal pump per skid for feeding anaerobically digested sludge to the belt filter press. The flow capacity of each pump shall be an adjustable range of 75 to 300 gpm. The pumps shall be sized to handle a minimum 1-5/8-inch diameter solid.
2. Each pump shall be at the manufacturer's option one of the following pump selections:
 - a. KSB Sewabloc per Specification Section 44 42 56.12, Induced Flow Recessed Impeller Centrifugal Pump.
 - b. Gorman Rupp T4 per Specification Section 44 42 56.18, Self-Priming Centrifugal Pump.

P. Power Transmission:

1. Couplings: Falk Steelflex spring-grid couplings or approved equal.
2. Sprockets and Sheaves: Standard quick-detachable hubs.
3. Provide all chain and belt drives and couplings with safety guards in accordance with applicable safety codes.

Q. Anchor Bolts:

1. Provide ASTM A320, Type 316 stainless steel anchor bolts not less than 3/4 inch in diameter.
2. Coat anchor bolts with fusion-bonded epoxy coating.
 - a. Coating: 100 percent solids, thermosetting, fusion bonded, dry powder epoxy, or polyurethane resin suitable for intended service manufactured by Fletcher Pipe Coating, Orange, CA, Western Coating, Inc., Ogden, UT, "or-equal".

R. Electrical:

1. Prewire all BFP-mounted devices, and other electrical equipment and instruments to two (2) separate terminal junction boxes (TJBs) that shall be mounted on each BFP. One TJB shall be for all discrete interfaces with the BFP control panel and the other TJB shall be for all power interfaces with the BFP control panel.
2. The TJBs shall be NEMA 4X, 316 stainless steel and be mounted and supported directly to the corresponding BFP.
3. Identify all wiring with permanent labels at both ends, terminate with solderless lug numbered terminal blocks. Shielded VFD rated cable (Type 8) shall be provided by the BFP Manufacturer for all motors that are operated from a variable frequency drive. Additionally, shielded analog cables (Type 3) shall be used for all conductors that are provided for analog signals. Refer to Section 26 05 05, Conductors for additional details on the specific conductor types to be provided by the BFP manufacturer.
4. Instruments: 120V ac rated.
5. Terminate at numbered terminal blocks all interconnecting wires between panel-mounted equipment and external equipment. Identify all wires with permanent heat impregnated PVC alpha-numeric labels at both ends.
6. Provide EMERGENCY STOP cords around the full perimeter of each BFP. Provide a DPDT dry contact output for cord suitable for control safety interlock functions provided by others.
7. List and label all electrical components in accordance with the National Electrical Code (NEC).
8. Belt Filter Press Control Panels: Constructed by UL-approved manufacturer and compliant with UL-508 requirements.
9. Throughout the system, various kinds of electrical wiring may be required. In addition to NEC requirements, comply with the following requirements for all wiring:
 - a. Only 480V and 120V ac circuits with wire insulation rated 600V may be run together in the same raceway (conduit) or enclosure.

- b. Low voltage dc and 4 mA to 20 mA signal wiring may be mixed in the same raceway and enclosure, but not run in the same multi-circuit control cable. All analog wiring is to be separated from all power and control wiring.
 - c. Run 4 mA to 20 mA signals in twisted shielded pair cables.
 - d. Raceways and Fittings: PVC schedule 40 conduit to match existing BFP that shall be relocated.
 - e. Raceway Support Systems: Match existing.
 - f. Washers, Bolts, Nuts, Etc.: Type 316 stainless steel.
10. Adjustable Frequency Drive: Provide adjustable frequency drives, as required, for each BFP. Mount adjustable frequency drives in the local BFP control panel. See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System, for requirements.

S. BFP Drive:

- 1. Provide each BFP with a suitable drive mechanism sized to accommodate the speed and torque requirements of the belt during all operating conditions. Supply input power to the drive roller shaft through an ac variable frequency drive unit. Control speed through cyclical variation in motor current, which is operator set at the control panel. The drive roller speed reduction is obtained through a helical gear reducer. Transmit the variable input power through a helical bevel gear reducer connected to the drive roller.
- 2. Drive Speed Range: 10:1 with the minimum frequency limited to 8 Hz and the maximum frequency limited to 80 Hz. The drive motors shall meet the requirements specified herein.
- 3. Select drive rollers to permit slip-free transmission of driving torque to the belt. Provide roller shafts and heads as specified above.

