CONTRACT DOCUMENTS

AND

SPECIFICATIONS

FOR

PROJECT NO. RMUA ES 2020-11 & BAMA HC21020 HAIKEY CREEK WWTP BIOSOLIDS IMPROVEMENTS FAP 25-005-L | FAP 24-0002-L | FAP 24-0016L

ATTENDANCE AT PRE-BID CONFERENCE IS MANDATORY

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SEALS PAGE

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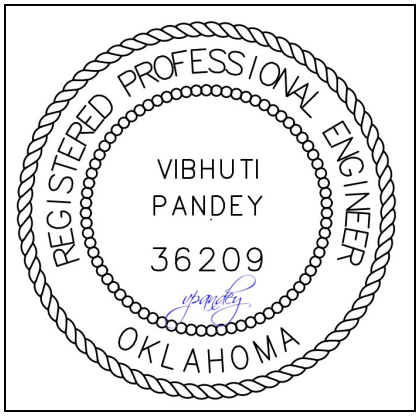
SPECIFICATIONS



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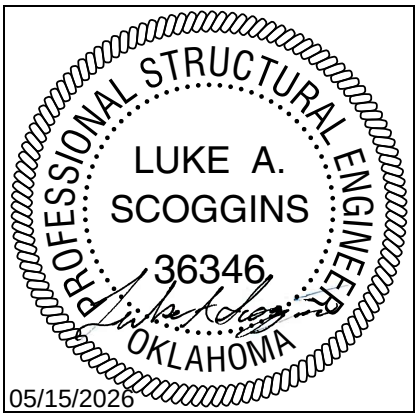

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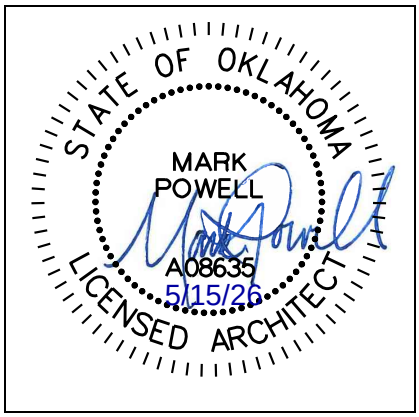

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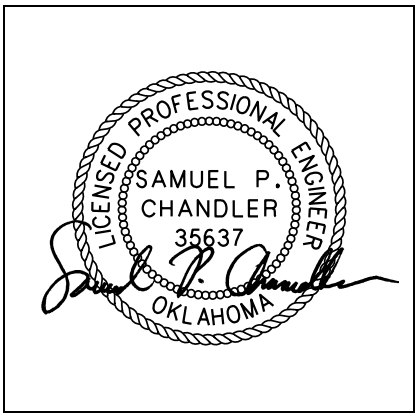

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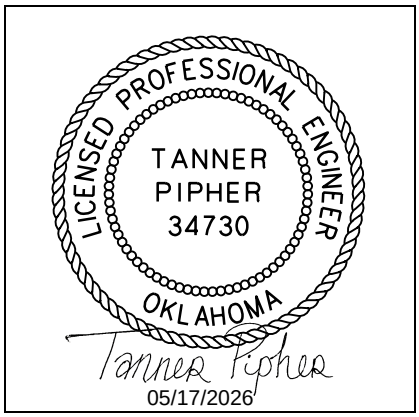

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END OF SECTION

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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, seismic 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. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
3. 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 where the Work is to be installed.

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. Piping 30 Inches and Larger: Support systems have been designed for piping shown.
4. 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.
5. Electrical Conduit Support: Include in design of framing support system.

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 though 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 58, 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, 1/2-inch minimum diameter, 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 seismic 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 inches.
   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 inches 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.
2. Existing Concrete Ceilings:
   a. Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
      1) Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
      2) 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.
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
Headworks	Stainless steel or FRP
Process Areas: High Humidity or Hydrogen sulfide	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
Alum	FRP	Precoated steel
Aqua Ammonia	Stainless steel	Precoated steel
Coagulants	FRP	Precoated steel or galvanized steel
Ferric Chloride	FRP	Precoated steel
Ferric Sulfate	FRP	Precoated steel
Hydrofluorosilic Acid	FRP	Precoated steel
Lime	Stainless steel, FRP, precoated steel	Stainless steel, FRP, precoated steel
Methanol	Galvanized steel	Galvanized steel
Polymers	FRP	Precoated steel
Potassium Permanganate	Precoated steel	Precoated steel
Powdered Activated Carbon	Precoated steel	Precoated steel
Sodium Carbonate	Stainless steel	Precoated steel
Sodium Hydroxide	Stainless steel	Precoated steel
Sodium Hypochlorite	FRP	Precoated steel
Sulfuric Acid	Stainless steel	Precoated steel

Notes:

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.
6. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

SECTION 40 05 33
PIPE HEAT TRACING

PART 1 GENERAL

1.01 REFERENCES

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

1. Factory Mutual.
2. Institute of Electrical and Electronics engineers, Inc (IEEE): 515, Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.
3. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
4. UL.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's descriptive literature.
2. Plastic Pipe Installations: Output adjustment factors for heating tape for the services indicated.
3. Pipe heat loss calculations for each pipe size to be heat traced.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN REQUIREMENTS

A. Design Heating Load:

1. Heating load to be calculated based upon a 50-degree F delta, 20 mph wind if pipes are located outdoors, insulation as specified in Section 40 42 13, Process Piping Insulation, pipe as specified in Section 40 27 00, Process Piping—General, and shall include a 10 percent safety factor.
2. Heat loss calculations shall be based on IEEE 515, Equation 1, Page 19.

2.02 ELECTRICAL HEATING TAPE

A. Cable: Self-limiting, parallel circuit construction consisting of continuous inner core of variable resistance conductive heating material between two parallel copper bus wires. Provide tinned copper braid for PVC, FRP, and stainless steel pipe applications.

B. UL Listing: Listed as self-limiting pipe tracing material for pipe freeze protection application in ordinary conditions.

C. Maximum Maintenance Temperature: 150 degrees F (65 degrees C).

D. Maximum Intermittent Temperature: 185 degrees F (85 degrees C).

E. Service Voltage: As indicated by branch circuits provided for heat tracing on the Drawings.

F. Manufacturers and Products:

1. Raychem; BTV-CR.
2. Thermon; BSX.
3. Nelson; CL1-J1 or L1-J1.

2.03 CONNECTION SYSTEM

A. Rating: NEMA 250, Type 4 and Factory Mutual approved.

B. Operating Monitor Light: Furnish with each circuit power connection kit to indicate when heat tracing is energized.

C. Manufacturers and Products:

1. Power Connection Kit:
   a. Raychem; JBS-100.
   b. Thermon; PCA-1-SR or DP-L.
   c. Nelson; PLT-BC.
2. Splice Kit:
   a. Raychem; S-150.
   b. Thermon; PCS-1-SR.
   c. Nelson; PLT-BS.
3. Tee Kit:
   a. Raychem; T-100.
   b. Thermon; DS-S.
   c. Nelson; PLT-BY.
4. End Seal Kit:
   a. Raychem; E-150.
   b. Thermon; DE-S.
   c. Nelson; LT-ME.
5. Lighted End Seal Kit:
   a. Raychem; E-100-L.
   b. Thermon; DLS.
   c. Nelson; LT-L.

2.04 SECURING TAPE

A. Plastic Piping Systems:

1. Type: Aluminum foil coated adhesive tape.
2. Manufacturers and Products:
   a. Raychem; AT-180.
   b. Thermon; AL-20P.
   c. Nelson; AT-50.

B. Metallic Piping Systems:

1. Type: Glass or polyester cloth pressure sensitive tape.
2. Manufacturers and Products:
   a. Raychem; GS54 or GT66.
   b. Thermon; PF-1.
   c. Nelson; GT-6 or GT-60.

2.05 PIPE MOUNTED THERMOSTAT

A. Type: Fixed, nonadjustable, set at 40 degrees F.

B. Sensor: Fluid-filled with 3-foot capillary.

C. Enclosure: Glass-filled nylon, NEMA 250, Type 4X weatherproof with gasketed lid.

D. Switch: SP-ST, UL listed, rated 22 amps, 120 to 240V ac.

E. Manufacturers and Products:

1. Raychem; DigiTrace Model AMC-F5.
2. Thermon; E4X-1.
3. Raychem; DigiTrace Model E507S-LS for hazardous areas.
4. Thermon; E7-25325 for hazardous areas.

2.06 AMBIENT THERMOSTAT

A. Type: Adjustable setting (15 degrees F to 140 degrees F).

B. Sensor: Fluid-filled probe.

C. Enclosure: Epoxy-coated NEMA 250, Type 4X aluminum enclosure with exposed hardware of stainless steel.

D. Switch: SP-DT, UL or FM listed, rated 22 amps, 125 V ac to 250V ac.

E. Manufacturers and Products:

1. Raychem; DigiTrace Model AMC-1A.
2. Thermon; B4X-15140.
3. Raychem; DigiTrace Model AMC-1H for hazardous areas.
4. Thermon; B7-15140 for hazardous areas.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install in accordance with the manufacturer's instructions and recommended practices.
2. Provide insulation as specified in Section 40 42 13, Process Piping Insulation, over all pipe heat tracing.
3. Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.
4. Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.
5. Provide end of circuit pilot lights on heat tracing circuits for buried piping.

B. Electrical Heating Tape:

1. Determine required length of electrical heating tape by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating tape output.
2. Where design heating load exceeds heating tape capacity, install by spiraling.
3. Derate heating tape capacity when installed on plastic piping.
4. Install on services as follows:

Service	Piping Material	Placement	Location
Centrate	Ductile Iron	Above Grade, Exposed	Headworks

5. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

Item	Heating Tape Length (min. feet)
Bolted flanges (per pair)	Two times pipe diameter
Valves	Four times valve length
Pipe hanger or support penetrating insulation	Three times pipe diameter

C. Heat Tracing Circuits: Limit individual lengths of heat tracing circuits such that maximum single circuit capacity is 20 amps when starting the circuit at 40 degrees F. Provide multiple 20-amp circuits as required at individual heat tracing locations.

D. Thermostats:

1. Install in accordance with manufacturer's instructions and as approved by Engineer.
2. For each group of heat traced circuit, install one ambient thermostat.

3.02 FIELD QUALITY CONTROL

A. Test each circuit with 500-volt insulation tester between circuit and ground with neutrals isolated from ground.

1. Insulation Resistance: Minimum 1,000 megohms per 1,000 feet.

END OF SECTION

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 Personal 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): 61 Drinking Water System Components—Health Effects.

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. Top face of channel walls and cover slabs.
   b. Liquid surface or within 3 feet above top of liquid surface.
   c. Top of tank wall or under tank cover.
   d. As depicted on the Drawings, when necessary.

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. Boiler and Steam Piping: ASME B31.1.
2. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
3. Building Service Piping: ASME B31.9, as applicable.
4. Sanitary Building Drainage and Vent Systems: local plumbing code.
5. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
6. Thrust Restraints:
   a. Design for test pressure shown in Piping Schedule located on the Drawings.
   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. Pipe Corrosion Protection: Product data.
2. 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. Qualifications:
   a. Nondestructive Testing Personnel: SNT-TC-1A Level II certification and qualifications.
   b. AWS QC1 Certified Welding Inspector: 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.
4. Welding Procedures: Qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
5. Nondestructive inspection and testing procedures.
6. Test logs.
7. Pipe coating applicator certification.
8. Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.
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, Observation, and Testing.
11. Torquing requirements and procedures, including torque values, for flanged piping assemblies.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Inspection and Testing Agency:
   a. 10 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: Provide services of independent inspection and testing agency for welding operations.

1. The presence of Owner's Special Inspector or Verification CWI does not relieve Contractor from performing 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 on the Drawings (01-G-0070).

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. Grooved End System:

1. Rigid type.
2. Use of flexible grooved joints allowed where shown on the Drawings or with prior approval by Engineer.
3. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.

B. 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.

C. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

D. 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.

E. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturer:
   a. Fernco Joint Sealer Co.
   b. “Or-equal.”

F. 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: As required in Pipe Schedule and Section 09 90 00, Painting and Coating.

B. 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.

C. Insulating Flanges, Couplings, and Unions:

1. Materials:
   a. In accordance with applicable piping material specified in Pipe Data Sheet. Complete assembly shall have ASME B31.3 working pressure rating equal to or higher than that of joint and pipeline.
   b. Galvanically compatible with piping.
   c. Resistant for intended exposure, operating temperatures, and products in pipeline.
2. Union Type, 2 Inches and Smaller:
   a. Screwed or solder-joint.
   b. O-ring sealed with molded and bonded insulation to body.
3. Flange Type, 2-1/2 Inches and Larger:
   a. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
   b. Bolt insulating sleeves shall be provided full length between insulating washers.
   c. Ensure fit-up of components of insulated flange assembly to provide a complete functioning installation.
   d. AWWA C207 steel flanges may be drilled oversize up to 1/8-inch to accommodate insulating sleeves.
   e. No less than minimum thread engagement in accordance with specified bolting standards will be permitted to accommodate thicknesses of required washers, flanges, and gasket.
4. Flange Insulating Kits:
   a. Gaskets: Full-face, G10 with elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.
   b. Insulating Sleeves: Full-length G10.
   c. Insulating Washers: G10.
   d. Steel Washers: Plated, hot-rolled steel, 1/8 inch thick.
      1) Flange Diameters 36 Inches or Less: Provide two washers per bolt.
      2) Flange Diameters Larger Than 36 Inches: Provide four washers per bolt.
5. Manufacturers and Products:
   a. Dielectric Flanges and Unions:
      1) PSI, Houston, TX.
      2) Advance Products and Systems, Lafayette, LA.

b. Insulating Couplings:
   1) Dresser; STAB-39.
   2) Baker Coupling Company, Inc.; Series 216.

2.07 THRUST BLOCKS

A. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

2.08 THRUST TIES

A. Steel Pipe: 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) and Piping Schedule located on the Drawings.

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 located on the Drawings 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. Grooved-End Joints:

1. Piping shall be grooved in accordance with manufacturer’s latest published instructions and shall be accurately cut with tools conforming to coupling manufacturer’s standards and to AWWA C606.
2. Install grooved joint couplings and gaskets in accordance with manufacturer’s latest published installation instructions.

F. 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.

G. Brazed Joints for Refrigerant Piping:

1. Braze copper piping with silver solder complying with AWS A5.8/A5.8M.
2. Construct joints according to AWS Brazing Handbook, Chapter Pipe and Tube.
3. Inside of tubing and fittings shall be free of flux.
4. Clean parts to be joined with emery cloth and keep hot until solder has penetrated the full depth of the fitting and extra flux has been expelled.
5. Cool joints in air and remove flame marks and traces of flux.
6. During brazing operation, prevent an oxide film from forming on inside of tubing by slowly flowing dry nitrogen to expel the air.
7. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

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

I. 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.

J. 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.

K. 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.

L. High-Density Polyethylene Piping:

1. Join pipes, fittings, and flange connections by means of thermal butt-fusion.
2. Perform butt-fusion in accordance with pipe manufacturer's recommendations as to equipment and technique.
3. Special Precautions at Flanges: Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

M. 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(es) 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.

G. Provide stainless steel bird screen on open pipe ends connected to process piping (such as, vent piping), unless otherwise indicated on the Drawings. Attach bird screen with ring flange, threaded connection or other applicable pipe fitting.

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 and low pressure (maximum 10 psi) 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. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
10. 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.
11. After joint has been made, check pipe alignment and grade.
12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
13. Prevent uplift and floating of pipe prior to backfilling.

C. PVC, CPVC, 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.
5. Backfill pipe zone material and allow thermal expansion and contraction to normalize prior to connecting to facility structures or pipe connections.

D. Tolerances:

1. Deflection from Horizontal Line, Except PVC, CPVC, 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 the 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 the Drawings for encasement requirements.

B. Where concrete encased piping crosses structure 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 nitrogen gas 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 located on the Drawings.
2. Buried: Manufacturers standard asphalt coating and wrap with polyethylene bagging.
3. Submerged or Embedded: Coat with coal-tar epoxy or high build epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF 61 approved epoxy.

B. Carbon Steel Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.
2. Buried:
   a. Pipe: Epoxy coating per System No. 8 in Section 09 90 00, Painting and Coating.
   b. Joints: Wax tape coating system as specified in Section 09 90 00, Painting and Coating.
3. Submerged or Embedded: Shop coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF 61 approved epoxy.

C. Copper Pipe:

1. Exposed: None.
2. Buried: 20 mil PVC tape as specified in Section 09 90 00, Painting and Coating.

D. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

E. Piping Accessories:

1. Exposed:
   a. Field paint black and galvanized steel, piping components 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 as specified in Section 09 90 00, Painting and Coating.
   b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.

c. Flexible Couplings Grooved Couplings, and Similar Items: Wax tape as specified in Section 09 90 00, Painting and Coating.
d. Buried Valves and Similar Elements on Wrapped Pipelines: Wax tape as specified in Section 09 90 00, Painting and Coating and wrap entire valve in polyethylene encasement.

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.

H. Insulating Flanges, Couplings, and Unions:

1. Applications:
   a. Dissimilar metal piping connections.
   b. Connections to existing metallic pipe.
   c. Submerged to unsubmerged metallic piping connections.
   d. Where required for electrically insulated connection.
2. Pipe Installation:
   a. Insulating joints connecting immersed piping to nonimmersed piping shall be installed above maximum water surface elevation.
   b. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
   c. Align and install insulating joints as shown on the Drawings and according to manufacturer's recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

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.
3. Submerged Piping: At all joints in piping.

B. Thrust Ties:

1. Ductile Iron Pipe: Attach with socket clamps anchored against grooved joint coupling or flange.

2. 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.

D. Thrust Blocking:

1. Place between undisturbed ground and fitting to be anchored.
2. Quantity of Concrete: Sufficient to cover bearing area on pipe and provide required soil bearing area as shown.
3. Place blocking so that pipe and fitting joints will be accessible for repairs.
4. Place concrete in accordance with Section 03 30 00, Cast-in-Place Concrete.

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 only where shown.

3.15 INSULATION

A. See Section 40 42 13, Process Piping Insulation.

3.16 HEAT TRACING

A. See Section 40 05 33, Pipe Heat Tracing.

3.17 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.

3.18 PIPE IDENTIFICATION

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

3.19 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, except that 5 percent of circumferential butt welds shall be random radiographed.
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.

3.20 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 plant process air, and instrument air lines with compressed air at 4,000 fpm; do not flush with water.

C. Immediately after cleaning , dry to minus 40 degrees F dew point with dry compressed instrument air or compressed commercial grade nitrogen.

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.

3.21 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Data Sheets.

Number	Title
40 27 00.01	Cement-Mortar, Glass, and Ceramic-Epoxy-Lined Ductile Iron Pipe and Fittings
40 27 00.08	Stainless Steel Pipe and Fittings—General Service
40 27 00.09	Fire Resistant Polyvinyl Chloride (PVC) Duct And Fittings

Number	Title
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
40 27 00.14	High Density Polyethylene (HDPE) Pipe and Fittings Data Sheet

END OF SECTION

SECTION 40 27 00.01 CEMENT-MORTAR, GLASS, AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance. 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. 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).
Pipe	Buried Liquid Service Using Mechanical or Proprietary Restrained Joints: AWWA C111/A21.11, and AWWA C151/A21.51, pressure class conforming to Table 3 and Table 5 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron. 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. Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.
Lining	Cement-mortar: AWWA C104/A21.4 with asphaltic seal coat. Use only for liquid service. Glass: ASTM B1000. 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, Protecto 401 by Induron Coating, “or-equal”, for sewer service. Ceramapure by Induron Coating, “or-equal”, for NSF 61 and potable water service. Lining shall

SECTION 40 27 00.01 CEMENT-MORTAR, GLASS, AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
	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.
Fittings	Lined and coated same as pipe. 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. 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. Grooved End: AWWA C606 and AWWA C110/A21.10, ductile iron, 250 psi minimum working pressure; Victaulic. Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face. Gray cast iron will not be allowed.