T. Motors: Provide squirrel cage induction motors designed, manufactured, and tested in accordance with NEMA MG 1. Use inverter-duty rated motors when combined with adjustable frequency drives.

- 1. Motors: Chemical-industry severe-duty type. See Section 26 20 00, Low-Voltage AC Induction Motors.
- 2. Motor Insulation: Class F.
- 3. Equip each motor with a thermostat embedded within the motor.
- 4. Adjustable Frequency Drives: See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System, for requirements.

2.06 CONTROL SYSTEM

- A. Perform all instrumentation and control work of this section in accordance with the control, signal, and component requirements specified in Section 40 99 90, Package Control Systems. Provide panels and controls as follows:

Panel No.	Name	NEMA 250 Rating	Material
20-VCP-20-1	Belt Filter Press No. 1 Control Panel	4X	Type 316 stainless steel
20-VCP-20-2	Belt Filter Press No. 2 Control Panel	4X	Type 316 stainless steel
20-VCP-20-3	Belt Filter Press No. 3 Control Panel	4X	Type 316 stainless steel
20-VCP-20-4	Belt Filter Press No. 4 Control Panel	4X	Type 316 stainless steel

- B. Each BFP Control Panel shall include an appropriately sized, filtered, side panel-mounted air conditioner unit. Air conditioning unit shall be in accordance with and as specified in Section 40 99 90, Package Control Systems. The AC unit shall be located on the right-hand side of the BFP control panel as you face the front of the control panel.
- C. Each belt filter press control panel shall include the following electrical components:
1. An appropriately sized main circuit breaker. The main circuit breaker shall include a short circuit rating of 65,000A.
 2. A surge protection device (SPD) located immediately downstream of the main circuit breaker for the BFP control panel.
 3. An integral 480V-120V control power transformer (CPT) for all controls related to the operation of the associated BFP. The CPT shall also be sized to provide external 120V power to the flow meter 20FE/FIT-20-X, where X=1, 2, 3, 4 located downstream of the corresponding sludge feed pump. A dedicated 20A, 120V circuit breaker shall be included within each BFP control panel to allow an operator to manually de-energize the 120V power to the associated flow meter if desired for maintenance.
 4. Dedicated 6-pulse adjustable frequency drive (AFD) for the associated sludge feed pump (20-AFD-20-XA, where X=1, 2, 3, 4).
 5. Dedicated 6-pulse adjustable frequency drive (AFD) for the associated sludge distributor (20-AFD-20-XC, where X=1, 2, 3, 4).
 6. Dedicated 6-pulse adjustable frequency drive (AFD) for the associated gravity belt (20-AFD-20-XE, where X=1, 2, 3, 4).

7. Dedicated 6-pulse adjustable frequency drive (AFD) for the associated belt drive (20-AFD-20-XD, where X=1, 2, 3, 4).
 8. An appropriately sized circuit breaker that is used to distribute power to the panel-mounted air conditioner used to cool each BFP control panel. The power feed for the panel-mounted air conditioner shall be derived from the incoming 480V, three phase power feed to each BFP control panel.
- D. The control system for all equipment and components of each Belt Filter Press shall be provided by a dedicated Programmable Automation Controller (PAC), mounted in each Belt Filter Press Control Panel. The PAC shall provide all control and monitoring functions required for the operation and monitoring of the belt filter press and associated equipment including, but not limited to, timing, interlocks, startup sequencing, normal and emergency shutdowns, and permissive functions required for safe operation of each belt filter press.
1. The PAC programming for the Belt Filter Press control system shall include documented description of all functions and logic.
 2. The PAC I/O signal types and voltages shall be as specified in Section 40 99 90, Package Control Systems.
 3. Provide uninterruptable power supply (UPS) backup power for all PAC equipment, network components, network components, and instrument components of the Belt Filter Press control system. The UPS shall be in accordance with and as specified in Section 40 99 90, Package Control Systems.
 4. The Ethernet switch and PAC equipment shall be in accordance with and as specified in Section 40 99 90, Package Control Systems.
 5. Provide application software (programming) for all digital, programmable components of the belt filter press systems including submittals, documentation, communication, and testing as specified in Section 40 99 90, Package Control Systems.
- E. Operator Controls and Indications: Provide the following control devices on the front of the control panel:
1. Provide externally operable main circuit breaker integral to each belt filter press control panel. The main circuit breaker shall include a short circuit rating of 65,000A.
 2. Panel mount Operator interface unit (OIU).
 3. Emergency STOP mushroom type pushbutton.
 4. Alarm horn and Silence Pushbutton.
 5. Belt tensioning adjustment and indication.

F. Operator Interface Unit (OIU):

1. Provide a panel-mounted OIU on each Belt Filter Press Control Panel.
2. The OIU manufacturer shall be as specified under Section 40 99 90, Package Control Systems.
3. The OIU shall provide the primary method for an operator to monitor the status of the Belt Filter Press and associated equipment and to affect its operation by command or directive entry. The OIU shall provide the graphics-based interface between the operator and Belt Filter Press PAC.
4. Belt Filter Press AUTO/MANUAL control selection shall be provided at the OIU.
 - a. In MANUAL mode, the Belt Filter Press PAC shall monitor only the equipment listed under number 5, where the Operator shall start and stop the equipment at the OIU. Manual speed control is also provided for equipment with AFDs.
 - b. In AUTO mode, the Belt Filter Press and ancillary equipment shall start/stop in a programmed sequence when all equipment is in the remote mode and without fault alarms.
 - c. See letter G below for additional requirements.
5. The OIU shall provide control of the following:
 - a. BFP Control (Auto Start/Stop).
 - b. Sludge Feed Pump Control (Start/Stop & Speed).
 - c. Washwater Booster Pump Control (Start/Stop & Speed).
 - d. Sludge Distributor Control (Start/Stop & Speed).
 - e. Gravity Belt Control (Start/Stop & Speed).
 - f. Main Belt Drive Control (Start/Stop & Speed).
 - g. Hydraulic Tensioning System Control (Start/Stop).
 - h. Polymer System Control (Start/Stop).
 - i. Alarm Reset Control.
6. The OIU shall provide the following statuses and displays:
 - a. System Control Power: ON.
 - b. System Control Power: RESET.
 - c. Auto Mode: AUTO.
 - d. Auto Start: PREWASH CYCLE.
 - e. Auto Stop: POST-WASH CYCLE.
 - f. Air Supply Valve: OPEN.
 - g. Belt Tension/Tracking: ON.
 - h. Hydraulic Pump: ON.
 - i. Belt Conveyor: ON.
 - j. Washwater Booster Pump: ON.
 - k. Washwater Valve: OPEN.
 - l. Main Belt Drive: ON.
 - m. Belt Filter Press: IN STANDBY MODE.
 - n. Polymer Feed Unit: ON.

- o. Sludge Feed Pump: ON.
 - p. Sludge Feed Pump AFD: IN REMOTE.
 - q. Main Belt Drive Speed: PERCENT.
 - r. Polymer Feed: LBS. ACTIVE/DRY TON SLUDGE.
 - s. Sludge Feed Flow: gpm.
 - t. Permissive from PAC (Based on Cake Conveyor System Status): ON.
- 7. Alarms:
 - a. Low Hydraulic Pressure.
 - b. Belt Limit: FAULT.
 - c. Low Washwater Pressure: FAULT.
 - d. Main Drive VFD: FAULT.
 - e. Machine E-Stop: FAULT.
 - f. Belt Break: FAULT.
 - g. Sludge Feed Pump: AFD FAILURE.
 - h. Sludge Feed Pump: LOW SUCTION PRESSURE.
 - i. Sludge Feed Pump: HIGH DISCHARGE PRESSURE ALARM.
 - j. Cake Conveyor System: NOT RUNNING.
- G. Provide the following hard-wired interface signals between the Polymer System Panel (20-VCP-52-1, 2, 3, 4) and Belt Filter Press Panel (20-VCP-20-1, 2, 3, 4):
 - 1. Inputs:
 - a. Polymer System On Status.
 - b. Polymer System Low Flow Alarm.
 - 2. Outputs:
 - a. Polymer System Run Command.
 - b. Polymer System Speed Control, 4-20mA signal.
- H. External Interfaces to the Plant SCADA System via Ethernet communication link (Data Exchange) on the Programmable Automation Controller (PAC):
 - 1. Outputs from Plant SCADA PAC: BFP Run Permissive.
 - 2. Inputs to Plant SCADA PAC:
 - a. BFP on.
 - b. BFP fault.
 - c. Polymer feed unit on.
 - d. Polymer feed unit low flow alarm.
 - e. Sludge feed pump on.
 - f. Sludge feed pump fault.
 - g. Sludge feed pump speed/flow indication.
 - h. Washwater pump on.
 - i. Washwater pump fault.
 - j. Washwater pump speed/flow indication.
 - k. E-Stop activated.