SECTION 40 27 00.01
CEMENT-MORTAR, GLASS, AND CERAMIC-EPOXY-LINED
DUCTILE IRON PIPE AND FITTINGS

Item	Description
Joints	Mechanical: 250 psi minimum working pressure. Proprietary Restrained: 250 psi minimum working pressure. American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex or HP Lok. Grooved End: Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure; Victaulic. Flange: Dimensions per AWWA C110/A21.10 flat face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed. Branch connections 3 inches and smaller, except from glass-lined pipe, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties. Branch connections, 3 inches and smaller from glass-lined pipe shall be made with glass-lined tee with a flanged branch for adapting to branch piping.
Couplings	Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic. Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.
Bolting	Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard. 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. 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.

SECTION 40 27 00.01 CEMENT-MORTAR, GLASS, AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Gaskets	General: Gaskets in contact with potable water shall be NSF ANSI 61 certified. Mechanical, and Proprietary Restrained Joints; Water and Sewage Service: Halogenated butyl or EPDM, Shore A hardness durometer 60, conforming to AWWA C111/A21.11. Mechanical, and Proprietary Restrained Joints; Hot Air Service: EPDM or Viton, Shore A hardness durometer 60, conforming to AWWA C111/A21.11. Grooved End Joints: Halogenated butyl conforming to ASTM D2000 and AWWA C606. Flanged, Water, Sewage and Hot Air Services: Full face, 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 D1330. Blind flanges shall be epoxy-lined in accordance with the system specified above. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.
Joint Lubricant	Manufacturer’s standard.

END OF SECTION

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	2-1/2" & smaller	Buttwelded Pipe, Schedule 40S: ASTM A312/A312M, Grade TP316/316L dual marked, seamless, pickled, and passivated. Threaded Pipe, Schedule 80S: ASTM A312/A312M, Grade TP316/316L dual marked, seamless, pickled, and passivated.
	3" thru 24"	Schedule 10S: ASTM A312/A312M, Grade TP316/316L, dual marked, seamless, or welded pickled and passivated.
Tubing	All	ASTM A269, Type 316 stainless steel, seamless, fully annealed hydraulic tubing, 0.065-inch wall thickness minimum.
Joints	1-1/2" & smaller	Threaded or flanged at equipment as required or shown.
	2" & larger	Butt-welded or flanged at valves and equipment.
Tubing Joints	All	Flareless compression fitting
Fittings	1-1/2" & smaller	Threaded: Forged ASTM A182/A182M, Grade F316, conforming to MSS SP-114 Class 1000.
	2" & 2-1/2"	Butt Welded: ASTM A403/A403M, Grade WP316/316L-S dual marked, conforming to ASME B16.9, annealed, pickled, and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
	3" thru 24"	Butt-Welded: ASTM A403/A403M, Grade WP316/316L dual marked, conforming to ASME 16.9, 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**
Tubing Fittings	All	Flareless Compression Type Forged: ASTM A182/A182M, Grade F316, Parker-Hannifin Ferulok, Flodar BA Series.
Branch Connections	1-1/2" & smaller 2" & larger	Tee or reducing tee in conformance with fittings above. Butt-welding tee or reducing tee in accordance with fittings above.
Tubing Branch Connections	All	Compression type tees or reducing tees in accordance with Tubing Fittings above.
Flanges	All	Stainless Steel: AWWA C228, Class SD, 316/316L or ASTM A182/A182M, Grade F316/316L, ASME B16.5 Class 150, flat face, weld neck, threaded, blind, or slip-on. Weld slip-on flanges inside and outside. Weld neck bore to match internal pipe diameter.
Unions	2" & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, CL 3000, integral ground seats, AAR design meeting the requirements of MSS SP-83.
Bolting	All	Flanges: AWWA C228, Type 316 stainless steel, ASTM A193/A193M Grade B8M, Class 2 heavy hex head or stud bolts, ASTM A194/A194M Grade 8M heavy hex head nuts. Torque bolts per gasket manufacturer recommendations. Anywhere mating flange on equipment is cast iron or plastic: Carbon steel ASTM A307 Grade B hex head or stud bolts, ASTM A563 Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendation.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Gaskets	All Flanges	Flanged, Water, Hot Air, Fuel Gas and Sewage Services: Full face, 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60-80 (Shore A), rated to 250 degrees F. continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade.
Thread Lubricant (fittings)	1 1/2" & smaller	General Service: 100 percent virgin PTFE Teflon tape. Fuel Gas Service: Yellow Teflon tape designed for fuel gas service, Air Force A-A-58092, AA Thread Seal Tape, Inc.

END OF SECTION

SECTION 40 27 00.09
FIRE RESISTANT POLYVINYL CHLORIDE (PVC) DUCT AND FITTINGS

Item	Size	Description
Duct	All	Ductwork shall be fabricated, reinforced, installed, sealed, and tested in accordance with requirements and recommendations of the SMACNA Thermoplastic Duct (PVC) Construction Manual. Pressure Class from 4 inches W.C., negative to 16 inches W.C., positive. Wall thickness per SMACNA PVC Construction Manual Tables 3-2 through 3-10 for appropriate static pressure and reinforcement spacing. Class 12454-B PVC compounds conforming to ASTM D1784-92 and ASTM F441/F441M. Duct to be FM approved for Fume Exhaust Only. Duct shall be manufactured with titanium dioxide for ultraviolet protection if the duct is exposed to sunlight.
Fittings	All	Wall thickness to match duct requirements. Follow SMACNA PVC Construction Manual Section 3.11.
Joints	All	Follow SMACNA PVC Construction Manual Section 3.10.
Flanges	All	Follow SMACNA PVC Construction Manual Section 3.12.
Bolting	All	Follow SMACNA PVC Construction Manual Section 3.12.3.
Gaskets	All	Follow SMACNA PVC Construction Manual Section 3.13.
Solvent Cement	All	Follow SMACNA PVC Construction Manual Section 2.2.9.

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 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 heavy hex head or stud bolts, ASTM A194/A194M Grade 8M heavy hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendations. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B heavy hex head or stud bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendations.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
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.
Solvent Cement	All	Socket type joints shall be made employing solvent cement that meets or exceeds 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. Solvent weld cement for PVC pipe joints in chemical service shall be free of silica filler and shall be certified by the manufacturer to be suitable for the intended service, IPS Weld-On 724, "or-equal." 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 00.11
CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

Item	Size	Description
Pipe	All	Schedule 80 CPVC: Type IV, Grade I or Class 23447 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 heavy hex head or stud bolts, ASTM A194/A194M Grade 8M heavy hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendations. Raised Face Mating Flange, Non-Corrosive Area: Carbon steel ASTM A307 Grade B heavy hex head or stud bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendations.
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	All socket type joints shall be made employing primer and solvent cements that meet or exceed the requirements of ASTM F493 and primers that meet or exceed the requirements of ASTM F656, resistant to the fluid service, and as recommended by the pipe and fitting manufacturer. Solvent weld cement for CPVC pipe joints in chemical service shall be free of silica filler and shall be certified by the manufacturer to be suitable for the intended service, IPS Weld-On 724 “or-equal.” 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	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. Other Services: Joints 2-1/2 Inch and Smaller: Wire solder (95 percent tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder. 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.

END OF SECTION

SECTION 40 27 00.14
HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

Item	Size	Description
General	All	Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier
Pipe		Schedule 80 PVC: Type I, Grade I or Class 12454 conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	6" & Smaller	Molded fittings, butt fusion joined, conforming to ASTM D3261.
	8" & larger	Same as pipe butt fusion joined, conforming to ASTM D3350. All fittings shall have same pressure rating as pipe, unless otherwise noted.
Flanges	All	Van Stone type, cast ASTM A536 (65/45/12), ductile iron backing ring, IPP Deltaflex convoluted design or equal for bolting to ANSI B16.5, Class 150; and AWWA C207, Class E. Pressure performance of the backing ring equal to SDR rating of pipe with safety factor of two. Stub ends same grade HDPE and pressure rating as pipe.
Bolting		Stainless Steel, ASTM A193/A193M Grade B8M studs and ASTM A194/A194M Grade 8M hex head nuts Washer shall be same material as bolts.
Gaskets		Flat ring, 1/8-inch ethylene propylene rubber (EPR).

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.

1.03 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools for basket strainer:

Item	Quantity
Basket	One for each strainer
Disc seals	One for each strainer
Special tools required to maintain or dismantle	One complete set

PART 2 PRODUCTS

2.01 GENERAL

A. Provide required piping specialty items, whether shown or not shown on the 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 and Products:
    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 the 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.

E. Galvanized and Black Steel Pipe Expansion Compensator:

1. Material: Carbon steel with stainless steel bellows.
2. Working Pressure Rating: 175 psig, minimum.
3. Accessories: Anti-torque device to protect bellows.
4. Manufacturers and Products:
   a. Senior Flexonics; Model H.
   b. Hyspan; Model 8503.
   c. Unisource Manufacturing, Inc.; Style EC-MMT.

F. Flexible Metal Hose:

1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Stainless steel, ASTM A276, Type 321.
3. End Connections:
   a. 3 Inches and Larger: Shop fabricated flanged ends to match mating flanges.
   b. 2-1/2 Inches and Smaller: Screwed ends with one union end.

4. Minimum Burst Pressure: 600 psig at 70 degrees F for 12 inches and smaller.
5. Length: Provide hose live-length equal to lengths shown on the Drawings.
6. Manufacturers and Products:
    a. U.S. Hose Corp.; Series 401M.
    b. Anamet Industrial, Inc.; BWC21-1.

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 the 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 the Drawings.

2.12 MISCELLANEOUS SPECIALTIES

A. Strainers, Water Service, 2 Inches and Smaller:

1. Type: Bronze body, Y-pattern, 200 psi nonshock rated, with screwed gasketed bronze cap.
2. Screen: Heavy-gauge Type 304 stainless steel or monel, 20-mesh.
3. Manufacturers and Products:
   a. Armstrong International; Inc.; Model F.
   b. Mueller Steam Specialty; Model 351M.

B. Strainers, Water Service, 2-1/2 Inches and Larger:

1. Type: Cast iron or ductile iron body, Y-pattern, 175 psi nonshock rated, with flanged gasketed iron cap.
2. Screen: Heavy-gauge Type 316 stainless steel, 0.045-inch perforations.
3. Manufacturer and Product: Armstrong International, Inc.; Model A7FL 125.

C. Strainers, Plastic Piping Systems, 4 Inches and Smaller:

1. Type: Y-pattern PVC body, 150 psi nonshock rated, with screwed PVC cap and Viton seals.
2. End Connections: Screwed or solvent weld, 2 inches and smaller. Class 150 ANSI flanged, 2-1/2 inches and larger.
3. Screen: Heavy-gauge PVC, 1/32-inch mesh, minimum 2 to 1 screen area to pipe size ratio.
4. Manufacturer: Hayward.

D. Basket Strainer:

1. Service Conditions:
   a. Material Handled: Potable or Non-Potable Water.
   b. Temperature of Material Handled: 50 degrees F, minimum to 80 degrees F, maximum.
   c. Specific Gravity of Material Handled: 1.
   d. pH Range of Material Handled: 7.
   e. Range of Total Suspended Solids: 0 NTU to 5 NTU.
2. Strainer Capacity: 1,050 gpm, maximum pressure drop shall not exceed 5 psi at 1,050 gpm.
3. Screen: Capable of removing material larger than 0.01 inch (250 microns) in diameter.
4. Strainer: Single chamber design of stainless steel construction with a quick opening cover.
5. Process Connections: 1-inch flanges faced and drilled 150 pound ASME B16.5.

6. Strainer: Double chamber design of stainless steel construction.
7. Permit one basket strainer to be removed for cleaning while other basket is in operation.
8. Inlet and Outlet Valves: Three-way globe type with neoprene disc seals.
9. Baskets: Type 304 or Type 316 stainless steel.
10. Wearing parts shall be replaceable without removing strainer from line.
11. Factory Finishing:
    a. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.
    b. Furnish manufacturer's standard.
12. Manufacturer: S.P. Kinney Engineers, Inc.

E. Water Hose:

1. Furnish 50-foot lengths of 1-inch and 50-foot lengths of 1-1/2-inch rubber hose. EPDM black cover and EPDM tube, reinforced with two textile braids. Provide each length with brass male and female NST hose thread couplings to fit hose nozzle and hose valve.
2. Rated minimum working pressure of 200 psi.
3. Manufacturers:
    a. Goodyear.
    b. Boston.

F. Hose Nozzles:

1. Furnish 1-inch and 1-1/2-inch cast brass, satin finish, nozzles with adjustable fog, straight-stream, and shut-off feature and rubber bumper. Provide nozzles with female NST hose thread.
2. Manufacturers:
    a. Croker.
    b. Elkhart.

G. 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 and Anchor Walls: 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 INJECTOR SYSTEM

A. Install in accordance with manufacturer's instructions.

3.12 MISCELLANEOUS SPECIALTIES

A. Basket Strainers:

1. Install in accordance with manufacturer's instructions.
2. Field Quality Control:
   a. Conduct test on each basket strainer.
   b. Test valves shall be tested for proper seating, travel, and operation.
3. Manufacturer's Services: Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified component, subsystem, equipment, or system.

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. 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, Observation, 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 the 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 Pneumatic Actuated Valve Schedule 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.
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.
   c. All-bronze, screwed bonnet, packed gland, single solid wedge gate, rising stem, Class 125 rated 200 psi CWP, complies with MSS SP-80 Type 2.
   d. Manufacturers and Products:
      1) Crane; Figure 428, NPT threaded ends.
      2) Stockham; Figure B-100, NPT threaded ends.

3) Crane; Figure 1334, soldered ends.
4) Stockham; Figure B-108, soldered ends.

3. Type V102 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, nonrising stem, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 1.
   b. Manufacturers and Products:
      1) Crane; Figure 437.
      2) Stockham; Figure B-128.
4. Type V103 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, rising stem, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 2.
   b. Manufacturers and Products:
      1) Crane; Figure 431.
      2) Stockham; Figure B122.
5. Type V104 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, nonrising stem, stainless steel seat rings, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80 Type 1.
   b. Manufacturers and Products:
      1) Crane; Figure 426.
      2) Stockham; Figure B-140.
6. Type V105 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, rising stem, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80 Type 2.
   b. Manufacturers and Products:
      1) Crane; Figure 424.
      2) Stockham; Figure B-132.
7. Type V106 Gate Valve 2 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, nonrising stem, stainless steel seat rings, Class 300 rated 300 psi SWP/1,000 psi CWP, complies with MSS SP-80 Type 1.
   b. Manufacturers and Products:
      1) Crane; Figure 636E.
      2) Stockham; Figure B-147.
8. Type V107 Gate Valve 2 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, NPT threaded ends, single solid wedge gate, rising stem, stainless steel seat rings, Class 300 rated 300 psi SWP/1,000 psi CWP, complies with MSS SP-80 Type 2.

b. Manufacturers and Products:
   1) Crane; Figure 634E.
   2) Stockham; Figure B-145.

9. Type V108 Gate Valve 2 Inches to 24 Inches:
   a. Iron body, bronze mounted, flanged ends, solid wedge gate, nonrising bronze stem, Class 125 rated 125 psi SWP, 200 psi CWP for 2 inches through 12 inches and 100 psi SWP, 150 psi CWP for 14 inches through 24 inches.
   b. Manufacturers and Products:
      1) Crane; Figure 461.
      2) Stockham; Figure G612.
10. Type V110 Gate Valve 2 Inches to 24 Inches:
   a. Iron body, bronze mounted, flanged ends, solid wedge gate, outside screw and yoke, Class 125 rated 125 psi SWP, 200 psi CWP for 2 inches through 12 inches and 100 psi SWP, 150 psi CWP for 14 inches through 24 inches.
   b. Manufacturers and Products:
      1) Crane; Figure 465-1/2.
      2) Stockham; Figure G623.
11. 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.
12. 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.
13. Type V124 Gate Valve 16 Inches and Larger for Low Pressure Water Service:
   a. Iron body, bronze mounted, flanged ends, double disc gate, nonrising bronze stem, rated for 50 psi, working water pressure, 125 psi ASME B16.1 drilling.
   b. Manufacturer and Product: Ludlow-Rensselaer Valve Division of Patterson Industries, Inc.; List 11.

14. Type V126 Gate Valve 4 Inches through 30 Inches for High Pressure Water Service:
    a. Iron body, bronze mounted, flanged ends, double disc gate with nonrising bronze stem rated 250 psi working water pressure.
    b. Operator:
        1) 2 Inches to 14 Inches Valves: Handwheel.
        2) 14 Inches and Larger Valves: Bevel gear.
    c. Options: Bypass valve.
    d. Manufacturer and Product: M&H; Style 871 02 or 881 02.
15. Type V128 Gate Valve 4 Inches Through 30 Inches for Buried High Pressure Water Service:
    a. Iron body, bronze mounted, mechanical joint ends, double disc gate, nonrising bronze stem, O-ring sealed stuffing box, 2-inch square wrench nut conforming to AWWA C500, rated 250 psi nonshock cold water.
    b. Manufacturer and Product: M&H; Style 871.
16. Type V130 Resilient Seated Gate Valve 3 Inches to 12 Inches:
    a. Iron body, resilient seat, bronze stem and stem nut, ASME B16.1 Class 125 flanged ends, nonrising stem , in accordance with AWWA C509, minimum design working water pressure 250 psig, full port, fusion-epoxy coated inside and outside per AWWA C550, NSF/ANSI 61 certified.
    b. Manufacturers and Products:
        1) M&H Valve; AWWA C509.
        2) U.S. Pipe; A-USPO.
17. Type V132 Resilient Seated Gate Valve 3 Inches to 12 Inches, for Buried Service:
    a. Iron body, resilient seat, bronze stem and stem nut, mechanical joint ends, nonrising stem, in accordance with AWWA C509, 2-inch operating nut, minimum design working water pressure 250 psig, full port, fusion epoxy coated inside and outside per AWWA C550, NSF/ANSI 61 certified.
    b. Manufacturers and Products:
        1) M&H Valve; AWWA C509.
        2) U.S. Pipe; A-USPO.
18. Type V134 Resilient Seated Ductile Iron Gate Valve 3 Inches to 36 Inches:
    a. Ductile iron body, resilient seat, bronze stem and stem nut, ASME B16.1 Class 125 flanged ends, nonrising stem, in accordance with AWWA C515, minimum design working water pressure 250 psig, full port, fusion epoxy coated inside and outside per AWWA C550, NSF/ANSI 61 certified.
    b. Manufacturers and Products:
        1) American Flow Control; Series 2500.
        2) M&H; Style 7000 and C515 Large RW Valves.