3. Any other data exchange or statuses considered by manufacturer as essential for safe operation and monitoring.
 4. Coordinate data exchange with the Plant SCADA System Supplier. Provide a detailed data exchange list as specified under Section 40 99 90, Package Control Systems.
- I. Provide SPDT dry alarm contacts to indicate PAC or adjustable frequency drive failure.
 - J. Provide 120V power for the respective washwater valve (20FV-20-X, where X=1, 2, 3, 4) located upstream of the corresponding washwater booster pump.
 - K. Functional Requirements: Provide the following functional requirements for each belt filter press:
 1. Provide EMERGENCY STOP pushbuttons and pull cords (maintained type) and provide for hard wired instant shutdown of belt filter press and ancillary equipment at all times.
 2. MANUAL Mode (At Starters or AFDs): In MANUAL mode, system components can be started at their respective starters or AFDs without sequence interlocks being satisfied. Emergency stop and belt limit alarms will always be active.
 3. AUTO Mode: In AUTO mode, startup and shutdown can be controlled from either BFP AUTO START/AUTO STOP OIU pushbuttons for an automatic sequential timed startup, or components can be controlled with their respective OIU pushbuttons, interlocks must be satisfied.
 - a. Operating the BFP AUTO START OIU pushbutton will initiate the following sequence of events:
 - 1) Hydraulic pump energizes (instantly).
 - 2) Open washwater valve (instantly).
 - 3) Start washwater booster pump (instantly).
 - 4) Start Belt Conveyor and sludge distributor (5-second preset/adjustable delay from auto start initiate).
 - 5) Start main belt drives (90-second preset/adjustable delay from auto start initiate).
 - 6) Start polymer feed unit (5-minute preset/adjustable delay from auto start initiate).
 - 7) Start sludge feed pump (BFP Feed Pump) (15-second preset/adjustable delay from polymer pump start).
 - b. While AUTO START is in progress "AUTO START" shall be indicated.
 - c. Operating the AUTO STOP OIU pushbutton will initiate the following sequence of events:
 - 1) Sludge feed pump stops (instantly).
 - 2) Polymer feed unit stops (instantly).

- 3) Main belt drives, washwater valve/booster pump, belt conveyor and hydraulic pump, (45-minute preset/adjustable delay from auto stop initiate).
 - 4) AUTO STOP indicator light will flash while in progress and go on steady when complete.
4. Alarms: Alarm conditions are indicated on the OIU and will cause alarm horn to sound. Alarm lights on the OIU will be activated as long as the condition is still in fault alarm status. Operating horn silence pushbutton will silence horn. The OIU reset button will clear alarm indicator and allow system startup.
 - a. Following conditions will immediately shutdown the complete system automatically:
 - 1) Emergency stop.
 - 2) Low hydraulic pressure.
 - 3) Belt misalignment.
 - 4) Belt broken.
 - 5) Main belt drive fail.
 - 6) Low washwater pressure.
 - 7) Loss of Run Permissive from PAC.
 - b. Following conditions will shut down polymer and sludge feed automatically:
 - 1) Low washwater pressure.
 - 2) If sludge pump is not detected “on” 1 minute after polymer unit run confirm. Lack of cake alarm.
 - 3) Belt conveyor fail.

2.07 ACCESSORIES

- A. Equipment Identification Plates: 16-gauge, Type 316 stainless steel or plastic, securely mounted on each separate equipment component and control panel(s) in a readily visible location. Plate shall bear 3/8-inch-high engraved block type equipment identification number and letters.
- B. Lifting Lugs: Provide lifting lugs for equipment weighing over 100 pounds.
- C. Equipment Anchor Bolts: Type 316 stainless steel, sized by manufacturer, and at least 5/8 inch in diameter and as specified in Section 05 50 00, Metal Fabrications.

2.08 INSTRUMENTATION AND CONTROLS

- A. Instrumentation, monitoring, and controls included shall interface with the BFP panel, via hardwired signals, as specified and shown on the Drawings.
- B. Pressure Switches:
1. Tags:
 - a. Sludge Feed Pump(s): 20-PSH-20-1A, 2A, 3A, and 4A.
 - b. Washwater Booster Pump(s): 20-PSL-20-1B, 2B, 3B, and 4B.
 - c. Hydraulic Tensioning System(s): 20-PSL-20-1C, 2C, 3C, and 4C.
 2. Piston-actuated, adjustable deadband, with repeatability of plus or minus 1 percent of range.
 3. SPDT contacts rated 10 amps, minimum at 120V ac.
 4. Set Points:
 - a. Sludge Feed Pumps (PSH): 40 psi.
 5. NEMA 4X construction with Buna-N actuator seal.
 6. Manufacturer: Ashcroft L or P series, United Electric, or approved equal.
- C. Pressure Gauges:
1. Tags:
 - a. Sludge Feed Pump(s): 20-PI-20-1A, 2A, 3A, and 4A.
 - b. Washwater Booster Pump(s): 20-PI-20-1B, 2B, 3B, and 4B.
 - c. Hydraulic Tensioning System(s): 20-PI-20-1C, 2C, 3C, and 4C.
 2. Ranges:
 - a. Sludge Feed Pumps.
 - b. Washwater Booster Pumps.
 - c. Hydraulic Tensioning System.
 3. Glycerin case filled.
 4. NEMA 4X construction, 4-inch diameter dial.
 5. Manufacturers: Ashcroft, 1259/1279 series, WIKA, or approved equal.
- D. Pressure Transmitter:
1. Sludge Feed Pump(s): 20-PIT-20-1, 2, 3, and 4.
 2. Range.
 3. Silicon fill fluid.
 4. Two-wire transmitter, HART protocol.
 5. NEMA 4X with type 316 stainless steel wetted metallic parts and LCD display.
 - 1) Manufacturer: Emerson Rosemount; Model 2051.
 - 2) Endress+Hauser; Model PMP71.

E. Pressure Seal, Annular:

1. Sludge Feed Pump (PIT) Tags: 20-PE-20-1A, 2A, 3A, and 4A.
2. Sludge Feed Pump (PI/PSH) Tags: 20-PE-20-1B, 2B, 3B, and 4B.
3. Materials of Construction: Carbon steel body and flange with Ethylene glycol/water or propylene glycol fill fluid, filled and assembled in factory with pressure instruments.
4. Mounting: In-line.
5. Manufacturers: Red Valve Series 40, Ashcroft Series 81, or approved equal.

F. Magnetic Flow Meters:

1. Tags: 20-FE/FIT-20-1, 2, 3, and 4.
2. Flow Meter Size: 4-Inch.
3. Flow Range: 50 – 400 gpm min.
4. Stainless steel tube with carbon steel flanges, polyurethane liner, and Hastelloy-C electrodes.
5. Transmitter: NEMA 4X with local display and isolated 4-20mA flow signal output.
6. Manufacturers: Endress & Hauser Promag W400, or approved equal.

2.09 FABRICATION

- A. Thickener Mounted Electric Devices (Excluding Motors): Factory prewired to terminal strips in a frame mounted, NEMA 250, Type 4X 316 stainless steel terminal junction box.

2.10 MISCELLANEOUS MATERIALS AND ACCESSORIES

- A. Piping Connections: Use U.S. standard pipe sizes with 150-pound flanges for pipes 2-inch diameter and larger and NPT for pipe 1-1/2-inch diameter and smaller.
- B. Corrosion Protection:
1. All parts of the equipment in contact with the belts including doctor blade support frames shall be Type 316L stainless steel or coated as specified under Paragraph Drum and Roller Assemblies hereinbefore.
 2. Coatings: Suitable for the expected service conditions.
 3. Wetted Parts: Suitable for the service conditions specified.
 4. Splash Guards: Type 316L stainless steel.