19. Type V135 Resilient Seated Ductile Iron Gate Valve 3 Inches to 36 Inches:
    a. Ductile iron body, resilient seat, bronze stem and stem nut, mechanical joint ends, nonrising stem, in accordance with AWWA C515, minimum design working water pressure 250 psig, full port, fusion epoxy coated inside and outside per AWWA C550, NSF/ANSI 61 certified.
    b. Manufacturers and Products:
        1) American Flow Control; Series 2500.
        2) M&H; Style 7000 and C515 Large RW Valves.
20. Type V136 Resilient Seated Gate Valve, Flanged Ends 4 Inches to 12 Inches:
    a. UL Listed and FM Approved, iron body, resilient seat, bronze mounted, ASME B16.1 Class 125 flanged ends, outside screw and yoke, handwheel operator, in accordance with AWWA C509, minimum design working water pressure 200 psig, full port, fusion-epoxy coated inside and outside per AWWA C550, NSF/ANSI 61 certified. Valve supervised in OPEN position so closing results in actuation of alarm.
    b. Manufacturers and Products:
        1) Kennedy Valve; Ken-Seal II.
        2) M&H Valve; Style 4068.
        3) Mueller; R-2360.
21. Type V140 Gate Valve 3/4 Inch to 2 Inches:
    a. UL Listed and FM Approved, all bronze, solid wedge disc, outside screw and yoke, screwed ends rated 175 pound WOG minimum.
    b. Manufacturer and Product: Kennedy; UL/FM.
22. Type V142 Gate Valve 3 Inches to 12 Inches:
    a. UL Listed, iron body, bronze-mounted, designed for fire protection service, rising stem, outside screw and yoke, ASME B16.1 flanged ends, rated 175 pound WOG.
    b. Double disc type gate, bronze wedge pins, parallel seat, gate stem in bronze bushing through stuffing box.
23. Type V150 Knife Gate Valve 24 Inches and Smaller:
    a. Bonnetless wafer body type, outside stem and yoke, rated for 150 psi cold water, ASME B16.1 flanged ends, self-cleaning, nonclogging, with round port, resilient neoprene seat, drip-tight shutoff.
    b. Wetted metal parts and stem, Type 316 stainless steel, yoke sleeve bronze, gate finish ground both sides with a sharp knife edge.
    c. Packing system leak-tight seal around gate, valve superstructure and yoke designed for full peripheral access to gland bolts when valve is equipped with manual or power actuator.
    d. In compliance with MSS SP-81.

e. Manufacturers and Products:
   1) DeZurik; Series L.
   2) Rovang; Model L17.
   3) ITT Fabri-Valve; Figure 37L.

B. Globe Valves:

1. Type V200 Globe Valve 3 Inches and Smaller:
   a. All-bronze, union bonnet, packed gland, inside screw, rising stem, TFE disc, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 2.
   b. Manufacturers and Products:
      1) Stockham; Figure B-22T, NPT threaded end.
      2) Crane Co.; Figure 7TF, NPT threaded end.
      3) Milwaukee; Model 1590T, soldered ends.
      4) NIBCO; Figure S-235-Y, soldered ends.
2. Type V201 Angle Pattern Valve 2 Inches and Smaller:
   a. All-bronze, NPT threaded ends, union bonnet, packed gland, inside screw, rising stem, TFE disc, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 2.
   b. Manufacturers and Products:
      1) Stockham; Figure B-222T.
      2) Crane Co.; Figure 17TF.
3. Type V202 Globe Valve 3 Inches and Smaller:
   a. All-bronze, union bonnet, packed gland, inside screw, rising stem, replaceable stainless steel tapered plug type disc and seat ring, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80 Type 3.
   b. Manufacturers and Products:
      1) Stockham; Figure B-62, NPT threaded end.
      2) Crane Co.; Figure 212P, NPT threaded end.
4. Type V204 Globe Valve 2 Inches and Smaller:
   a. All-bronze, NPT threaded ends, union bonnet, packed gland, inside screw, rising stem, replaceable stainless steel tapered plug type disc and seat ring, Class 300 rated 300 psi SWP/1,000 psi CWP, complies with MSS SP-80 Type 3.
   b. Manufacturers and Products:
      1) Crane; Figure 382P.
      2) Stockham; Figure B-74.
5. Type V205 Angle Pattern Valve 2 Inches and Smaller:
   a. All-bronze, NPT threaded ends, union bonnet, packed gland, inside screw, rising stem, replaceable stainless steel tapered plug type disc and seat ring, Class 300 rated 300 psi SWP/1,000 psi CWP, complies with MSS SP-80 Type 3.

b. Manufacturers and Products:
   1) Stockham; Figure B-274.
   2) Crane; Figure 384P.

6. Type V208 Needle Disc Type Globe Valve 1/8 Inch to 3/4 Inch:
   a. All-bronze, threaded bonnet, packed gland, rising stem, bronze body and stem, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80.
   b. Manufacturers and Products:
      1) Crane Cat.; No. 88.
      2) Stockham; B-64.
7. Type V209 Needle Disc Type Globe Valve 1/8 Inch to 3/4 Inch:
   a. All-bronze, threaded bonnet, packed gland, rising stem, bronze body and stem, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80.
   b. Manufacturers and Products:
      1) Crane Cat.; No. 89.
      2) Stockham; B-264.
8. Type V210 Globe Valve 2 Inches to 10 Inches:
   a. Iron body, bronze mounted, flanged ends, bronze seat, outside screw and yoke, bolted bonnet, Class 125 rated 125 psi SWP/200 psi CWP, complies with MSS SP-85 Type 1.
   b. Manufacturers and Products:
      1) Stockham; G-512.
      2) Crane; Figure 351.
9. Type V234 Angle Type Hose Valve 1/2 Inch to 3/4 Inch:
   a. Bronze or manufacturer’s standard brass, angle sillcock type body, threaded or solder inlet as applicable, pressure rating 125 psi cold water.
   b. Manufacturer and Product: Nibco; QTX Series.
10. Type V235 Angle Type Hose Valve 3/4 Inch:
   a. 3/4-inch NPT female inlet, 3/4-inch male hose thread outlet, heavy rough brass body rated 125 psi, lockshield bonnet, removable handle, atmospheric vacuum breaker conforming to ASSE 1011 and IAPMO code.
   b. Manufacturers and Products:
      1) Acorn; 8126, surface pipe mount valve, bent nose without flange.
      2) Acorn; 8121, surface mount through wall valve, bent nose with flange.
      3) Acorn; 8131, pipe and pedestal mounted valve located above 6 inches, straightnose.
      4) Acorn; 8136, pedestal mounted valve located lower than 6 inches, inverted nose.

11. 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 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.
12. 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.

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.
    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 V301 Ball Valve 2 Inches and Smaller for General Water and Air Service:
    a. Two-piece, full 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.
    b. Manufacturers and Products:
        1) Threaded:
            a) Conbraco Apollo; 77-100.
            b) Nibco; T-585-70.

2) Soldered:
a) Conbraco Apollo; 77-200.
b) Nibco; S-585-70.

3. Type V302 Actuator Ready Ball Valve 2 Inches and Smaller for General Water and Air Service:
a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, actuator mounting pad, Type 316 stainless steel ball and stem, vented ball, reinforced PTFE seats and seals, adjustable packing nut, blowout-proof stem, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.
b. Manufacturers and Products:
1) Conbraco Apollo; 71-140.
2) Milwaukee; 20BSOR-02.

4. Type V303 Ball Valve 2 Inches and Smaller for Equipment Air System Shutoff:
a. Two-piece, 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, 125 psig rated, safety exhaust port to exhaust downstream side when valve is in closed position, zinc-coated steel locking handle with vinyl grip.
b. Meets OSHA Regulation 29 CFR Part 1910.147 requirements.
c. Manufacturers and Products:
1) Conbraco Apollo; 75-100-41.
2) Nibco; T-580-70-SV/T-585-70-SV.

5. Type V304 Ball Valve 2 Inches and Smaller for General Water and Air Service:
a. Three-piece, full port, NPT threaded ends, bronze body and end pieces, hard chrome plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150 psi SWP, complies with MSS SP-110.
b. Manufacturers and Products:
1) Threaded Ends:
a) Conbraco Apollo; 82-100.
b) Nibco; T-595-Y.
c) Stockham; T-395 Series.
2) Solder Ends:
a) Conbraco Apollo; 82-200.
b) Nibco; S-595-Y.
c) Stockham; S-395 Series.

6. Type V305 Ball Valve 2 Inches and Smaller for Fuel Oil Service:
a. Two-piece bronze or forged brass body and end piece, NPT threaded ends, hard chrome-plated solid brass ball, RTFE seats and seal, blowout-proof stem, zinc-plated hand lever operator with vinyl grip, UL Listed Guide MHKZ for Fuel Oil, 600 WOG.

b. Manufacturers and Products:
   1) Conbraco Apollo; 80-100.
   2) Nibco; T-585-70-UL/T-580-70-UL.

7. Type V306 Stainless Steel Ball Valve 2 Inches and Smaller:
   a. Two-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end piece, NPT threaded ends, ASTM A276 Type 316 stainless steel ball, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 1,000 psig CWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 76F-100 Series.
      2) Nibco; T-585-S6-R-66-LL.
8. 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.
9. Type V308 Stainless Steel Ball Valve 2 Inches and Smaller:
   a. Two-piece, standard port, NPT threaded ends, ASTM A351/A351M GR CF8M stainless steel body and end pieces, actuator mounting pad, Type 316 stainless steel ball and stem, vented ball, reinforced PTFE seats and seals, adjustable packing nut, blowout-proof stem, rated 1,500 psig WOG minimum, 150 psi SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 76-100.
      2) Nibco; T-580-S6-R-66-LL.
      3) Milwaukee; 20SSOR-02.
10. 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.

11. 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.
    b. Manufacturers and Products:
        1) Nibco; Chemtrol Tru-Bloc.
        2) ASAHI/America; Type 21.
        3) Spears; True Union.
12. 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, Viton 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.
    b. Manufacturers and Products:
        1) Nibco; Chemtrol Tru-Bloc.
        2) ASAHI/America; Type 21.
13. Type V335 CPVC Ball Valve 2 Inches and Smaller:
    a. Rated 150 psi at 100 degrees F, 80 psi at 140 degrees, with ASTM D1784, Type IV, Grade 1 chlorinated polyvinyl chloride (CPVC) body, ball, and stem, end entry, double union design, with solvent-weld socket ends or single union ball with flanged ends drilled to ASME B16.1, replaceable Teflon seat, Viton or Teflon O-ring stem seals, to block flow in both directions.
    b. Manufacturers and Products:
        1) Nibco; Chemtrol Tru-Bloc.
        2) ASAHI/America; Type 21.
        3) Spears; True Union.

D. Plug Valves:

1. Type V400 Eccentric Plug Valve 2 Inches and Smaller:
    a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, threaded ends, lever operator, cast-iron plug with round or rectangular port, plug coated with Buna-N, stem bearing lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber.
    b. Manufacturers and Products:
        1) Pratt; Ballcentric.
        2) DeZurik; Style PEC.
        3) Milliken; Millcentric Series 603.

2. 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.
3. Type V406 Eccentric Plug Valve 14 Inches to 20 Inches:
   a. Nonlubricated type rated 150 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 joints ends, unless otherwise shown, 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.
   b. 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.
   c. For buried service, provide external epoxy coating.

d. Manufacturers and Products:
   1) Pratt; Ballcentric.
   2) DeZurik; Style PEC.
   3) Milliken; Millcentric Series 600.

4. Type V407 Eccentric Plug Valve 24 Inches to 48 Inches:
   a. Nonlubricated type rated 150 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1, buried service mechanical joints ends unless otherwise shown, plug cast iron port opening of no less than 70 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.
   b. 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.
   c. For buried service, provide external epoxy coating.
   d. Manufacturers and Products:
      1) Pratt; Ballcentric.
      2) DeZurik; Style PEC.
      3) Milliken; Millcentric Series 600.
5. Type V408 Eccentric Plug Valve 3 Inches to 12 Inches for Digester Gas Service:
   a. Nonlubricated type rated 175 psig working pressure, bubble-tight shutoff with gas pressure from one direction, body cast iron with flanged ends, 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 bearing lubricated stainless steel, stem seal multiple V-rings or U-cups with O-rings of nitrile rubber.
   b. Internal surfaces of valve body epoxy lined (except seat).
   c. Operators:
      1) 3-Inch and 4-Inch Valves: Wrench lever manual.
      2) 6-Inch through 12-Inch Valves: Totally enclosed, geared, manual operator, with handwheel, 2-inch nut, or chain wheel.
   d. Manufacturers and Products:
      1) Pratt; Ballcentric.
      2) DeZurik; Style PEC.
      3) Milliken; Millcentric Series 600.

6. Type V410 Three-Way, Nonlubricated, Tapered Plug Valve 3 Inches to 16 Inches:
   a. Cast-iron body with Buna-N-coated plug, multiple V-rings or U-cups with O-ring seals, lubricated stainless steel bearings, and nickel- or epoxy-coated seat, rated 125 psi CWP minimum, flanged to ASME B16.1.
   b. Operator: Lever type or Gear type, totally enclosed and lubricated, with handwheel. See Drawings for installation.
   c. Manufacturers and Products:
      1) DeZurik; Style PTW, Combination.
      2) Milliken; Millcentric Series 600, Style.

E. Butterfly Valves:

1. General:
   a. In full compliance with AWWA C504 and following requirements:
      1) Suitable for throttling operations and infrequent operation after periods of inactivity.
      2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
      3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
      4) No travel stops for disc on interior of body.
      5) Self-adjusting V-type or O-ring shaft seals.
      6) Isolate metal-to-metal thrust bearing surfaces from flowstream.
      7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
      8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
      9) Provide linings and coatings per AWWA, unless otherwise indicated on the Drawings or specified herein.
      10) Valves to be in full compliance with NSF/ANSI 61.
   b. Non-AWWA butterfly valves to meet the following actuator requirements:
      1) For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on the Drawings or specified herein.

2. Type V500 Butterfly Valve Water Works Service 3 Inches to 72 Inches:
   a. AWWA C504, Class 150B.
   b. Short body type, flanged ends.
   c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, Buna-N rubber seat bonded or molded in body only, and stainless steel seating surface.
   d. Manufacturers and Products:
      1) Pratt; Model 2FII or Triton XR-70.
      2) DeZurik; AWWA Valve.
3. Type V501 Butterfly Valve Water Works Service 30 Inches to 72 Inches:
   a. AWWA C504, Class 75.
   b. Short body type, flanged ends.
   c. Cast-iron body, ductile iron disc with Type 316 stainless steel seating edge, Type 316 stainless steel shafts, Buna-N rubber seat bonded or molded in body only.
   d. Manufacturers and Products:
      1) Pratt; Model Triton XR-70.
      2) DeZurik; AWWA Valve.
4. Type V502 Butterfly Valve General Service 3 Inches to 20 Inches:
   a. AWWA C504, Class 150B.
   b. Wafer style type.
   c. Buna-N rubber seat.
5. Type V504 Butterfly Valve General Service 4 Inches to 48 Inches:
   a. AWWA C504, Class 150B.
   b. Mechanical joint end type.
   c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, Buna-N rubber seat bonded or molded in body only, and stainless steel seating surface.
   d. Manufacturers and Products:
      1) Pratt; Groundhog.
      2) DeZurik; Buried AWWA Valve.
6. Type V510 Lug Style Butterfly Valve, Resilient Seated, 2 Inches to 20 Inches for Low Pressure Process Air Service:
   a. Lug style cast-iron body, aluminum bronze discs, Type 316 stainless steel one-piece stem, self-lubricating sleeve type bushings, EPDM replaceable resilient seat suitable for operating temperatures up to 250 degrees F, 150 psi working pressure rating, bubble-tight at 50 psi differential pressure, valve body to fit between ASME B16.1 Class 125/150 flanges.
   b. Manufacturers and Products:
      1) Bray Controls; Series 31.
      2) Tyco/Keystone; Model AR2.

7. Type V511 Flanged Style Butterfly Valve, Resilient Seated, 24 Inches to 48 Inches for Low Pressure Process Air Service:
   a. Flanged style cast-iron body, aluminum bronze discs, Type 304 stainless steel one-piece stem, self-lubricating bronze sleeve type bearing, EPDM replaceable resilient seat suitable for operating temperatures up to 250 degrees F, 150 psi working pressure, rating, bubble-tight at 50 psi differential pressure, externally adjustable bronze packing gland with Buna-N packing, valve body to fit between ASME B16.1 Class 125/150 flanges.
   b. Manufacturers and Products:
      1) Bray Controls; Series 35.
      2) Tyco/Keystone; Figure 106.
8. Type V512 Lug Butterfly Valve 2 Inches to 20 Inches for Digester Gas:
   a. Lug style, two-piece cast-iron body, one-piece Type 316 stainless steel thin-profile disc and stem, heavy-duty stem bushing, NBR stem seal, FKM (Viton) replaceable resilient seat, 50 psi pressure bi-directional bubble-tight rating, suitable for temperatures up to 250 degrees F, valve body to fit between ASME B16.1 Class 125/150 flanges. Supply reduced disc diameter, if available.
   b. Manufacturers and Products:
      1) Bray Controls; Model 21.
      2) Tyco/Keystone; Model 920.
9. Type V513 Butterfly Valve 2 Inches to 20 Inches:
   a. Lug style, cast-iron or ductile iron body, Type 316 stainless steel disc, Type 316 or Type 18-8 stainless steel one-piece stem, FKM (Viton) replaceable resilient seat, heavy-duty self-lubricating sleeve type bushings, NBR stem seal, 150 psi working pressure rating, valve body to fit between ASME B16.1 Class 125/150 flanges.
   b. Manufacturers and Products:
      1) Bray Controls; Series 30/31.
      2) Tyco/Keystone; Model AR1/AR2.
      3) Crane/Centerline; Series 200.
10. Type V514 High Performance Butterfly Valve 2 Inches to 36 Inches:
   a. ASME B16.1 Class 150 lug style, high performance type, Type 316 stainless steel body, Type 316 stainless steel single or double offset disc, Type 316 stainless steel shaft and taper pins, PTFE seat, PTFE stem packing, stainless steel with RTFE thrust washer.
   b. Manufacturers and Products:
      1) Tyco/Keystone; K-Lok Series.
      2) DeZurik; BHP Series.

F. Check and Flap Valves:

1. Type V600 Check Valve 2 Inches and Smaller:
   a. All bronze, threaded cap, threaded or soldered ends, swing type replaceable bronze disc, rated 125-pound SWP, 200-pound WOG.
   b. Manufacturers and Products:
      1) Stockham; Figure B-319, threaded ends.
      2) Milwaukee; Figure 509, threaded ends.
      3) Stockham; Figure B-309, soldered ends.
      4) Milwaukee; Figure 1509, soldered ends.
2. Type V602 Check Valve 2 Inches and Smaller:
   a. All bronze, threaded cap, threaded ends, swing type replaceable Teflon disc and bronze disc holder, rated 150-pound SWP, 300-pound WOG.
   b. Manufacturers and Products:
      1) Walworth; Figure 3412.
      2) Milwaukee; Figure 510.
3. Type V604 Check Valve 2-1/2 Inches to 12 Inches:
   a. Flanged end, cast-iron body, bronze mounted swing type, solid bronze or cast-iron disc, bronze seat ring, rated 125-pound SWG, 200-pound WOG.
   b. Manufacturers and Products:
      1) Stockham G-931; List 37, Clearway check valve.
      2) Crane Co.; Cat. No. 373.
4. Type V606 Check Valve 2 Inches to 12 Inches:
   a. Flanged end, cast-iron body, bronze mounted swing type, solid bronze or cast-iron disc, bronze seat ring, outside lever and weight, rated 125-pound SWP, 200-pound WOG.
   b. Manufacturers and Products:
      1) Stockham; G-931.
      2) Crane Co.; Cat. No. 383.
5. Type V608 Swing Check Valve 2 Inches to 24 Inches:
   a. AWWA C508, 125-pound flanged ends, cast-iron body, bronze body seat, bronze mounted cast-iron clapper with bronze seat, stainless steel hinge shaft.
   b. Valves, 2 inches through 12 inches rated 175-pound WWP and 14 inches through 24 inches rated 150-pound WWP. Valves to be fitted with adjustable outside lever and weight . Increasing-pattern body valve may be used where increased outlet piping size is shown.
   c. Manufacturers and Products:
      1) M&H Valve; Style 59, 159, or 259.
      2) Mueller Co.; No. A-2600 Series.

6. Type V610 Swing Check Valve 2-1/2 Inches to 12 Inches for Fire Protection Service:
   a. UL Listed, FM Approved, iron body, bronze-mounted, rated 175 pounds WOG, self-adjusting bronze disc, ends ASME B16.1 flanged, with a 1-inch NPT tapped and plugged boss.
   b. Manufacturers and Products:
      1) Kennedy; Figure 126.
      2) Mueller; A-2120-6.
7. Type V620 Silent Check Valve 2 Inches to 10 Inches:
   a. Wafer style, iron body, center guided valve, bronze trim, Buna-N seat, stainless steel springs, rated 150-pound WOG.
   b. Manufacturers and Products:
      1) Mueller; Steam Specialty 91AP.
      2) APCO; Series 300.
8. Type V622 Silent Check Valve 3 Inches to 24 Inches:
   a. Globe style, center guided, 250-pound flanges, cast-iron body, bronze trim, Buna-N seat, stainless steel spring. Valves to be FM Approved in sizes up to and including 12 inches.
   b. Manufacturers and Products:
      1) APCO; Series 600.
      2) Val-Matic; 1800 Series.
      3) Cla-Val; Series 581.
9. Type V624 Silent Check Valve 4 Inches to 12 Inches for Fire Protection Service:
   a. UL Listed or FM Approved, center-guided globe style valve with ASME B16.1, Class 125 flanges, iron body, bronze trim, stainless steel spring, rated 175-pound nonshock, CWP.
   b. Manufacturers and Products: Mueller; Steam Specialty.
10. Type V630 PVC Ball Check Valve 4 Inches and Smaller:
    a. ASTM D1784, Type I, Grade 1 polyvinyl chloride body, dual union socket weld ends, rated 150 psi at 73 degrees F, and Viton seat and seal.
    b. Manufacturers and Products:
       1) Nibco; Chemtrol Tru Union.
       2) ASAHI/America.
       3) Spears; True Union.
11. Type V631 CPVC Ball Check Valve 4 Inches and Smaller:
    a. ASTM D1784 Cell Class 23477B CPVC body, single or dual union socket weld ends, rated 150 psi at 73 degrees F, 110 psi at 140 degrees F, Viton seat and seal.
    b. Manufacturers and Products:
       1) Nibco; Chemtrol Tru Union.
       2) ASAHI/America.
       3) Spears; True Union.

12. Type V632 Ball Check Valve 3 Inches and Larger:
    a. Flanged end, iron body valve with cleanout and floating or sinking based on installation type hollow steel ball, vulcanized nitrile rubber exterior, flanges ASME B16.1, Class 125, rated 150-pound working pressure, suitable for vertical up or horizontal flow.
    b. Manufacturers:
        1) FLYGT Corp.
        2) Flomatic Corp.
        3) Golden Anderson.
13. Type V634 Rubber Flapper Check Valve 2 Inches to 24 Inches:
    a. Iron body, ASME B16.1, Class 125 flanges, steel-reinforced Buna-N flapper raised seating ring, rated 150-pound CWP.
    b. Manufacturers and Products:
        1) APCO; Series 100.
        2) Val-Matic; “Swingflex.”
14. Type V640 Double Check Valve Backflow Prevention Assembly 3/4 Inch to 10 Inches:
    a. Two resilient seated check valves, two nonrising stem resilient-seated isolation valves, test cocks, in accordance with AWWA C510, 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 850.
        2) Danfoss Flomatic; Model DCVE/DCV.
        3) Watts; Series 007/709.
15. 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 cocks, in accordance with AWWA C511, 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.
16. Type V644 Wet Pipe Alarm Valve:
    a. Valve and Trim:
        1) UL Listed and FM Approved as a complete unit, rated 175 psi working pressure, grooved end outlet.
        2) Supplied with full trim for position as shown on the Drawings including, but not necessarily limited to, water pressure gauges (with test valves), alarm test valve,

mechanical sprinkler alarm bell connection (with strainer), pressure switch for electric alarm signal, retarding chamber, alarm and retard chamber drains, and main drain.

3) Provide with additional valves, piping, and fittings as required for complete and fully functioning arrangement.

b. Manufacturers and Product:
   1) Reliable Automatic Sprinkler Co., Inc.; Model E Alarm Valve.
   2) Tyco/Central.

17. Type V652 Check Valve 2 Inches and Smaller for Fuel Oil Service:
   a. Forged steel, lift-check type integral seat, stainless steel disc, screwed ends, rated 800 psi at 850 degrees F.
   b. Manufacturers and Products:
      1) Smith; C80.
      2) R-P&C; F90.
18. Type V654 Check Valve 2 Inches and Smaller for Heating, Chilled, and Cooling Service:
   a. All-bronze type silent check valve, screwed ends, rated 200-pound WOG.
   b. Manufacturers and Product:
      1) Mueller; Steam Specialty No. 203-BP.
      2) Metraflex.
19. Type V690 Flap Gate 6 Inches to 96 Inches:
   a. Cast-iron body and cover, bronze-mounted, flanged frame type, dual pivot-point hinge arms, hinge arms bronze, hinge pins Type 304 stainless steel, seat bronze and impacted into grooves in body and cover flap, lubrication fittings for each pivot, upper and lower pivot adjustment.
   b. Manufacturers and Products:
      1) Rodney Hunt Co.; Series FV-AC or FV-AR.
      2) Hydro Gate; Model 50C or 50.
20. Type V692 Flap Valve 4 Inches to 30 Inches:
   a. Flange style frame, cast-iron body, bronze seats on body and cover, bronze hinge pins.
   b. Manufacturers and Products:
      1) M&H Valve; Style 47-02.
      2) Clow Valve; No. F-3012.
21. Type V694 Check Valve 1 Inch to 48 Inches:
   a. Elastomer type flanged or slip-on as shown on the Drawings, round entry area to match pipe, contoured duckbilled shaped exit, flat bottom and off-set bill design, curved bill for 18 inches and larger, valve open with approximately 2 inches of line pressure and return to CLOSED position under zero flow condition, rated for 50 psi minimum operating pressure; flanges steel backing flange type, drilled to ASME B16.1, Class 125, plain-end valve

attached with two Type 316 stainless steel adjustable bands, elastomer nylon-reinforced Buna-N.

b. Manufacturer and Product: Red Valve Co.; Tideflex Check Valve Series TF-1 or 35-1.

G. Self-Regulated Automatic Valves:

1. Type V720 PVC Pressure Relief, By-Pass Relief, Back-Pressure Regulator, Back-Pressure, Anti-Siphon Valve 1/2 Inch to 2 Inches:
   a. Direct acting diaphragm, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.
   b. PVC body, Teflon or Viton diaphragm, PVC or Teflon piston, high-density polyethylene or stainless steel adjusting bolt and locknut, stainless steel or coated steel spring, stainless steel fasteners.
   c. Designed to open when upstream pressure reaches setpoint; set pressure adjustable from 10 psi to 100 psi, minimum. Factory set pressure setting at 25 psi for back-pressure and anti-siphon valves, 10 psi for pressure relief valves, 100 psi for bypass relief valves, and 50 psi for back-pressure regulator valves.
   d. Manufacturers and Products:
      1) Plast-O-Matic; Series RVDT.
      2) Griffco; Series BPV.
      3) Primary Fluid Systems; TOP Valve.
2. Type V730 Pressure-Relief Valve 2 Inches and Smaller:
   a. Direct diaphragm, spring controlled, cast-iron body, spring case, nitrile seat, neoprene diaphragm, stainless steel valve stem, NPT threaded ends, 200 psi rated.
   b. Opens when upstream pressure reaches a maximum set point.
   c. Size/Rating: As shown in Valve Schedule.
   d. Manufacturer and Product: Fisher; 98 Series.
3. Type V732 Pressure-Relief Valve 3 Inches and Larger:
   a. Hydraulically operated, diaphragm actuated, pilot controlled angled body valve, ductile iron body, ASME B16.1, Class 150 flanged ends, rated 250 psi, stainless steel trim, stainless steel stem, externally mounted strainers with cocks, to open when upstream pressure reaches a maximum set point.
   b. Fusion-bonded epoxy lining and coating installed in accordance with AWWA C550.
   c. Size/Rating: 4 inch, set point as shown in Valve Schedule.
   d. Valve selection suitable for wastewater sludge applications.
   e. Manufacturers and Products:
      1) Cla-Val; 650-01.
      2) Singer; Model 106-DL.
      3) Flomatic; Model C401-Type CA.

4. Type V740 Air and Vacuum Valve 1/2 Inch to 16 Inches:
   a. 1/2-inch through 3-inch NPT inlets and outlets, 4-inch and larger ASME B16.1 Class 125 flanged inlet with plain outlet and protective hood.
   b. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.
   c. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 140 or 150.
      2) Val-Matic Valve; Series 100.
5. Type V741 Air and Vacuum Valve 4 Inches to 16 Inches with Anti-Slam Device:
   a. Equipped with anti-slam device to throttle flow of water into air valve. Design anti-slam device to permit full, unrestricted flow of air into and out of air valve but reduce flow area for water to approximately 10 percent.
   b. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512, ASME B16.1 Class 125 flanged inlet and plain outlet with protective hood.
   c. Provide air release valve and isolation gate valve to meet rated working pressure.
   d. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 1900.
      2) Val-Matic Valve; Series 1200/100.
6. Type V742 Air and Vacuum Valve 1/2 Inch to 16 Inches for Vertical Turbine Service:
   a. Equip 1/2 inch through 3 inches with stainless steel diffuser screen to break up solid water column before coming in contact with float, manufacturer’s standard double acting throttling device in outlet for throttling, NPT threaded inlet and outlet.
   b. Equip 4 inches and larger with anti-slam device to throttle flow of water into air valve. Design anti-slam device to permit full, unrestricted flow of air into and out of air valve, but reduce flow area for water to approximately 10 percent. ASME B16.1, Class 125 flanged inlet and NPT threaded outlet.
   c. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.
   d. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 141DAT to 146DAT or Series 1904 to 1916.
      2) Val-Matic Valve; Series 100WS to 116WS.

7. Type V744 Air Release Valve 1/2 Inch to 2 Inches:
   a. Suitable for water service, automatically exhaust small amounts of entrained air that accumulates in a system. In CLOSED position, seat against resilient seat to prevent water leakage.
   b. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, NPT threaded inlet and outlet, built and tested to AWWA C512.
   c. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 50, 200, and 200A.
      2) Val-Matic Valve; Series 15A to 45.6.
8. Type V745 Air Release Valve 1/2 Inch to 1 Inch:
   a. Suitable for water service, automatically exhaust small amounts of entrained air that accumulates in system. In CLOSED position, seat against resilient seat to prevent water leakage.
   b. Rated 230-psi working pressure, reinforced nylon body, foamed polypropylene float, EPDM rolling seal, Buna-N O-ring, NPT threaded inlet.
   c. Manufacturer and Products: ARI Valves; S-050, S-050-C.
9. Type V746 Combination Air Release Valve 1 Inch to 16 Inches:
   a. Suitable for water service, combines operating features of air and vacuum valve and air release valve. Air and vacuum portion to automatically exhaust air during filling of system and allow air to re-enter during draining or when vacuum occurs. Air release portion to automatically exhaust entrained air that accumulates in system.
   b. Valve single body or dual body, air release valve mounted on air and vacuum valve, isolation valve mounted between the dual valves. 1-inch through 3-inch valves with NPT threaded inlet and outlet, 4-inch and larger valves with ASME B16.1 Class 125 flanged inlet and cover outlet.
   c. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.
   d. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 143C to 147C or 1804 to 1816.
      2) Val-Matic Valve; Series 201C to 203C or 104/22 to 116/38.
10. Type V747 Rolling Seal Combination Air Valve 3/4 Inch to 2 Inches:
    a. Designed for water service and uses rolling seal to allow smaller and larger amounts of air to automatically exhaust under pressure and air to enter when vacuum occurs in a single valve body.
    b. Cast-iron body with polypropylene discharge elbow, NPT inlet, 230 psi working pressure.

c. Foamed polypropylene float, EPDM rubber rolling seal mechanism with reinforced nylon plug, plug cover, and clamping stem, Buna-N O-ring.
d. Manufacturer and Product: ARI Valves; D-040 or D-040-C.

11. Type V748 Rolling Seal Combination Air Valve 2 Inches to 8 Inches:
    a. Suitable for water service, combines operating features of air and vacuum valve and air release valve. Air and vacuum portion to automatically exhaust air at a high rate during filling of system and allow air to re-enter during draining or when vacuum occurs. Air release portion to automatically exhaust entrained air that accumulates in system. Air release uses rolling seal mechanism.
    b. High flow air/vacuum valve, cast-iron body with stainless steel float and seat, EPDM seal, ASME B16.1 Class 125 flanged inlet, 230-psi working pressure nonslam feature.
    c. Air release valve with foamed polypropylene float, EPDM rubber rolling seal mechanism with reinforced nylon plug, plug cover, and clamping stem, Buna-N O-ring.
    d. Manufacturer and Product: ARI Valves; D-060-C HF.
12. Type V750 Sewage Air and Vacuum Valve 2 Inches to 14 Inches:
    a. Suitable for sewage service; automatically exhausts air during system filling and allows air to re-enter during draining or when vacuum occurs.
    b. Rated working pressure of 150 psi, 1-inch through 3-inch valves with NPT threaded inlet and outlet, 4-inch and larger valves with ASME B16.1 Class 125 flanged inlet and threaded cover outlet, built and tested to AWWA C512.
    c. Materials: Cast-iron or ductile iron body and cover, concave or skirted stainless steel float and trim, Buna-N seat.
    d. Sewage air and vacuum valve fitted with blowoff valve, flushing valve with quick disconnect couplings, and a minimum 5 feet of hose with quick disconnect couplings to permit backflushing after installation without dismantling valve.
    e. Manufacturers and Products:
        1) APCO Valve and Primer Corp.; Series 401 SAVV to 414 SAVV.
        2) Val-Matic Valve; Series 301 to 306.
13. Type V752 Sewage Air Release Valve 2 Inches to 4 Inches:
    a. Suitable for sewage service; automatically exhausts entrained air that accumulates in a system.
    b. Rated working pressure of 150 psi, built and tested to AWWA C512.
    c. Materials: Cast-iron or ductile iron body and cover with NPT threaded inlet and 1/2-inch NPT threaded outlet, concave or skirted stainless steel float and trim; Buna-N resilient seat.

d. Sewage air release valve fitted with blowoff valve, flushing valve with quick disconnect couplings, and a minimum 5 feet of hose with quick disconnect couplings to permit backflushing after installation without dismantling valve.
e. Manufacturers and Products:
1) APCO Valve and Primer Corp.; Series 400 SARV or 450 SARV.
2) Val-Matic Valve; Series 48 or 49.

14. Type V754 Sewage Combination Air Valve 2 Inches to 6 Inches:
a. Suitable for sewage service; combines operating functions of air and vacuum valve and an air release valve. Air and vacuum portion shall automatically exhaust air during filling of a system and allow air to re-enter during draining or when a vacuum occurs. Air release portion to automatically exhaust entrained air that accumulates in system. Single body unit with air and vacuum valve and an air release valve in a single housing.
b. Rated working pressure of 150 psi; built and tested to AWWA C512.
c. Materials: Cast-iron or ductile iron body and covers, NTP threaded inlet and outlet, with concave or skirted stainless steel float and trim.
d. Sewage air release valve fitted with blowoff valve, flushing valve with quick disconnect couplings, and a minimum 5 feet of hose with quick disconnect couplings to permit backflushing after installation without dismantling valve.
e. Manufacturers and Products:
1) APCO Valve and Primer Corp.; Series 440 SCAV.
2) Val-Matic Valve; Series 800.

15. Type V757 Sewage Rolling Seal Combination Air Valve 2 Inches to 8 Inches:
a. Designed for sewage service, uses rolling seal to allow smaller and larger amounts of air to automatically exhaust under pressure and air to enter when a vacuum occurs in a single valve body. Body designed to allow sewage solids to flow out of valve.
b. Stainless steel funnel shaped body with ASME B16.1 Class 150 flanged inlet and access flanges, reinforced nylon combination air and vacuum valve assembly and polypropylene discharge elbow, 250-psi working pressure, all-bronze drain/flush valve, flushing connection.
c. Foamed polypropylene float, EPDM rubber rolling seal mechanism with reinforced nylon plug, plug cover, and clamping stem, Buna-N O-ring.
d. Manufacturer and Product: ARI Valves; D-020.

H. Miscellaneous Valves:

1. Type V900 Diaphragm Valve 1/2 Inch to 12 Inches:
   a. Weir type, polypropylene-lined cast-iron body, ASME B16.1 flanged ends, manual operator indicating, rising stem type with handwheel, diaphragm Buna-N, in accordance with MSS SP-88 Category B.
   b. Manufacturers:
      1) ITT Engineered Valves.
      2) Saunders Valve, Inc.
2. Type V901 Diaphragm Valve 1/2 Inch to 12 Inches:
   a. Straight-through type, polypropylene-lined cast-iron body, ASME B16.1 flanged ends, manual operator indicating, rising stem type with handwheel, diaphragm Buna-N, in accordance with MSS SP-88, Category B.
   b. Manufacturers:
      1) ITT Engineered Valves.
      2) Saunders Valve, Inc.
3. Type V915 Mud Valve 4 Inches to 24 Inches:
   a. Cast-iron frame, yoke, and gate; heavy-duty 125-pound flange style, bronze seat, Buna-N seal, nonrising stem, bronze stem and stem nut, 2-inch square operating nut, Type 304 stainless steel extension stem; stem guides spaced for L/R of 200 maximum.
   b. Manufacturers:
      1) Troy Valve.
      2) Trumbull Industries, Inc.
      3) Clow Valve Company.
4. Type V920 Hydrostatic Pressure Relief Valve, Floor Type 4 Inches:
   a. Floor type, stainless steel body, grate, and cover, removable cover and strainer, body with integral seep ring, body length as shown on the Drawings, neoprene rubber cover seat, epoxy body seat.
   b. Manufacturers and Products:
      1) M&H Valve; Style 147, F-1493.
      2) Clow Valve; Figure F-1493.
      3) Trumbull; Style 1367-1540.
      4) Troy Valve; Model A2550.
5. Type V921 Hydrostatic Pressure Relief Valve, Wall Type 4 Inches:
   a. Wall type, flange style frame, cast-iron body and cover, bronze seat body, resilient rubber seat on cover, bronze hinge pins, cast-iron wall pipe with integral seep ring and strainer, length as shown on the Drawings.
   b. Manufacturers and Products:
      1) M&H Valve; Style 147, F-1494/F-1496.
      2) Clow Valve; Figure F-1494/F-1496.