5. Miscellaneous Hardware Including Bolts, Nuts, Washers, and Fastener Clips: Type 316L stainless steel.
6. Drives and Motors: Factory painted with the manufacturer's standard epoxy enamel finish suitable for indoor exposed, wet corrosive service.
 - a. Primer, Intermediate, and Finish Coats: Continuous heat resistance of 90 degrees C.
 - b. Intermediate Coat: 12-hour heat resistance of 125 degrees C.
- C. Dissimilar Metals: Properly electrically insulate any dissimilar metals or connectors in direct contact. Provide 1/8-inch-thick continuous neoprene gaskets to isolate aluminum from all steel members.
- D. Equipment Identification Plates: 16-gauge, Type 316L stainless steel or plastic identification plate securely mounted on each press with stainless steel panhead screws. Locate identification plate in a readily visible location with 1/2-inch die-stamped equipment identification number indicated in this section and shown on the P&IDs. Refer to Nameplates and Name Tags hereinbefore for identification of I&C components.
- E. Lifting Lugs: Provide equipment and removable equipment components weighing over 100 pounds with lifting lugs to permit easy handling.

2.11 FACTORY FINISHING

- A. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating, System No. 5, unless items are stainless steel or galvanized or are otherwise specified herein.

2.12 SOURCE QUALITY CONTROL

- A. Factory Inspections: Inspect control panels and equipment for required construction, electrical connection, and intended function.
- B. Factory Tests and Adjustments: Satisfactorily test all equipment and control panels prior to shipment.
- C. Functional Test: Perform on equipment according to procedures accepted by Engineer.

PART 3 EXECUTION

3.01 GENERAL

- A. Manufacture and test the BFP system in accordance with the applicable trade and industry practices and in compliance with state, OSHA, and other governing code requirements.

- B. Install equipment in conformance with the manufacturer's written instructions, with supervision and inspection performed by manufacturer's representative.
- C. Anchor and mount equipment in accordance with manufacturer's requirements for the load criteria specified in Section 01 61 00, Common Product Requirements.
- D. Accurately place anchor bolts using templates furnished by the manufacturer in accordance with Section 05 50 00, Metal Fabrications.

3.02 FIELD TESTS

- A. Field Motor Tests: Megger test (500-volt megger) each motor phase-to-phase and phase-to-ground prior to startup, Contractor or manufacturer's representative to perform test in the presence of Engineer. Engineer will make a record of these values. Values of resistance less than 1 megohm will not be acceptable.

3.03 FIELD QUALITY CONTROL

- A. Coordinate timing and schedule test with Owner and be dependent upon quantity of sludge available for testing.
- B. Functional Test (and Clean Water Test):
 - 1. Inspect equipment for proper alignment, quiet operation, proper connection, and satisfactory performance of all components by means of a functional test conducted by the manufacturer's representative, assisted by the installing contractor and Owner, and as approved by Engineer, prior to startup.
 - 2. Conduct functional testing after the installation of the BFP equipment and all appurtenances.
 - 3. Perform functional test on completed BFP system without sludge feed prior to startup.
 - 4. Demonstrate complete normal start, normal stop, and controlled shutdown cycles on each unit.
 - a. Conduct an uninterrupted 2-hour running test on each unit.
 - 1) At the beginning and end of the test, and at periodic intervals between, observe and record all thermometer readings.
 - b. Adjust belt tension at the start of the test, check and readjusted if necessary at the end of the test.

- c. Check all safety devices for satisfactory operation.
- d. Check instrumentation and control systems for conformance with Specifications.
5. Measure operating amperage and kilowatts per phase of all motors for overload condition. Report measured values to Engineer.
6. Develop proposed test procedures and submit for review, comment, and approval. Begin testing only after test procedures are approved by Engineer.
7. Provide a qualified manufacturer's representative to supervise each test, analyze data, and certify the BFP's performance during the test.
8. Submit test log to Engineer upon completion of each test.
9. Complete and sign Manufacturer's Certificate of Proper Installation, as specified in Section 01 43 33, Manufacturers' Field Services.
10. Complete successful functional testing prior to pre-performance testing.