6. Type V925 Sampling Valve:
   a. Type 316 stainless steel wetted parts, hand operated iron crank, piston to extend to inner surface of vessel or pipe, sealed by two compressible replaceable Teflon rings, one above discharge port and other below discharge port, 1-inch NPT inlet and 1-inch NPT outlet.
   b. Manufacturers and Products:
      1) Strahman Valves, Inc.; Piston Type Sampling Valve.
      2) Fetterolf Corporation; Rod-Seal Sampling Valve.
7. Type V930 Fire Hydrant: (Describe agency standard.)
8. 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, 120V 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 Schedule or Drawings.
   b. Minimum operating pressure differential no greater than 5 psig, maximum operating pressure differential not less than 125 psig.
   c. Manufacturers:
      1) ASCO.
      2) Skinner.
9. Type V950 Manual In-Line Lockout/Tagout Valve 1/4 Inch to 1-1/4 Inches for Air Service:
   a. Manual in-line, three-port, heavy-duty cast aluminum body, NPT threaded ports, tee-handle, aluminum spool, stainless steel spring, nitrile seals, suitable for air pressures 0 psig to 250 psig. Safety yellow body with contrasting black, red or blue handle.
   b. Lockout/tagout valve for compliance to OSHA 29 CFR Part 1910.147. Full flow in open position, exhausts downstream air in closed position, lockable in closed position.
   c. Complete with NPT male threaded aluminum exhaust silencer with internal mesh element, lockout hasp.
   d. Manufacturers and Products:
      1) Norgren; In-Line Lockout Valve Series C00.
      2) Parker Pneumatic; LV Series.
      3) Ross Controls; L-O-X Valve.
10. Type V951 Manual Soft-Start In-Line Lockout/Tagout Valve 1/4 Inch to 1-1/4 Inches for Air Service:
   a. Manual in-line, three-port, single unit type, heavy-duty cast aluminum body, NPT threaded ports, tee-handle, aluminum spool, stainless steel spring, nitrile seals, suitable for air pressures 30 psig to 150 psig. Safety yellow body with contrasting black, red or blue handle.

b. Lockout/tagout valve with soft start feature for compliance to OSHA 29 CFR Part 1910.147. Full flow in open position, exhausts downstream air in closed position, lockable in closed position, soft-start feature to allow gradual air pressure buildup.
c. Complete with NPT male threaded aluminum exhaust silencer with internal mesh element, lockout hasp.
d. Manufacturers and Products:
   1) Parker Pneumatic; EZ Series.
   2) Ross Controls; L-O-X/EEZ-ON Valve.

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: 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. [B: 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 24V dc.

5. Limit Switch:
   a. Single-pole, double-throw (SPDT) type, field adjustable, with contacts rated for 5 amps at 120V 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:
   a. Rotork Controls.
   b. Flowserve Limitorque.
   c. AUMA.

D. Pneumatic Actuators:

1. General:
   a. Actuator complete with air sets, exhaust mufflers, speed controls, pilot solenoids, safety vented isolation valves, and accessories.
   b. Suitable for full operation range of valve at air supply pressure indicated.
   c. Position indication and stop limiting devices on all actuators.
2. Vane Style Actuator:
   a. In compliance with AWWA C541.
   b. Air supply of 80 psig.
   c. Pressure die-cast aluminum housing with corrosion resistant fusion bonded epoxy finish, stainless steel bolting, stainless steel adjustable end stops.
   d. Electroless nickel-plated steel shaft and vane, single-component machined or cast part.
   e. Dual-opposed polyurethane lip seals with stainless steel expander.
   f. Double Acting:
      1) Complete with mounting hardware.
      2) Suitable for non-lubrication air.
   g. Spring Return:
      1) Wound stainless steel spring type in separate housing.
      2) Attached to pneumatic actuator housing.
   h. Geared Manual Override: Geared type with de-clutchable handwheel, torque rated for application.

i. Visual Indicator: High visibility, OPEN-CLOSED indication, color coded, chemical resistant, clear polycarbonate cover.
j. Manufacturers:
1) Kinetrol.
2) K-Tork.

3. Cylinder Actuator:
a. In compliance with AWWA C541.
b. Air supply pressure of 80 psig.
c. Nonswivel type totally enclosed:
1) Travel stops and position indicator.
2) Factory lubricated and sealed requiring no additional lubrication.
d. Double Acting:
1) Nonmetallic for operation on nonlubricated air.
2) Handwheel override independent of cylinder.
e. Spring Return:
1) Open, closed, or throttling, steel cylinder with air line lubricators. Nonlubricated air may be used if certified by manufacturer.
2) Modulating: Nonmetallic for operation on nonlubricated air.
3) Manual override manufacturer’s standard.
f. Actuators used on quarter-turn valves to include a totally enclosed valve actuating mechanism. Actuating mechanism to be factory lubricated and sealed.
g. Manufacturers and Products:
1) Rotork.
2) DeZurik.

4. Diaphragm Actuator:
a. Spring return with steel or aluminum diaphragm case and spring barrel, steel spring and actuator stem, and fabric-reinforced neoprene diaphragm.
b. Actuators used on quarter-turn valves to include a totally enclosed valve actuating mechanism. Actuating mechanism to be factory lubricated and sealed.
c. Diaphragm actuators sized and configured for service indicated and air supply pressure of 35 psig.
d. Manufacturers and Products:
1) Fisher Controls; Type 1051.
2) Keystone Valve; Figure 723.

5. Accessories:
a. Air Set: Pressure regulator with internal relief, filter, outlet pressure gauge, and adjustable reduced pressure range as required by valve actuator.
1) Aluminum body and handwheel.
2) Safety vented lockout isolation valve.

3) Gauge range 1-1/3 to 2 times maximum operating pressure.
4) Manufacturers and Products:
   a) Fisher Controls; Type 67 AFR.
   b) Masoneilan; No. 77-4.

b. Air Exhaust Muffler:
1) In the exhaust port of actuator pilot solenoid valves.
2) Manufacturers:
   a) Barry Wright Corp.
   b) Allied Witan Co.

c. Limit Switch:
1) Single-pole, double-throw (SPDT) type, rated 10 amps at 120V ac.
2) Housed in NEMA 4X enclosure.
3) Adjustable for OPEN and CLOSED valve positions.

d. Positioner:
1) For modulating actuators, shall be pneumatic force balance instruments to control valve position as a function of input signal. Accomplish positive positioning of valve by a mechanical feedback connection from valve actuating mechanism. Position feedback through a characterized linear cam to allow adjustment of valve positioning and input signal. Positioner suitable for double acting or spring return actuator.
2) Positioner to have zero and span adjustment and be field reversible for direct or reverse action.
3) Gauges for supply and output pressure and for input signal pressure.
4) Positioner for 3 psig to 15 psig pneumatic input signal or 4 mA dc to 20 mA dc input signal as indicated.
5) Positioner for dc input signal with transducers shall convert electrical signal to appropriate pneumatic signal. Transducer integral with positioner or separate component. If separate, factory mount transducer on pneumatic operator. Line electric power not required for transducer.
6) Corrosion-resistant enclosures for positioners and transducers to be splash-proof and moisture-proof with gasketed covers.

e. 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 120V ac, 60-Hz, unless otherwise indicated. Solenoid enclosure as defined in NEMA 250, Type 4X.
3) Manufacturers:
a) Asco Red Hat.
b) C. A. Norgren Co.

6. Open-Close and Throttling Valve:
a. Double Acting Cylinders: Four-way solenoid with dual coils.
b. Spring Return Cylinders: Three-way solenoids, spring return.
7. Modulating Valve: Positioner with 4 mA to 20 mA input signal, unless otherwise indicated.
8. Control Features: Pneumatic actuators with features noted in the Pneumatic Actuated Valve Schedule.

2.07 ACCESSORIES

A. Tagging: See Section 01 61 00, Common Product Requirements. Tag attached with No. 16 stainless steel jack chain for each valve, bearing valve tag number shown on Electric Actuated Valve Schedule and Pneumatic Actuated Valve Schedule.

B. Limit Switch: Factory installed NEMA 4X limit switch by actuator manufacturer.

C. T-Handled Operating Wrench:

1. Two each galvanized operating wrenches, 4 feet long.
2. Manufacturers and Products:
a. Mueller; No. A-24610.
b. Clow No.; F-2520.
3. Two each galvanized operating keys for cross handled valves.

D. Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.

1. Manufacturers:
a. Pratt.
b. DeZurik.

E. Floor Stand:

1. Nonrising, heavy pattern, indicating type.
2. Complete with solid extension stem, coupling, handwheel, stem guide brackets, and yoke attachment. Stem length as required to connect valve operating nut and floor stand.
3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
4. Anchor Bolts: Type 304 stainless steel.
5. Manufacturers and Products:
    a. Clow; Figure F-5515.
    b. Mueller, Figure A-26426.

F. Floor Box:

1. Plain type, for support of nonrising type stem.
2. Complete with solid extension stem, operating nut, and stem guide brackets. Stem length as required to extend valve operating nut to within 3 inches of finish floor.
3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
4. Anchor Bolts: Type 304 stainless steel.
5. Manufacturers and Products:
    a. Neenah Foundry; R 7506.
    b. Clow; No. F5690.

G. Chain Wheel and Guide:

1. Handwheel direct-mount type.
2. Complete with chain.
3. Galvanized or cadmium-plated.
4. Manufacturers and Products:
    a. Clow Corp.; Figure F-5680.
    b. Walworth Co.; Figure 804.
    c. DeZurik Corp.; Series W or LWG.

H. 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, locking type, marked SEWER.
3. Extensions: Cast iron.
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.

I. Concrete Valve Box: Designed for traffic loads, sliding type, with minimum of 10-inch ID shaft.

1. Box: High-density, reinforced concrete, minimum depth 12 inches, cast-iron ring seat.
2. Lid: Cast iron, minimum depth 3 inches, marked SEWER.
3. Extensions: Cast-iron pipe.
4. Manufacturers and Products:
    a. Christy Concrete Products; G Series.
    b. BES Concrete Products; G Series.

J. Indicator Post Assembly:

1. Cast or ductile iron post head, bell, and wrench with cast or ductile iron or steel barrel.
2. Plexiglas or equal protected window to indicate OPEN and CLOSED position.
3. Padlockable eye bolt for wrench.
4. Adjustable bury depth. Bury depth as required for valve installation.
5. UL Listed and FM Approved.
6. Manufacturers and Products:
    a. Clow; Style 2945.
    b. Mueller; A-20806.

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 the 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 the 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 compressed air and fuel oil.

G. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

H. 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.

I. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of valve.

J. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

K. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches 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 MANUFACTURER'S SERVICES

A. Manufacturer's Representative:

1. Present at Site for minimum person-days listed below, travel time excluded:
   a. 2 person-days for installation assistance and inspection.
   b. 2 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

B. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

3.04 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Electric Actuated Valve Schedule.
2. Self-Regulated Valve Schedule.

END OF SECTION

Electric Actuated Valve Schedule

Tag Number	Valve Type	Actuator Power Supply	Valve Size (inches)	Process Fluid	Maximum Operating Flow (gpm)	Maximum ΔP (psi)	Service	Travel Time (Seconds)	Control Feature Modifications/ Supplements
SNV51	Solenoid	120-volt	1”	W2	175	80			
SNV52	Solenoid	120-volt	1”	W2	15	80			
SNV54	Solenoid	120-volt	1”	W2	175	80			
SNV55	Solenoid	120-volt	1”	W2	15	80			
SNV57	Solenoid	120-volt	1”	W2	175	80			
SNV58	Solenoid	120-volt	1”	W2	15	80			
SNV71	Solenoid	120-volt	2”	W2	20	80			

Service: O/C = Open-Close, T = Throttling, M = Modulating

Control Feature Modifications/Supplements:

A = Actuator shall open valve upon loss of signal.

B = Actuator shall close valve upon loss of signal.

C = Actuator shall remain in last position upon loss of signal.

D = Local OPEN-CLOSE momentary pushbuttons that must be continuously depressed to initiate/maintain valve travel; travel stops when pushbutton is released or when end of travel limit is reached.

E = Remote OPEN-CLOSE maintained dry contacts; travel stops when remote contact opens, or when end of travel limit is reached.

F = Three 24-volt dc interposing relays for remote OPEN-STOP-CLOSE control. Relays powered externally, thereby permitting valve control from greater distances.

G = Motor and control enclosure(s) NEMA 250, Type 4 with 120-volt space heaters.

H = Motor and control enclosure(s) NEMA 250, Type 6 (IP 68) with 120-volt space heaters.

I = Motor and control enclosure(s) NEMA 250, Type 7 with 120-volt space heaters.

J = 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 24V dc.

K = 120-volt secondary control power transformer.

L = Externally operable power disconnect switch.

Self-Regulated Valve Schedule								
Tag No.	**Location**	**Valve Type No.**	**Size (inches)**	**Inlet* Pressure**	**Outlet* Pressure**	**Maximum psig**	**Flow (gpm)**	**Fluid**
ARV01	WAS Pump	V740	1	8.7	6.7	10	400	WAS
ARV02	WAS Pump	V740	1	8.7	6.7	10	400	WAS
ARV03	WAS Pump	V740	1	8.7	6.7	10	400	WAS
ARV01	Scum Vault	V740	0.5	13	11	15	100	SSC
ARV02	Scum Vault	V740	0.5	13	11	15	100	SSC
ARV01	Recir Pump	V740	2	As req'd	As req'd	30	1,000	TWAS
ARV02	Recir Pump	V740	2	As req'd	As req'd	30	1,000	TWAS
PSV 01	Sludge Feed Pump	V732	4	-	-	85	-	TS
PSV 02	Sludge Feed Pump	V732	4	-	-	85	-	TS
PSV 03	Sludge Feed Pump	V732	4	-	-	85	-	TS
ARV01	Sludge Pump Discharge	V750	2	-	-	90	-	TS
ARV02	Sludge Pump Discharge	V750	2	-	-	90	-	TS
ARV03	Sludge Pump Discharge	V750	2	-	-	90	-	TS
ARV01 ARV02	Sanitary Lift Station	V740	2	As req'd	As req'd	12	100	SS

*Inlet Pressure = Set pressure for pressure relief valve or downstream set pressure for pressure reducing valve.

SECTION 40 42 13
PROCESS PIPING INSULATION

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 Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
   a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   b. C165, Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
   c. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   e. C534/C534M, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   f. C547, Standard Specification for Mineral Fiber Pipe Insulation.
   g. C552, Standard Specification for Cellular Glass Thermal Insulation.
   h. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
   i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
   j. C1729, Standard Specification for Aluminum Jacketing for Insulation.
   k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   l. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
3. International Code Council (ICC): International Energy Conservation Code (IECC).
4. UL.

1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s descriptive literature.

B. Informational Submittals: Maintenance information.

PART 2 PRODUCTS

2.01 PIPE AND FITTING INSULATION

A. Type 1—Elastomeric:

1. Material: Flexible elastomeric pipe insulation, closed-cell structure in accordance with ASTM C534/C534M.
2. Temperature Rating: Minus 297 degrees F to 220 degrees F.
3. Nominal Density: 3 pcf to 6 pcf.
4. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.25 Btu-in./hr-square foot degrees F at 75 degrees F per ASTM C177 or ASTM C518.
5. Maximum water vapor transmission of 0.06 perm-inch per ASTM E96/E96M, Procedure A.
6. Joints: Manufacturer’s adhesive.
7. Flame Spread Rating: Less than 25 per ASTM E84.
8. Smoke Developed Index: Less than 50 per ASTM E84.
9. Manufacturers and Products:
   a. Nomaco; K-Flex.
   b. Armacell; AP Armaflex.

B. Type 2—Fiberglass:

1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
2. Insulation Temperature Rating: Zero to 850 degrees F.
3. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in./hr-square foot degrees F at 75 degrees F.
4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.
5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
6. Flame Spread Rating: Less than 25 per ASTM E84.
7. Smoke Developed Index: Less than 50 per ASTM E84.

8. Manufacturers and Products:
    a. Owens Corning Fiberglass; ASJ/SSL-11.
    b. John Manville; Micro-Lok with Jacket.

C. Type 3—Foamglass:

1. Material: Cellular glass per ASTM C552.
2. Nominal Density: 7.5 pcf.
3. Compressive Strength: 90 psi per ASTM C165.
4. Temperature Rating: Minus 290 degrees F to 900 degrees F.
5. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.29 Btu-in./hr-square foot degrees F.
6. Minimum water vapor transmission for insulation of 0.00 perm-inch per ASTM E96/E96M.
7. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
8. Flame Spread Rating: 0 per ASTM E84.
9. Smoke Developed Index: 0 per ASTM E84.
10. Follow manufacturer’s recommendation, based upon temperature of piping to be insulated.
11. Manufacturer and Product: Pittsburgh Corning; Foamglas One.

2.02 ROOF DRAIN AND OVERFLOW DRAIN SUMP INSULATION

A. Type 1: 1 inch thick.

2.03 INSULATION AT PIPE HANGERS AND SUPPORTS

A. Refer to Section 40 05 15, Piping Support Systems.

B. Copper, Ductile Iron, and Nonmetallic Pipe: High-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield. Extend insert beyond shield.

C. Steel Pipe: Insulation saddle or high-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield at support location. Extend insert beyond shield.

2.04 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, minimum 20 mils indoors and 30 mils outdoors, for straight run piping and fitting locations, temperatures to 140 degrees F.
2. Color: PVC jacketing shall be color coded to match colors listed in pipe schedule where suitable matching colors are available. If no suitable colors are available jacketing shall be white.
3. Flame Spread Rating: 25 per ASTM E84.
4. Smoke Developed Index: 50 per ASTM E84.
5. Manufacturers and Products:
   a. Knauf Insulation; Proto 1000.
   b. Johns Manville; Zeston 2000 or 300.
   c. Speedline; 25/50 Smoke-Safe.

B. Type F2—Paint:

1. Type 1 Insulation: Acrylic latex paint, white, and suitable for outdoor use.
   a. Manufacturer and Product: Armacell; WB Armaflex finish.
2. Type 2 Insulation: In accordance with Section 09 90 00, Painting and Coating.

C. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, in accordance with ASTM C1729, minimum 0.016-inch thickness, with smooth mill finish.
2. Vapor Barrier: Provide factory applied vapor barrier, heat and pressure bonded to inner surface of aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
4. Manufacturers:
   a. RPR Products; Insul-Mate.
   b. ITW, Pabco-Childers.

D. Type F4—Foamglass Jacketing:

1. Type 3 Insulation—Buried and Up to 1 Foot Above Grade: 70-mil bituminous resin with woven, glass fabric, aluminum foil layer, and plastic film coating, self-sealing manual pressure seals; Pittsburgh Corning Pittwrap SS.

2. Type 3 Insulation—Greater that 1 Foot Above Grade: 30-mil modified bituminous membrane with self-sealing manual pressure seals; Pittsburgh Corning Pittwrap CW30.

PART 3 EXECUTION

3.01 APPLICATION

A. General:

1. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to Supplement Service and Insulation Thickness table following “End of Section” and to Piping Schedule in Section 40 27 00, Process Piping—General.

3.02 INSTALLATION

A. General:

1. Install in accordance with manufacturer’s instructions and as specified herein.
2. Install after piping system has been pressure tested and leaks corrected.
3. Install over clean dry surfaces.
4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
5. Do not allow insulation to cover nameplates or code inspection stamps.
6. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
7. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
8. Personnel Protection: Install on pipes from floor to 8 feet high. Install on pipes within 4 feet of platforms and to 8 feet high above platforms.

B. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

C. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

D. Placement:

1. Insulate valves and fittings with sleeved or cut pieces of same material.
2. Seal and tape joints.

E. Heat Traced Piping: Apply insulation after heat-tracing work is completed and inspected.

F. Roof Drains: Insulate vertical drops from roof drains to horizontal pipe, exposed and concealed horizontal piping, and 2 feet down on vertical risers from horizontal pipe.

G. Roof Drains and Overflow Drains: Insulate entire pipe runs. Where roof and overflow drains exist through an exterior wall ensure annular space between pipes and walls are properly sealed prior to insulating.

H. Roof Drain and Overflow Drain Sumps: Insulate entire sumps.

I. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

J. Aluminum Jacket:

1. Use continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.
2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.
4. Do not use screws or rivets to fasten fitting covers.
5. Install removable prefabricated aluminum covers on exterior flanges and unions.
6. Caulk and seal exterior joints to make watertight.

3.03 FIELD FINISHING

A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

B. Where pipe labels or banding are specified, apply to finished insulation, not to pipe.

C. Painting Piping Insulation (Exposed to View):

1. Aluminum or color coded PVC jacketing does not require painting.
2. If insulated piping system is indicated to be painted in Section 40 27 00, Process Piping—General, piping shall receive the following:
   a. Prime coat in accordance with Section 09 90 00, Painting and Coating.
   b. Finished insulation (and not pipe) shall be painted in accordance with Section 09 90 00, Painting and Coating.

3.04 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this specification:

1. Service and Insulation Thickness Table.

END OF SECTION

Service and Insulation Thickness								
					Finish Systems			
Service Type	Pipe Legend	Thickness	Fluid Temperature (degrees F)*	Insulation	Concealed from View	Indoors Exposed	Outdoors	Buried
HG-Heating Systems (steam condensate, and hot water)	HWR HWS	ASHRAE 90.1 or IECC whichever results in thickest insulation.	201 to 250	Type 2	None	F3 below 8′ None above 8′	F3	NA
DW–Domestic and Service Hot Water Systems.	HW, W1, W2	ASHRAE 90.1 or IECC whichever results in thickest insulation.	105 to 140	Type 1 (6" or less)	None	F3 below 8' F3 above 8'	F3	NA
Water, Non-Potable Plant Effluent	W3	Pipe Size-to-Insulation Thickness: 1/4–3″: 1″ 3.5–10″: 1.5″ 12–16″: 2″ 18–24″: 2.5″		Type 1 (6″ or less) Type 2 Insulate and heat trace outside lines 1′ above grade. Type 3 insulation from 1′ above grade to frost depth.	None	None	F3	F4 on Type 3
HT–Piping requiring heat tracing.		Pipe Size: Insulation Thickness Inches:* 1/4–3: 1 3.5–10: 1.5 12–16: 2 18–24: 2.5		Type 2 Insulate and heat trace outside lines 1' above grade. Use Type 3 insulation from 1' above grade to frost depth.	None	F3 below 8' F3 above 8'	F3	F4 on Type 3

Service and Insulation Thickness								
					Finish Systems			
Service Type	**Pipe Legend**	**Thickness**	**Fluid Temperature (degrees F)***	**Insulation**	**Concealed from View**	**Indoors Exposed**	**Outdoors**	**Buried**
Air, Low Pressure	ALP	Pipe Size: All Insultation Thickness: 2 Inches		Type 1	None	F1	NA	NA
PE–Personnel Exposure		ASHRAE 90.1 or IECC whichever results in the thickest insulation	>140	Type 2 Minimum 1.5" thick	No insulation or finish	F3 below 8' F3 above 8'	F3	NA
Use these fluid temperatures unless otherwise noted in the Piping Schedule. Inches: Based upon insulation with glass fiber per ASTM C547, outdoors with 20 mph wind with 10 percent safety and no value assigned to cladding or air space at cladding. Matches the watts per foot in Section 40 05 33, Pipe Heat Tracing. 2012 IECC requires 1-inch minimum thickness.								

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 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. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
4. 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.

5. Items that do not require testing include: Piping between wetwells and wetwell isolation valves, Equipment seal drains, tank overflows to atmospheric vented drains, and tank atmospheric vents.
6. Test Pressure: As indicated on Piping Schedule on Drawing 01-G-0070.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. 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. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.

C. Buried Piping:

1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

4. Maintain hydrostatic test pressure continuously for 2 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. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

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. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.

B. 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.

C. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

D. Exfiltration Test:

1. Hydrostatic Head:
   a. At least 6 feet above maximum estimated groundwater level in section being tested.
   b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

E. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

G. Defective Piping Sections: Replace and retest as specified.

3.05 PNEUMATIC TEST FOR GRAVITY PIPING

A. Equipment:

1. Calibrate gauges with standardized test gauge at start of each testing day. Engineer or Project Inspector 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:

1. 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
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

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

*Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.

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 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 95 80, Fiber Optic Communication System.
3. Section 40 96 00, Applications 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. Process instrumentation including primary elements, transmitters, control devices, and control panels.
2. Programmable Logic Controller (PLC) system complete with an adequately sized Control Panel and UPS.
3. Copper communication cabling of control equipment and devices within the Facility, new Network panels and Ethernet switches, and Fiber Optic Link within existing Client Facility to extend the Network.
4. Provide two SCADA workstations, including Wonderware licensing for the Composting Operations Building.
5. Provide new SCADA mounted PC on H090-DEW1-MCP01 including Wonderware licensing.
6. Provide two new four-post network racks including all cable management, UPS, Power distribution, mounting hardware etc. for a complete system.
7. Provide four new network switches. Two for the SCADA Network and two for the IT Network.
8. Provide two new SCADA servers including all required Wonderware licensing.
9. Provide two new programming Laptops, with PLC programming software and backpacks.
10. Follow Owner Standards as specified in Article Owner ICS Standards and Site Access.
11. Application Software:
    a. Engineer is responsible for all control system application software related to this Project, except for items listed below to be performed by the Owner. Contractor is responsible to provide all

software licensing as required for all hardware and software provided under this contract. Reference Section 40 96 00, Applications Software, for detailed requirements. Major work items include:

1) Engineer will provide the Allen-Bradley PLC programming.
2) Engineer will provide the Integration of the Centrifuge package control system into SCADA system.
3) Engineer will provide the Integration of the Compost package control system into SCADA system.
4) Engineer will provide the modifications to the existing Wonderware Intouch HMI graphics system to include new plant upgrades and processes.
5) Engineer will provide the modifications to the existing Wonderware Intouch system for addition of new Wonderware HMI Operator Interface Terminal.
6) Engineer will provide the addition of new project tags to the existing Wonderware Historian.
7) Support work by Owner, including scheduling and providing appropriate documentation. Work by Owner includes:
    a) WIN-911 software alarm dialer configuration.
    b) Hach WIMS automated reporting.

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. The Instrument, Systems, and Automation Society (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. UL: 508A, Standard for Safety, Industrial Control Panels.

1.03 DEFINITIONS

A. Abbreviations:

1. DCU: Distributed Control Unit.
2. FDT: Factory Demonstration Test.
3. HMI: Human-Machine Interface.
4. HVAC: Heating, Ventilating, and Air Conditioning.
5. I&C: Instrumentation and Control.
6. I/O: Input and Output.
7. O&M: Operation and Maintenance.
8. P&ID: Process and Instrument Diagram.
9. PC: Personal Computer.
10. PIC: Process Instrumentation and Control.
11. PLC: Programmable Logic Controller.
12. RTU: Remote Terminal Unit.

13. SCADA: Supervisory Control and Data Acquisition.
14. SCS: Supervisory Control System.
15. SDT: Software Demonstration Test.
16. SLDC: Single Loop Digital Controller.
17. SSDT: Staging Site Demonstration Test.

B. Application Software:

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

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

D. Instructor Day: 8 hours of actual instruction time.

E. 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.

F. Signal Types:

1. Analog Signal, Current Type:
   a. 4 mA dc 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: 1V dc to 5V 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.

G. 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 and developing application software for PLCs.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. Complete detailed design of PIC components and PIC drawings, including panel wiring diagrams, loop wiring diagrams, and interconnecting wiring diagrams.
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, and network diagrams.
4. Typical drawings for installation details, control panel layouts, and control diagrams.

B. Use a qualified PIC System Integrator for at least the following work:

1. Application Software: As specified in Section 40 96 00, Applications Software.
2. 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.
3. 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.
4. Non-PIC 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) Motor control centers.
      4) Adjustable speed and adjustable frequency drive systems.

1.05 OWNER ICS STANDARDS AND SITE ACCESS

A. Site Access:

1. Prior to entering the Project Site, obtain from the Owner the necessary documentation and provide to the Owner evidence of the following:
   a. For each Third-Party Company:
      1) Read WPC ICSN Acceptable Use Policy.
      2) Signed and executed WPC ICSN Third Party Agreement (TPA).
   b. For each Third-Party Company employee requesting ICS access:
      1) Read WPC ICSN Acceptable Use Policy.
      2) Signed and executed WPC ICSN User Access Request (UAR).
      3) Executed City of Tulsa Access Card Form.
      4) Executed City of Tulsa Security Background.
      5) Executed City of Tulsa Prescreen Investigation Form.
   c. Access to SCADA or Control Networks: Obtain approval in writing from WPC Support Services.
   d. Access to SCADA and Control Equipment: Contractors and employees working directly on equipment or installing control software must possess an ODEQ Class B Certification or be supervised by someone who has this certification. Reference ODEQ Certification Rules “252:710-3-31 Certificate Required” and “252:710-3-34 Classes of Certifications.”

B. Standards:

1. Follow these minimum Owner requirements:
   a. PLC Equipment: New PLC equipment shall be Allen-Bradley ControlLogix based on the L7XT or L8XT processor with conformal coating. PLC firmware updated to the latest practical firmware release as established by Owner. Provide latest firmware prior to installing and testing application software. Provide Owner with final electronic copy on CD or DVD of all as-built PLC programs.
   b. Copper and Fiber Cabling: Installation and documentation in accordance with Building Industry Consulting Services, International (BICSI).
   c. Communication Cabling: Test traces in both directions with as-built documentation certifying installation meets or exceeds manufacturer’s warranty and ISO Certification Standards.

d. Documentation:
   1) All documentation provided in both paper and electronic format. Electronic format as follows:
      a) Application Software: Native electronic files in original programming format.
      b) Printable Documentation: Microsoft Office, Visio, or Adobe Acrobat PDF.
   2) Application Software Functional Documentation: Functional diagram following ISO 31320-1 IDEF0. Obtain examples from Owner for similar scope and level of detail.
   3) PLC Program: Document all logic and special functions, including program header, rung, and element tags and descriptions in sufficient detail to allow interpretation and diagnostics by Owner and by Third-Party programmer.

e. Application Software:
   1) No PLC bridges in SCADA HMI. All control-level process automation software shall be programmed into PLC code and shall operate independently of SCADA HMI system.
   2) PLC Program: All programming shall be provided in ladder logic format except where infeasible to do so.
   3) SCADA HMI: All SCADA HMI application software shall be Wonderware InTouch, expanding on existing plant system.
   4) SCADA HMI Graphics: Graphics for the new systems and interfaces shall match the existing system graphics approaches, including format and level of detail. The City will provide a copy of the existing system HMI application at the software kickoff/coordination meeting.
   5) IO Drivers: Kepware KepServer EX OPC server with Allen Bradley Suite drivers.
   6) Software Tags: Final tag names to be developed as part of Application Software workshops early in construction.

f. Networking:
   1) Obtain IP addresses for new devices from Owner’s WPC ICS Support Services.
   2) Network Definitions and Requirements:
      a) Control Network includes I/O racks and field devices connected to PLC.
      b) SCADA Network includes SCADA HMI terminals and PLCs.
      c) Control Networks shall be isolated from the SCADA Network. Provide separate PLC modules and Ethernet switches as necessary for Control Network, do not connect the Control Network to the SCADA Network.

g. WPC Standards Work-in-Progress: Obtain and follow latest version of Owner's "WPC ICS Policy and Standards."

1.06 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 for all submittals.
   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.
         b) Lists: Microsoft Excel, unless otherwise noted for specific items.
         c) Drawings: MicroStation.
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, SCADA 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. 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.
   7) Brief description of component application within the PICS.
c. Formats: Hard copy and Microsoft Excel.

2. Catalog Cuts:
   a. I&C components, electrical devices, and mechanical devices:
      1) Catalog information, marked to identify proposed items and options.
      2) Descriptive literature.
      3) External power and signal connections.
      4) Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
3. Instrument List:
   a. Refer to Supplement Instrument List for initial list. Data from this may be used as starting point for creating final Instrument List and Component Data Sheets.
   b. Update list with manufacturer and complete model number for each instrument.
   c. Submit updated version of Instrument List.
   d. Electronic Copies: Microsoft Excel.
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:
      1) Specific features and configuration data for each component, including but not limited to:
         a) Tag Number.
         b) Component type identification code and description.
         c) Location or service.
         d) Service conditions.
         e) Manufacturer and complete model number.
         f) Size and scale range.
         g) Setpoints.
         h) Materials of construction.
         i) Options included.

j) Power requirements.
k) Signal interfaces.
l) 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. Preliminary Panel Elevation Drawings:
   a. Provide prior to submitting Panel Construction Drawings:
      1) Scale Drawings: Show dimensions and location of front of panel devices.
      2) Panel Legend (Bill of Material): List front of panel devices by tag number. Include nameplate inscriptions, service legends, and annunciator inscriptions.
      3) Submit electronic copies of Drawings.
7. 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 keyed to the associated layout or location drawings.
   c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number keyed to the associated layout or location drawings.
   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.
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 hard wired control logic, permissives or interposing relays are used. Include devices that are mounted in or on the panel that require electrical connections. Identify individual components or devices with the Bill of Materials' key identifier and tag number. 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.
    3) Wire interconnect drawings of entire PICS showing all conductor connections within panels and between panels, field devices, motor controls.
d. Item Identification: Identify each item with attributes listed below in all diagrams and Drawings.
    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, Bill of Materials key identifier, 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: PLC 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.
    8) Identify external power sources with distribution panel name or number, motor control center (MCC) and associated circuit breaker number with the panel or MCC.

9) Identify individual components or devices with the Bill of Materials' key identifier and tag number.

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 corresponding to Circuit and Raceway Schedule and electrical drawings 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 individual components or devices with the Bill of Materials' key identifier and tag number, 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 PLC.

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.
    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:
    a. For control panels tabulate and summarize:
        1) Required voltages, currents, and phases(s).
        2) Maximum heat dissipations Btu per hour.
        3) Calculations.
        4) Steady State Temperature Calculations: For nonventilated panels, provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures of 110 degrees F.
12. Installation Details: Include modifications or further details required and define installation of I&C components.
13. Spares, expendables, and test equipment.
14. Electronic Copies: Microsoft Excel.
15. PLC I/O List: Submit I/O assignment and Rack/Slot/Point.
16. Shop Drawings for Changes Impacting PLC and SLDC Programming:
    a. Submit details of changes required to PLC and SLDC monitoring and control resulting from installation of alternative or upgraded process equipment and instrumentation, and other causes.
    b. Submit changes at 30-day intervals.
17. Color schedule for control panels.
18. Applications Software Documentation:
    a. Complete configuration documentation for microprocessor based programmable devices.
    b. Functional diagram in accordance with ISO 31320-1 IDEF0.
    c. For each device, include program listings, showing:
        1) Ladder logic.
        2) Configuration, calibration, and tuning parameters.
        3) Descriptive annotations for each program, ladder rung, and program element.
19. Refer to PIC subsections for additional requirements.

C. Informational Submittals:

1. Statements of Qualification:
   a. PIC System Integrator.
   b. PIC System Integrator's site representative.
   c. Resume for each PIC System Integrator's onsite startup and testing team member (engineers, technicians, and software/configuring personnel).
2. 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) Detailed Wiring Diagrams: As-built drawings.
         a) Panel wiring diagrams.
         b) Loop diagrams.
         c) Interconnecting wiring diagrams.
      5) 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 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.

3. Provide Manufacturer's Certificate of Proper Installation where specified.
4. 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. 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.
   c. 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.
5. Owner Training Plan: In accordance with Section 01 43 33, Manufacturers' Field Services.
6. Application Software: Final electronic copy of all PLC and SCS application software provided for the Project.

1.07 QUALITY ASSURANCE

A. Qualifications:

1. PIC System Integrator: Minimum of 5 years' experience providing, integrating, installing, and starting up similar systems as required for this Project.
2. PIC System Integrator's Site Representative: Minimum of 5 years' experience installing systems similar to PIC required for this Project.

B. PIC Coordination Meetings:

1. General: Refer to Section 01 31 19, Project Meetings, for PIC coordination meetings.
2. PIC Schedule Coordination Meeting:
   a. Timing: Following Engineer review of PIC Schedule.
   b. Purpose: Discuss Engineer's comments and resolve scheduling issues.
3. Application Software Meetings: As specified in Section 40 96 00, Applications Software.
4. Training Coordination Meeting:
   a. Timing: Following Engineer review of preliminary training plan.
   b. Purpose:
      1) Resolve required changes to proposed training plan.
      2) Identify specific Owner personnel to attend training.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

B. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

1.09 SEQUENCING AND SCHEDULING

A. Prerequisite Activities and Lead Times:

1. Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:
   a. Shop Drawing Reviews by Engineer:
      1) Prerequisite: Engineer acceptance of Schedule of Values and Progress Schedule.
      2) Schedule: In accordance with completed schedule of Shop Drawing and Sample submittals specified in Section 01 33 00, Submittal Procedures.
   b. Test Prerequisite: Associated test procedures Submittals completed.
   c. Training Prerequisite: Associated training plan Submittal completed.

1.10 MAINTENANCE - SERVICE

A. Telephone Support: As specified in PICS subsections.

B. Software Support: As specified PICS subsections.

1.11 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	3
Terminal Blocks	10	10
Hand Switches and Lights	10	5

PART 2 PRODUCTS

2.01 GENERAL

A. Provide PIC functions shown on the 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. 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.

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 control logic, sequence controls, and display layouts.

2.02 I&C COMPONENTS

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.

B. Instrument Components: Major components for each process area are listed in Instrument List referenced in Article Supplements. Furnish all equipment that is necessary to achieve required loop performance.

2.03 PROGRAMMABLE LOGIC CONTROLLERS

A. Provide Programmable Logic Controller system as shown and specified. Reference the following for requirements:

1. PLC IO List in Article, Supplements.
2. PLC Component Specifications in Section 40 91 00, Instrumentation and Control Components.
3. Drawings 09-N-0001 thru 09-N-0013.

2.04 NETWORK AND SCADA COMPONENTS

A. Reference PIC subsections.

2.05 SERVICE CONDITIONS

A. Standard Service Conditions:

1. 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:
   a. Computer Room, Air Conditioned:
      1) Temperature: 60 degrees F to 80 degrees F.
      2) Relative Humidity: 40 percent to 60 percent.
      3) NEC Classification: Nonhazardous.

b. Inside, Air Conditioned:
   1) Temperature:
      a) Normal: 60 degrees F to 80 degrees F.
      b) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 105 degrees F.
   2) Relative Humidity:
      a) Normal: 10 percent (winter) to 70 percent (summer).
      b) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
   3) NEC Classification: Nonhazardous.
c. Inside:
   1) Temperature: 20 degrees F to 104 degrees F.
   2) Relative Humidity: 10 percent to 100 percent.
   3) NEC Classification: Nonhazardous.
d. Inside, Corrosive:
   1) Temperature: 20 degrees F to 104 degrees F.
   2) Relative Humidity: 10 percent to 100 percent.
   3) Corrosive Environment: Hydrogen sulfide gas and Chlorine gas.
   4) NEC Classification: Nonhazardous.
e. Inside, Hazardous:
   1) Temperature: 20 degrees F to 104 degrees F.
   2) Relative Humidity: 10 percent to 100 percent.
   3) NEC Classification: As shown on Electrical Drawings.
f. Outside:
   1) Temperature: Minus 20 degrees F to 104 degrees F.
   2) Relative Humidity: 10 percent to 100 percent, rain, snow and freezing rain.
   3) NEC Classification: Nonhazardous.
g. Outside, Corrosive:
   1) Temperature: Minus 20 degrees F to 104 degrees F.
   2) Relative Humidity: 0 percent to 100 percent, rain, snow, and freezing rain.
   3) Corrosive Environment: Hydrogen sulfide gas.
   4) NEC Classification: Nonhazardous.
h. Outside, Hazardous:
   1) Temperature Minus 20 degrees F to 104 degrees F.
   2) Relative Humidity: 0 percent to 100 percent, rain, snow, and freezing rain.
   3) NEC Classification: As shown on Electrical Drawings.