C. Pre-performance Test:

1. Following successful completion of functional testing, conduct testing by manufacturer's representative, assisted by installing contractor and Owner, to demonstrate continuous, reliable operation, not performance, while dewatering the liquid biosolids at the flow rates and having the characteristics as specified in Article Service Conditions.
2. Notify Owner and Engineer in writing at least 14 days prior to scheduled pre-performance test.
 - a. Provide complete Operation and Maintenance Manuals and conduct prestartup classroom training on the BFPs prior to pre-performance test.
 - b. Field training may occur during the pre-performance test.
3. Conduct pre-performance test of the BFPs for a period of 2 working days (minimum of 6 hours operation per day) without shutdown due to equipment, control, or system failures.
4. Shutdown is defined as:
 - a. Stoppages due to any failure of provided equipment and instrumentation, such as the BFP control panel, in excess of 30 minutes.
 - b. More than one stoppage(s) over the 2-day period for all BFPs.
 - c. Stoppages caused by Owner may occur without causing failure of the test.
5. Develop proposed test procedures and submit to Engineer for review, comment, and approval. Begin testing only after test procedures are approved by Engineer.

6. Provide a qualified manufacturer's representative to supervise each test, analyze data, and certify the BFP's performance during the test.
7. If, in the opinion of Engineer, the pre-performance test is successful and meets the requirements specified herein, Engineer will accept the pre-performance test in writing and identify that BFPs may begin the performance test, providing other prerequisites for the performance test are satisfied.
8. If a shutdown occurs or the BFP is otherwise unable to achieve the pre-performance test requirements:
 - a. Perform whatever equipment modifications are necessary to achieve the performance specified.
 - b. Document modifications and submit to Engineer.
 - c. Repeat pre-performance test in its entirety.
9. Owner will provide polymer, power, feed sludge, and cake disposal during testing.

D. Performance Test:

1. Demonstrate through performance testing actual system operating conditions and verify that BFPs meet or exceed minimum performance requirements specified in Article Performance Requirements, while dewatering the sludge stream specified in Article Service Conditions.
 - a. Conduct testing at the solids loading rates specified in Article Service Conditions.
2. Notify Owner in writing at least 14 days prior to scheduled performance test.
 - a. Successful completion of the pre-performance test is a prerequisite of performance testing.
3. Manufacturer's representative, assisted by installing contractor and Owner, shall startup and operate each BFP on the sludge stream specified herein, for a period of 8 hours per day for 2 days, with no interruptions allowed during the 8-hour period.
 - a. Provide BFP operations and associated manufacturer's field services required to adjust machine settings prior to and exclusive of the above specified performance test duration.
4. Develop proposed test procedures and submit for review, comment, and approval. Begin testing only after test procedures are approved by Engineer.
5. Provide qualified manufacturer's representative to supervise each test, analyze data, and certify the BFP's performance during the test.
6. Maintain steady state operation at the specified sludge feed solids rates throughout the test, and all hourly quantities shall be the average during the test period.
 - a. Maintain acceptable performance while dewatering feed sludge with properties within plus or minus 10 percent of the specified criteria listed in Article Service Conditions.

7. During each performance test, take measurements and collect all required samples for analysis to make the following determinations:
 - a. Sludge Feed Rate: gpm.
 - b. Sludge Feed Concentration: The total dry solids concentration of the feed sludge entering the BFP (percent TS).
 - c. Dewatered Cake Concentration: The total dry solids concentration of the dewatered sludge cake discharged from the BFP (percent TS). Take two duplicate samples per sample interval.
 - d. Filtrate Concentration: The total suspended solids concentration of the filtrate discharged from the BFP (percent TSS).
 - e. Solids Capture: Percent.
 - f. Feed Hydraulic Loading Rate (Exclusive of Polymer): gpm.
 - g. Feed Solids Loading Rate (Exclusive of Polymer): Pounds per hour of total dry solids.
 - h. Polymer Feed Rate: gpm.
 - i. Polymer Dose: Pounds active per dry ton of feed solids.
8. Collect samples at approximate 1-hour intervals.
9. Variations in Sludge Feed Characteristics:
 - a. Make compensating calculations for the effects if feed sludge characteristics are not within the ranges specified herein. Provide supporting data to be considered by Engineer in determining conformance with the specified design conditions. Engineer will be sole judge of conformance with performance testing requirements.
 - b. If retesting to document compliance is required due solely to feed sludge characteristics outside of the specified range, Owner may waive retesting or may compensate Contractor for reasonable costs to witness retesting at Owner's sole option.
10. Performance will be based upon the arithmetic average of the test results obtained during the test period.
 - a. Owner reserves the right to discard obviously high or low erroneous test results.
 - b. As specified below, laboratory testing will be performed by Owner.
 - c. Turnaround time for cake concentration samples are approximately 24 hours.
 - d. Laboratory standard methods results will be used for performance evaluation.
11. Prepare a formal test report including all laboratory analysis reports, all measured flows, the mass balance calculations, and the percent capture.
 - a. Submit six copies of final report to Engineer within 20 days after completion of the test.