B. Standard Service Conditions for Panels and Consoles:

1. Unless otherwise noted, design equipment for continuous operation in these environments:
   a. Freestanding Panel and Consoles:
      1) Inside, Air Conditioned: NEMA 1.
      2) Inside: NEMA 12.
   b. Smaller Panels and Assemblies (that are not freestanding):
      1) Inside, Air Conditioned: NEMA 12.
      2) All Other Locations: NEMA 4X.
   c. Field Elements: Outside.

2.06 NAMEPLATES AND TAGS

A. All Equipment/devices like Pumps, Mixers, Valves, Instruments, Control Panel, Local Control Station etc. shall be provided with a physical lamacoid label with the Tag Number and a description of the device.

Label Type	Size	Lines	Font Height
A	75 x 31 (3" x 1-1/4")	2	Line 1 = 6.5 mm, Line 2 = 5 mm
Line 1: Equipment Tag number – e.g., H040-ARB1-FIT03. Line 2: Equipment description – e.g., Aeration Basin 1, Air Flow Transmitter 3.			

B. Panel Nameplates: Enclosure identification located on enclosure face.

1. Location and Inscription: As shown on the 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.

C. 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.

D. 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.

E. 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 the 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.

F. 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.

G. 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-guage or 18-gauge stainless steel wire or stainless steel screws.

2.07 MECHANICAL SYSTEM COMPONENTS

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

2.08 FUNCTIONAL REQUIREMENTS FOR CONTROL

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 the Drawings.

B. Supplemented by standard functional requirements in PIC subsections.

2.09 ELECTRICAL REQUIREMENTS

A. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.

B. 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.

C. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

D. 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 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 18 AWG Type 9341, Triad Beldon No. 1121A.
   c. Size: 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current carried, but not less than 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 Sleev.
      2) Tyco Electronics.

E. 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.

F. Terminal Blocks for Enclosures:

1. Quantity:
   a. Accommodate present and spare indicated needs.
   b. Wire spare PLC I/O points to terminal blocks.
   c. One wire per terminal for field wires entering enclosures.
   d. Maximum of two wires per terminal for 18 AWG wire for internal enclosure wiring.
   e. Spare Terminals: 20 percent of connected terminals, but not less than 10 per terminal block, unless otherwise shown on the Drawings.
2. Terminal Block Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.

G. 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.
   c. Group and ground wire shields in control panel enclosure
4. Ground terminal block rails to ground bus.

H. 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.

I. 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.

J. 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 on the Drawings.
   c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
      1) Connection of ac power to PIC equipment including panels, consoles assembles, 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: As shown on the Drawings.
2. Instrument Arrangements: As shown on the Drawings.
3. 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.
4. 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.
5. UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A and/or “Industrial Control Panels Relating to Hazardous (Classified) Locations” per UL 698A as applicable.

6. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

B. Temperature Control:

1. Freestanding Panels:
   a. Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel and on panel.
   b. 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.
   c. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation.
2. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel and on panel face.
3. Space Heaters:
   a. Thermostatically controlled to maintain internal panel temperatures above dewpoint.
   b. Refer to Control Panel Schedule in Article Supplements.

C. Freestanding Panel Construction:

1. Materials:
   a. Sheet steel, unless otherwise shown on the Drawings or as required for the environment being installed.
   b. Minimum Thickness: 10-gauge, unless otherwise noted.
2. Panel Front:
   a. Fabricated from a single piece of sheet steel, unless otherwise shown on the 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 the 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 the Drawings.

D. Nonfreestanding Panel Construction:

1. Based on environmental design requirements and referenced in, provide the following:
   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. H. F. Cox.

E. Breather and Drains:

1. Furnish with NEMA 250, Type 4 and 4X panels.
2. Manufacturer and Products: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

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 the 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: Refer to Division 26, Electrical.
   c. Circuit Wiring:
      1) P&IDs and Control Diagrams on the Drawings show function only. Use following rules for actual circuit wiring:
         a) Devices on Single Circuit: 20, maximum.
         b) 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.
         c) Branch Circuit Loading: 12 amperes continuous, maximum.
         d) Panel Lighting and Service Outlets: Put on separate 15 amp, 120V ac branch circuit.
         e) 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 mA dc to 20 mA dc signals may be distributed as 1V dc to 5V dc.
   c. Outside Panels: Isolated 4 mA dc 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 mA to 20 mA loops during switching.
   c. Switching Transients in Associated Signal Circuit:
      1) 4 mA dc 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 17-Watt, 1,700-Lumen, 3,000K color temperature LED back-of-panel lights.
   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 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 17-Watt, 1,700-Lumen, 3,000K color temperature LED light.
   b. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI 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 in individual Loop Specifications:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black

Tag Function	Inscription(s)	Color
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

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 in individual Loop Specifications:

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
AUTO	AUTO	Green
MANUAL	MANUAL	Red
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

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 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, allowed only at device terminals or terminal blocks.
8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. 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.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
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: 14 AWG, MTW.
    b. 24V dc: 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.

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 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.

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 panels and system, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
3. Location: PIC System Integrator's facility. If the PIC System Integrator's Facility is outside a 100-mile radius of the Project Site, the Contractor shall pay all Owner's and Engineer's travel expenses associate with witnessing tests.
4. Correctness of wiring from panel field terminals to PLC 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 PLCs and remote I/O and between PLCs and computers.
6. Loop-Specific Functions:
   a. 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.
7. 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.
8. Correct deficiencies found and complete prior to shipment to Site.
9. 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.
10. 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.

11. 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. 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.

3. 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. Leak Tests: During preparation for testing, conduct leak tests in accordance with Section 40 80 01, Process Piping Leakage Testing.

D. Testing Sequence:

1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.
2. Refer to Section 01 91 14, Equipment Testing and Facility Startup, for overall testing requirements.
3. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.

E. 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. Phase 1 Operational Readiness Test (ORT). Phase 1 ORT is provided by the Contractor: Prior to Phase 2 ORT, startup test period and Performance Testing, inspect, test, and document that entire PIC is ready for operation. Performed by PIC Contractor to test and document that PIC, excluding Software Supplier provided PLC and SCS applications software.
3. Phase 2 Operational Readiness:
    a. Phase 2 ORT: Contractor shall confirm that the Software Supplier is ready with the Application Software for operation.
    b. Prerequisite: Completion of Phase 1 ORT.
    c. Joint test with Software Supplier. Repeat of Software Supplier’s SDT, except using real field sensors and equipment. Plant interlocking and communications with PLCs and SCS shall be tested on loop-by-loop basis.
    d. Test procedures provided by Software Supplier based on Loop Specifications.

4. Functional Test:
    a. Scope: Confirm PIC, including applications software, is ready for operation. Refer to Section 40 96 00, Applications Software, for specific test requirements.
    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.
5. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.
6. Performance Acceptance Tests (PAT): These are the activities that Section 01 91 14, Equipment Testing and Facility Startup, refers to as performance testing.
    a. Once ORT Phase 1 and Phase 2 has been completed and facility has been started up, perform a witnessed PAT on complete PIC and software to demonstrate that it is operating as required by the Contract Documents and software Loop Specifications. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop basis.
    b. Loop-specific and non-loop-specific tests same as required for FDT and SDT except that entire installed PIC tested using actual process variables and all functions demonstrated. Refer to Section 40 96 00, Applications Software.
    c. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
    d. 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.
    e. Make updated versions of documentation required for PAT available to Owner at Site, both before and during tests.
    f. Make one copy of all software O&M manuals available to the Owner at the Site both before and during testing.

F. 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:

1. 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:
   a. Analysis Instrumentation for Ammonia, DO, TSS measurements.
   b. Thermal Mass flow meters for Aeration air flow measurements.

C. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

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 on three working shift(s) as needed to accommodate the Owner's personnel schedule.
5. Owner reserves the right to reuse videotapes of training sessions.

B. 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: 2 instructor days.
   b. Number of Training Sessions: Three.
   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: 2 instructor days.
b. Number of Training Sessions: Three.
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. The supplements listed below, following “End of Section,” are a part of this specification:

1. 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.
2. 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

JACOBS **LOOP STATUS REPORT—EXAMPLE FORMAT** **Rev.06.05.92**

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

JACOBS **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

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N	CONTROL? N
Indicate? Y Record? N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
	Scale:	*1-14*	*pH units*		SWITCH? N Unit Range:
Transmit/	Input:	*1-14*	*pH units*		Differential: fixed/adjustable
Convert? Y	Output:	*4-20*	*mA dc*		Reset? automatic / manual

ANALOG CALIBRATIONS							**DISCRETE CALIBRATIONS**					**Note**
REQUIRED			**AS CALIBRATED**				**REQUIRED**			**AS CALIBRATED**		**No.**
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.					*1.*
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**
	1. Need to recheck low pH calibration solutions.	**for Start-up**
		By: *J.D. Sewell*
		Date: *Jun-6-92*
		Tag No.: *AIT-12-6*[pH]

JACOBS **I&C VALVE ADJUSTMENT SHEET—EXAMPLE** Rev.06.05.92

PARTS	Project Name: *SFO SEWPCP*	Project Number: *SFO10145.G2*
Body	Type: *Vee-Ball*	Mfr: *Fisher Controls*
	Size: *4-inch*	Model: *1049763-2*
	Line Connection: *159 # ANSI Flanges*	Serial #: *1003220*
Operator	Type: *Pneumatic Diaphragm*	Mfr: *Fisher Controls*
	Action: *Linear – Modulated*	Model: *4060D*
	Travel: *3-inch*	Serial #: *2007330*
Positioner	Input Signal: *3-15 psi*	Mfr: *Fisher Controls*
	Action: *Direct - air to open*	Model: *20472T*
	Cam: *Equal percentage*	Serial #: *102010*
Pilot	Action:	Mfr:
Solenoid	Rating: *None*	Model: Serial #:
I/P	Input: *4-20 mA dc*	Mfr: *Taylor*
Converter	Output: *3-15 psi*	Model: *10-T-576-3*
	Action: *Direct*	Serial #: *1057-330*
Position	Settings: *Closed / Open 5 deg, rising*	Mfr: *National Switch*
Switch	Contacts: *Close / Close*	Model: *1049-67-3*
		Serial #: *156 &157*
Power	Type: *Pneumatic*	Air Set Mfr: *Air Products*
Supply	Potential: *40 psi*	Model: *3210D*
		Serial #: *1107063*

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set	*JDS*	*Jun-06-92*	Valve Action	*JDS*	*Jun-03-92*
Positioner	*JDS*	*Jun-06-92*	Installation	*JDS*	*Jun-03-92*
Position Switches	*JDS*	*Jun-06-92*	Wire Connection	*JDS*	*Jun-04-92*
I/P Converter	*JDS*	*Jun-07-92*	Tube Connection	*JDS*	*Jun-04-92*
Actual Speed	*JDS*	*Jun-07-92*			

REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Start-up**
Observed to be correctly installed May-25-92	By: *J.D. Sewell*
	Date: *Jun-07-92*
	Tag No.: *FCV-10-2-1*

JACOBS PERFORMANCE TEST SHEET - EXAMPLE Rev.06.05.92

Project Name: *SFO SEWPCP Plant Expansion*				Project No.: *SFO12345.C1*
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.				
1. MEASURE EFFLUENT FLOW				
1.a With no flow, water level over weir should be zero and				
FIT indicator should read zero.				*Jun-20-92 BDG*
2. FLOW INDICATION AND TRANSMISSION TO LP & CCS				
With flow, water level and FIT indicator should be related by expression				
*Q(MGD) = 429*H**(2/3) (H = height in inches of water over weir).*				
Vary H and observe that following.				
2.a Reading of FIT indicator.				*Jun-6-92 BDG*
2.b Reading is transmitted to FI on LP-521-1				*Jun-6-92 BDG*
2.c Reading is transmitted and displayed to CCS.				*Jun-6-92 BDG*
H(measured)	*0*	*5*	*10*	*15*
Q(computed)	*0*	*47.96*	*135.7*	*251.7*
Q(FIT indicator)	*0*	*48.1*	*137*	*253*
Q(LI on LP-521-1)	*0*	*48.2*	*138*	*254*
Q(display by CCS)	*0*	*48.1*	*136.2*	*252.4*

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report	*J.D. Sewell*	*May-18-92*	By: *J.D. Smith*
Instrument Calibration Sheet	*J.D. Sewell*	*May-18-92*	Date: *Jun-6-92*
I&C Valve Calibration Sheet	*N.A.*		
Performance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-92*	
Witnessed	*B. DeGlanville*	*Jun-6-92*	Loop No.: *30-12*

SECTION 40 90 02
PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS)
SAMPLE FORMS

JACOBS **SYSTEM PROBLEM REPORT**			
Project Name:		Project No.:	
Test Name:		SPR Number:	
Test Number:		Problem Status:	
Problem Type: Hardware Software Documentation Unknown Other			
SYMPTOMS:	Time:	Date:	By:
Description:			
		Can problem be reproduced at will? Y / N	
DIAGNOSIS:	Time:	Date:	By:
Description:			
CORRECTION:	Time:	Date:	By:
Description:			
FINAL SIGN OFF	Time:	Date:	By:

JACOBS
LOOP STATUS REPORT

Project Name:	Project No.

FUNCTIONAL REQUIREMENTS:

COMPONENT STATUS (Check and initial each item when complete)

Tag Number	Delivered	Tag ID Checked	Installation	Termination Wiring	Termination Tubing	Calibration	

REMARKS:

Loop Ready for Operation	By:	Date:	Loop No.:

JACOBS
INSTRUMENT CALIBRATION SHEET

COMPONENT	**MANUFACTURER**	**PROJECT**
Code:	Name:	Number:
Name:	Model:	Name:
	Serial #:	

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? Y / N	CONTROL? Y / N Action? direct / reverse Modes? P / I / D
Indicate? Y / N	Chart:			Describe:	
Record? Y / N	Scale:				SWITCH? Y / N Unit Range:
Transmit/	Input:				Differential: fixed/adjustable
Convert? Y / N	Output:				Reset? automatic / manual

ANALOG CALIBRATIONS

REQUIRED			AS CALIBRATED			
Input	Indicated	Output	Increasing Input		Decreasing Input	
			Indicated	Output	Indicated	Output
CONTROL MODE SETTINGS:			P:	I:	D:	

DISCRETE CALIBRATIONS

REQUIRED			AS CALIBRATED		Note.
Number	Trip Point (note rising or falling)	Reset Pt.	Trip Point (note rising or falling)	Reset Pt.	No
1.					
2.					
3.					
4.					
5.					
6.					

#	**NOTES:**

Component Calibrated and Ready for Start-up

By:

Date:

Tag No.:

JACOBS
I&C VALVE ADJUSTMENT SHEET

PARTS	Project Name:	Project Number:
Body	Type:	Mfr:
	Size:	Model:
	Line Connection:	Serial #:
Operator	Type:	Mfr:
	Action:	Model:
	Travel:	Serial #:
Positioner	Input Signal:	Mfr:
	Action:	Model:
	Cam:	Serial #:
Pilot	Action:	Mfr:
Solenoid	Rating:	Model:
		Serial #:
I/P	Input:	Mfr:
Converter	Output:	Model:
	Action:	Serial #:
Position	Settings:	Mfr:
Switch	Contacts:	Model:
		Serial #:
Power	Type:	Air Set Mfr:
Supply	Potential:	Model:
		Serial #:

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set			Valve Action		
Positioner			Installation		
Position Switches			Wire Connection		
I/P Converter			Tube Connection		
Actual Speed					

REMARKS:	**Valve Ready for Start-up**
	By:
	Date:
	Tag No.:

JACOBS **PERFORMANCE TEST SHEET**	
Project Name:	Project No.:
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.	

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report			By:
Instrument Calibration Sheet			Date:
I&C Valve Calibration Sheet			
Performance Test	By	Date	
Performed			
Witnessed			Loop No.:

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.

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.

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 Product:
   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 the 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 the 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 the 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 the 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. Spool Valve:

1. Type: Five-port arrangement as shown, two-position, push-to-operate knob attached to the spool stem, and spring return.
2. Materials: Aluminum construction with Teflon impregnated aluminum spool, stainless steel spring, and Buna-N O-rings.
3. Port Connection: 1/4-inch outside diameter tube fittings.
4. Manufacturer and Product: Norgren; T71DAOO-TSO-TKO.

J. Solenoid Valve, Two-Way:

1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
2. Materials:
   a. Body: Brassed or stainless steel globe valves as recommended by manufacturer for designated service, unless otherwise shown on the 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.

K. 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.

L. 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.

M. 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.

N. 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 the Drawings.
3. Provide corrosion protection for all exposed copper.
4. Manufacturers:
    a. Parker-Hannifin.
    b. Swagelok tube fittings.

O. 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.

P. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on the Drawings.

Q. 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.

R. Air Set: Consists of a shutoff valve, pressure regulator, discharge pressure gauge, and interconnecting tubing.

S. Purge Set:

1. Parts: Purge rotameter flow element, pressure regulator, pressure gauge, test tap, shutoff valve, spool valve, and interconnecting tubing as shown on the Drawings and as required in this section.
2. Pressure Gauge Scale Range: 150 percent of the process variable.
3. Mounting: Within consoles, panels, or a separate enclosure as shown.

T. 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 the Drawings.
4. Manufacturers:
    a. Globetray.
    b. Cope.

U. Air Supply Sets:

1. Parts:
    a. Integrally Mounted:
        1) Pressure Controls: Automatic START/STOP, factory set at 30 psig to 50 psig.
        2) Valves: Manual drain, manual shutoff, pressure relief, and check valve.
        3) Pressure gauge.
        4) Inlet filter muffler.
        5) Power: 120V ac.
        6) Compressor: Oilless, single cylinder, rated for at least 1 scfm at 50 psig.
        7) Manufacturers and Products:
            a) ITT Pneumotive; GH Series.
            b) 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. Provide corrosion protection for all exposed copper.
   e. Insulation:
      1) Thermoplastic rated for minus 131 degrees F to plus 230 degrees F.
      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.
   j. Test Plugs: Soldered connections for 18 AWG wire.
      1) Pin Diameter: 0.079 inch.
      2) Quantity: 20, (need two plugs per test meter).
      3) Manufacturer and Product: Entrelec; Type FC2.
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. PLC Interface Relay:
    a. Type: Narrow design for high density and direct connection of field wiring to relay terminals.
    b. Function: Covert PLC input to dry contact for isolated discrete signal interface.
    c. Relay Mounting: Plug into terminal block style socket.
    d. Socket Mounting: DIN rail.
    e. Socket Width: 0.25 inch nominal.
    f. Coil Voltage: 120V ac or 24V dc to suit application.
    g. Coil Power: 0.5 VA.
    h. Expected Mechanical Life: 10,000,000 operations.
    i. Operating Indicator: LED lights when coil is energized.
    j. Contact Arrangement: One Form C, SPDT contact.
    k. Contact Rating: 5A, at 24V dc and 250V ac.
    l. Connection Type: Screw compression clamp.
    m. Terminal Marking: Numbered with preprinted or field-marked tags.
    n. Manufacturers and Products:
        1) Phoenix Contact; PLC-RSC Series.
        2) Allen-Bradley; Bulletin 700-HL Terminal Block Relays.
        3) Idec; RV8H Series.
3. 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.