12. If a BFP does not meet the requirements of Specifications during the performance test:
 - a. Make changes to equipment and methods of operation as recommended by manufacturer and as approved by Engineer as soon as practical, but within a period not to exceed 30 days.
 - b. Following adjustments, perform a second test run similar to the first run.
 - c. If BFP still does not achieve specified performance during the second test, equipment will be subject to rejection.
 - d. The BFP manufacturer retains responsibility for the BFPs until the acceptance test has been successfully completed.
 - e. After initial startup, Owner shall have the right to use the BFP as needed to process sludge.
13. If, after a maximum of two test runs, in the opinion of Engineer, a BFP meets the performance requirements specified herein, Engineer will recommend acceptance of the BFP. If, in the opinion of Engineer, performance test results do not meet the requirements specified herein, Engineer will notify the BFP manufacturer and Owner of nonacceptable performance.
14. Should the BFP be unable to achieve performance specified under Article Performance Requirements, perform whatever equipment modifications are necessary for the equipment to achieve the performance specified. Submit for review by Engineer all modifications and pay review costs at Engineer's standard billing rate. Following completion of equipment modifications, run the performance test again in its entirety.
15. Laboratory tests necessary to confirm the sludge characteristics for the initial performance test on a BFP will be provided by Owner.
 - a. Laboratory tests for performance testing will be performed by Owner in conformance with applicable portions of standard methods.
 - b. If retesting is required, BFP manufacturer shall pay Owner for all laboratory tests subsequent to the initial test.
16. Owner will provide power, water, feed sludge, and disposal for the initial test.

E. Manufacturer's Field Services:

1. Manufacturer's Authorized Representative: Present at Work Site or classroom designated by Owner, for the minimum person-days listed below, travel time excluded. A minimum of three trips required.
2. Minimum services to include:
 - a. 2 person-days for installation assistance, inspection, and certification of installation.
 - b. 1 person-day for functional testing.

- c. 2 person-days for prestartup classroom or Job Site training.
- d. 5 person-days for performance testing and operator training during facility startup.
- 3. Video record all classroom training sessions and provide original video recordings and three copies of recordings on CD or DVD.
- 4. The periods stated above are minimums only and the manufacturer is required to be onsite for all of the functions listed above to the extent that is required to complete those functions to the satisfaction of Owner and Engineer.
- 5. For additional field services regarding the AFDs, see Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

3.04 SUPPLEMENTS

- A. Supplement listed below, following “End of Section,” is a part of this Specification.
 - 1. Induction Motor Data Sheet.

END OF SECTION

INDUCTION MOTOR DATA SHEETProject: C.C. Williams Dewatering Facility and Other ImprovementsOwner: Mobile Area Water and Sewer SystemEquipment Name: Belt Filter PressEquipment Tag Number(s): Belt Filter Press (1 – 4)

Type: Squirrel-cage induction meeting requirements of NEMA MG 1

Manufacturer: BDP

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

Motor Horsepower: Sludge Distributor: 0.33

Gravity Belt: 3Belt Drive 1 and 2: 3Tensioning Unit: 2Voltage: 460Phase: 3Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15Frequency: 60Enclosure Type: CISD-TEFCSynchronous Speed: rpm☐ Multispeed, Two-Speed: / rpm☒ Thermal Protection: Thermostat Winding: ☐ One ☐ Two☐ Space Heater: volts,
single-phaseMounting Type: ☒ Horizontal ☐ Vertical☐ Vertical Shaft: ☐ Solid ☐ Hollow☐ Vertical Thrust Capacity (lb): Up Down ☒ Adjustable Speed DriveOperating Speed Range: 50 to 100 % of Rated Speed☐ Variable Torque☐ Constant TorqueAdditional Motor Requirements: ☒ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features:

All motors that operate from an adjustable frequency drive (AFD) shall be inverter duty rated.

PART 3

DRAWINGS
(BOUND SEPARATELY)