4. 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.
5. 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.
6. 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 50 degrees F to 131 degrees F.
   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 68 degrees F to plus 185 degrees F.
   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. Analog Signals Lines: Emerson Edco PC-642 or SRA-64 series.
   b. 120V ac Lines: Emerson Edco HSP-121.
   c. Field Mounted at Two-Wire Instruments (Type 3):
      1) Encapsulated in stainless steel pipe nipples.
      2) Emerson Edco; SS64 series.

d. Field Mounted at Four-Wire Instruments (Type 4): With 120V ac outlet, ac circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
   1) Enclosure:
      a) NEMA 4X fiberglass with door.
      b) Maximum Size: 12 inches by 12 inches by 8 inches deep.
   2) Emerson Edco; SLAC 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.
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.
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.

2.04 I&C COMPONENTS

A. D07 Suspended Solids Element and Transmitter, Microwave:

1. General:
   a. Function: Measure, indicate, and transmit the percent total solids density of a process liquid in a full pipe.
   b. Type: Microwave.
   c. Parts: Density element, transmitter, interconnecting cables, and mounting hardware.

2. Service:
    a. Stream Fluid: Thickened sludge from water treatment.
3. Performance:
    a. Measuring Range: 0 percent to 16 percent total solids.
    b. Output Range: As noted.
    c. Repeatability: Plus or minus 0.02 percent.
    d. Temperature, Ambient: Minus 20 degrees C to 50 degrees C.
    e. Temperature, Process: 0 degree C to 100 degrees C.
    f. Damping: 1 second to 99 seconds.
4. Element:
    a. Type: Flanged spool, ANSI 150.
    b. Pipe Size: As noted.
    c. Body: Type 316 stainless steel.
    d. Enclosure: NEMA 4X.
    e. Pressure Rating: 200 psig, minimum.
    f. Wetted Materials: Type 316 stainless steel, ceramic, and EPDM.
5. Transmitter:
    a. Mounting: Remote wall mounted, unless otherwise noted. Furnish with all manufacturer's appurtenances for wall-mounting.
    b. Display: Digital LCD display, indicating percent solids.
    c. Parameter Adjustments: By keypad or nonintrusive means.
    d. Enclosure: NEMA 4, minimum.
    e. Signal Outputs:
        1) Total Solids Signal Output: Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply. Supports superimposed digital HART protocol.
        2) Secondary Output: If noted, configured for temperature or conductivity.
        3) Communication: If and as noted.
    f. Power: 120V ac.
6. Accessories:
    a. Interconnecting Cable: For connecting element to transmitter, 25-feet, minimum or longer to suit mounting locations.
7. Manufacturers and Products:
    a. Valmet; TS.
    b. Toshiba; LQ500.
    c. "Or-equal."

B. F4 Flow Element and Transmitter, Electromagnetic:

1. General:
   a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
   b. Type:
      1) Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
      2) Full bore meter with magnetic field traversing entire flow-tube cross-section.
      3) Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
   c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
2. Service:
   a. Stream Fluid:
      1) As noted.
      2) Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.
   b. Flow Stream Descriptions: If and as described below.
3. Operating Temperature:
   a. Element:
      1) Ambient: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.
      2) Process: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.
   b. Transmitter:
      1) Ambient: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.
      2) Storage: 15 degrees F to 120 degrees F, typical, unless otherwise noted.
4. Performance:
   a. Flow Range: As noted.
   b. Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 feet to 30 feet per second.
   c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
5. Features:
   a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
   b. No obstructions to flow.
   c. Very low pressure loss.
   d. Measures bi-directional flow.

6. Process Connection:
    a. Meter Size (diameter inches): As noted.
    b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
    c. Flange Material: Carbon steel, unless otherwise noted.
7. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.
8. Element:
    a. Meter Tube Material: Type 304 or Type 316 stainless steel, unless otherwise noted.
    b. Liner Material:
        1) For polymer, PTFE.
        2) For all else, Hard rubber or elastomer, unless otherwise noted.
    c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
    d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
    e. Electrode Material:
        1) For polymer, Alloy C22.
        2) For all else, Type 316L, unless otherwise noted.
    f. Grounding Ring:
        1) Required, unless otherwise noted.
        2) Quantity: Two, unless otherwise noted.
        3) Material: Type 316 stainless steel, unless otherwise noted.
    g. Enclosure: NEMA 4X, minimum, unless otherwise noted.
    h. Submergence:
        1) Continuous (up to 10 feet depth), NEMA 6P/IP68.
    i. Direct Buried (3 feet to 10 feet): If noted.
9. Transmitter:
    a. Mounting: Remote wall mounted, unless otherwise noted. Furnish with all manufacturer’s appurtenances for wall mounting.
    b. Display: Required, unless otherwise noted.
        1) Digital LCD display, indicating flow rate and total.
        2) Bi-directional Flow Display: Required, unless otherwise noted.
            a) Forward and reverse flow rate.
            b) Forward, reverse, and net totalization.
    c. Parameter Adjustments: By keypad or nonintrusive means.
    d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
    e. Empty Pipe Detection:
        1) If noted.
        2) Drives display and outputs to zero when empty pipe detected.

10. Signal Interface (at Transmitter):
    a. Analog Output:
        1) Isolated 4 mA dc to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
        2) Supports Superimposed Digital HART Protocol: If noted.
11. Cables:
    a. Types: As recommended by manufacturer.
    b. Lengths: As required to accommodate device locations plus 50 feet.
12. Built-in Diagnostic System:
    a. Features:
        1) Field programmable electronics.
        2) Self-diagnostics with troubleshooting codes.
        3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
        4) Initial flow tube calibration and subsequent calibration checks.
13. Factory Calibration:
    a. Calibrated in an ISO 9001 and NIST certified factory.
    b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
    c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
14. Factory Ready for Future In situ Verifications: Original meter parameter values available from vendor by request.
15. Accessories:
    a. In situ Verification System:
        1) Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.
        2) Physical access to the flow-tube not required.
        3) Meet standards established by the National Testing Laboratory.
        4) Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.
        5) Verification standard shall be plus or minus 1 percent of wet calibration for meters produced using the calibration verification service, or plus or minus 2 percent for standard meters.
        6) Windows-based software.

b. Primary Simulation System:
1) Quantity: Two complete systems provided for the Project.
2) Verifies proper operation of the signal converter by simulating the flow meter's output signal.
a) Generates pulsed dc excitation signal with a reference voltage of 70 mV.
b) Generated signal ranges from 0 percent to 99 percent (0 feet to 32.8 feet per second) with a resolution of 0.1 percent.
c) Switch selectable for forward, reverse and zero flow rate.
3) Verifies various input and output signals.

16. Warranty: Provide 1 year full factory warranty for each meter and all accessories provide under this specification.
17. Manufacturers:
a. Endress + Hauser, Inc. Flow Measuring System with Promag 400 Flow Indicating Transmitter:
1) Promag W10 (Size: 1 inch to 78 inches).
b. Siemens:
1) Mag 1100 (Size: 1/2 inch to 1.5 inch).
2) Mag 3100 Flow with Verificator accessory (Size: 1/2 inch to 78 inches).
Mag 5100W (Size: 1/2 inch to 48 inches).
3) Transmitter: Mag 6000.

C. F51 Flow Element and Transmitter, Thermal Mass Flow:

1. General:
a. Function: Directly measure, indicate, and transmit mass flow of gas in pipe.
b. Type: Insertion type, thermal dispersion detection probe using platinum resistance temperature detectors (RTD).
c. Parts: Elements, transmitter, and interconnecting cable.
2. Performance:
a. Process Gas: As noted or shown.
b. Range for Air at 70 Degrees F and 14.7 psia:
1) As noted, within the following:
a) 0.25 to 1,600 standard fps.
b) 0.25 to 200 actual fps.
c. Calibrated Span: As noted.
d. Accuracy:
1) Flow: Plus or minus 1 percent of reading plus 0.5 percent full scale.
2) Temperature: Plus or minus 2 degrees F.

e. Repeatability:
   1) Flow: Plus or minus 0.5 percent of reading.
   2) Temperature: Plus or minus 1 degree F.
f. Temperature, Operating:
   1) Flow Element: Minus 50 degrees F to plus 350 degrees F, unless otherwise noted.
   2) Transmitter Housing: 0 degree F to plus 150 degrees F.
g. Pressure, Operating, Flow Element: Up to 50 psig, unless otherwise noted.

3. Flow Element:
   a. Features:
      1) Insertion Length: As noted or manufacturer's recommendation.
      2) Wetted Surfaces Materials: Type 316 stainless steel with nickel braze, unless otherwise noted.
   b. Process Connection:
      1) Line Size: As noted or shown.
      2) Connection Type: Retractable sensor with graphite-packed gland with 1-1/4-inch MNPT, unless otherwise noted.
      3) Connection Material: Type 316 stainless steel, unless otherwise noted.
   c. Sensor Enclosure:
      1) Type: Aluminum, NEMA 4X, rated for Classes 1 and 2, Divisions 1 and 2, Groups B, C, D, E, F, G, and Eexd IIC; unless otherwise noted.
4. Transmitter:
   a. Features: 4-line by 20-character LCD, keypad programmable.
   b. Nonvolatile memory.
   c. Signal Interface:
      1) Outputs:
         a) Analog: Two isolated 4 mA to 20 mA dc for maximum 600 ohm load, unless otherwise noted.
         b) Discrete:
            (1) Two independently adjustable 10 amps at 115V ac or 24V dc.
            (2) Configurable as high or low flow or process temperature.
      2) Digital Communication: Modbus RTU/RS-485.
   d. Power:
      1) Selectable: 115V ac, 230V ac, 24V dc.
   e. Electrical Connection: 1-inch FNPT.
   f. Transmitter Enclosure:
      1) Type: Fiberglass NEMA 4X, unless otherwise noted.
      2) Mounting: Remote from sensor.
   g. Single factory calibration, unless otherwise noted.

5. Cables:
    a. Length: As required.
    b. Cable Jacket: PVC rated for 220 degrees F, unless otherwise noted.
6. Manufacturer and Product: Fluid Components International; Model ST50.

D. L7 Level Element and Transmitter, Radar – Non-Contact, Type S:

1. General:
    a. Function: Continuous level measurement.
    b. Type: Radar; Non-contacting.
    c. Loop-powered.
    d. Parts: Element/integral transmitter and accessories as noted.
2. Service:
    a. Application: If and as noted.
    b. Operating Temperature Range:
        1) Outside Ambient: Minus 40 degrees F to 176 degrees F.
        2) Transducer (inside vessel): Minus 40 degrees F to 212 degrees F.
3. Performance:
    a. Process Range: As noted.
    b. Zero Reference: As noted.
    c. Frequency: 80 GHz FMCW (frequency modulating, continuous wave).
    d. Accuracy: The greater of 25 mm (1 inch) or 0.25 percent of range from minimum detectable distance to full range.
    e. Medium Suitability: Non-contacting element for medium with dielectric constant greater than 1.6.
    f. Blanking Distance: 15.75 inches.
4. Element/Integral Transmitter:
    a. Enclosure Rating:
        1) NEMA 4X/IP67 watertight.
        2) NEMA 6/IP68.
    b. Enclosure Material: Aluminum, polyester powder-coated, C5 corrosion equivalent
    c. Lens Antenna:
        1) Lens Antenna Material: PP, FKM, or EPDM.
        2) Include flange adapters.
        3) Process Connection:
            a) 6-inch ASME 150-pound, flat faced flange, unless otherwise noted.
                (1) Material: Type 316L stainless steel.
            b) Cantilever Arm, unless otherwise noted.

4) Process Seal/Gasket: As required.
5) Pressure Rating of 14.31 psig Maximum: If noted.

d. Beam Angle: 3 degrees.
e. Approvals:
1) FM, Classes I, II, III, Division 1, Groups A, B, C, D, E, F, G, and T6.
2) FM, Class I, Division 2, Groups A, B, C, D, and T6.
f. Element Beam Angle: 3 degrees inclusive.
g. Display: Local LCD with bar graph (local display interface).

5. Transmitter Mounting: Remote wall mounted, unless otherwise noted. Furnish with all manufacturer's appurtenances for wall mounting.
6. Signal Interface:
a. Analog: 4 mA dc to 20 mA dc (HART) with maximum impedance of 550 ohms and nominal 24V dc power supply.
b. Digital, HART.
7. Conduit Entry: 1/2-inch NPT.
8. Accessories:
a. Handheld Programmer:
1) One Per Lot of Level Units Provided: Required.
2) Intrinsically safe version, unless otherwise noted.
b. Integral sunshield.
c. Stainless steel tag.
d. Wall mount bracket.
e. Others: As noted.
9. Manufacturer and Product:
a. Siemens; SITRANS LR 550.
b. No substitution allowed.

E. L08 Level Switch, Capacitance:

1. General: Capacitance type level switches shall be made up of a control relay, mechanically rigid and rugged non-metallic probe and probe housing.
2. Switch:
a. For capacitance level switches in chemical tanks, instrument shall be chemically compatible with the application.
1) Use Type 316 Stainless steel for instrument probe.
b. Provide a rigid, non-metallic element.
c. The control relay senses the liquid level by capacitance measurement between the electrode probe, the process liquid, and the equipment ground:
1) Power Supply:
a) 120V ac.
b) Power consumption: 10 VA maximum.

2) Outputs:
a) Relay Outputs:
(1) One Form C contact.
(2) Rated at 6 amperes at 120V ac.
(3) Programmable.
d. Electrical connection: One 1/2-inch NPT conduit entry.
e. Enclosure: NEMA Type 4X.
3. Manufacturers and Products:
a. Siemens; Pointek CLS200.
b. E+H; Liquicap M FTI51/FTI52.
c. “Or-equal.”

F. L18 Level Switch, Nonmercury:

1. General:
a. Function: Actuate contact at preset liquid level.
b. Type:
1) Direct-acting, stainless steel float with enclosed, encapsulated switch and integral cable.
2) Mercury free.
2. Service (Liquid): Sludge, unless otherwise noted.
3. Performance:
a. Setpoint: As noted.
b. Differential: 8 inches maximum.
c. Temperature: 32 degrees F (nonfreezing) to 160 degrees F.
4. Features:
a. Entire Assembly: Watertight and impact-resistant.
b. Float:
1) Material and Size: 5.5-inch diameter polymer-coated, Type 316 stainless steel float.
2) Buoyancy: 2 pounds.
c. Cable:
1) Length as noted or as necessary per mounting requirements.
2) Plastic-jacketed cable, oil-resistant, and suitable for continuous service.
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) Anchor Mounting Kit: If noted.
a) 15-pound vinyl-coated cast-iron anchor.
b) 1/8-inch, Type 316 stainless steel wire rope.
c) Stainless steel cable clips.

5. Signal Interface:
    a. Switch Type: Magnetic reed.
    b. Switch Contacts:
        1) Isolated, rated at least 0.8 amp continuous at 120V ac.
        2) Contact Type: Either NO or NC, as required by application or as noted; or SPDT (NO and NC).
6. Accessories: As noted.
7. Manufacturers and Products:
    a. App4Water; Model 9G-EF Direct Acting Float Switch (B100).
    b. Contegra; Model FS90.
    c. No substitution allowed.

G. L42 Level Element/Transmitter, Submersible, Wastewater:

1. General:
    a. Function: Measure and transmit signal proportional to level.
    b. Type:
        1) Totally submersible pressure sensor (loop powered).
        2) Suitable for wastewater.
    c. Parts: Sensor, interconnecting cable, other parts as noted.
2. Service:
    a. Fluid: Wastewater, unless otherwise noted.
3. Performance:
    a. Process Range:
        1) As noted.
        2) Provide fixed factory range such that noted process range is between 40 percent and 80 percent of fixed factory range.
    b. Accuracy: 0.25 percent of full scale.
    c. Temperature, Operating: Negative 4 degrees F to plus 140 degrees F.
    d. Overpressure:
        1) Proof: At least 1.5 times full scale.
        2) Burst: At least 2.0 times full scale.
4. Features:
    a. Sensor:
        1) Silicon pressure-sensing element.
        2) External Diaphragm: Flush type, coated with fluoro-polymer.
        3) Titanium or Type 316 stainless steel pressure module assembly, unless otherwise noted.
            a) Special Warranty: 5-year corrosion warranty, replace sensor if it fails due to corrosion.
        4) NEMA 6/IP 68 rating (submersible).
        5) Temperature compensation.

6) Dimensions, Nominal:
a) Diameter: 1.2 inches.
b) Length: 5 inches.
7) Loop powered, 9V dc to 30V dc.

b. Interconnecting Cable:
1) Length: As required.
2) Polyurethane sheathed, unless otherwise noted.
3) Kevlar strain relief cord.
4) Integral vent tube.

c. Sensor Termination Enclosure: Required, unless otherwise noted.
1) Enclosure: NEMA 4X.
2) Terminations: Terminal blocks for termination of cable wiring.
3) Houses moisture control elements.
4) Mounting: 2-Inch Pipe Mounting.

d. Accessories:
1) Moisture Control:
a) Terminate the integral vent tube with one of the following:
(1) Moisture filter cap.
(2) Aneroid bellows.
(3) Desiccant Module.
2) Spare Desiccant Modules: One per element when desiccant modules are provided.
3) Cable Hanger, Kellems Type Grip: Required, unless otherwise noted.
4) Lightning Protection:
a) Internal (protects against water lightning strike): If noted.
b) External (protects 4 mA dc to 20 mA dc output): Required, unless otherwise noted.
5) Anchor Assembly: If noted or shown.
a) Marine anchor, clamps, Type 316 stainless steel cable or chain, length as required, nominally 3 feet longer than interconnecting cable.
6) Level Indicator: If noted or shown.

5. Signal Interface: 4 mA dc to 20 mA dc output, for load impedance of 0 ohm to 750 ohms, minimum for 24V dc supply without load adjustment.
6. Certification(s): Class I, Division 1, Groups A, B, C, and D.
7. Manufacturers and Products:
a. Endress + Hauser; Waterpilot FMX21.
b. Blue Ribbon Corp.; Model BC001, Birdcage Series.

H. 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.

I. 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. Manufacturer and Product: Federal Signal; Model 225.

J. M43 Intrusion Switch:

1. General:
   a. Function: Monitor intrusion of entry points such as doors, overhead doors, and chain link gates.
   b. Type:
      1) Magnetic.
      2) Large.
   c. Parts: Magnet, switch, and cabling.
2. Features:
   a. Type: Large magnet, surface-mount suitable for door, unless otherwise noted.
   b. Cable: Armored, 36 inches long.
   c. Mounting Kits:
      1) For Overhead Doors: If noted.
      2) Angle bracket for door mounting.
   d. Magnet Length: 2.5 inches, nominal.
   e. Magnet and Switch Dimensions: Each, 2.6 long by 0.875 wide by 0.600 thick, nominal inches.
   f. Housing: Weather-resistant aluminum.
   g. Two holes on switch and magnet for fasteners.
   h. Current Sensor Assembly: If noted.
      1) Suited for use in 24V ac/dc circuits to protect the 10 watt rated standard switch.
      2) Includes shunt-to-ground circuit that shunts voltage above 60V ac/dc to ground.
      3) Quick blow fuse blows at 0.5 amp.
   i. Additional Features: If and as noted.
3. Signal Interface:
   a. Switch: DPDT.
   b. Contact Rating: 5 watts dc, unless otherwise noted.
   c. Maximum Voltage: 175V dc.
   d. Maximum Switching Current: 0.25 amp dc.
4. Manufacturer and Product:
   a. George Risk Industries; intrusion switch, Model 4405-A.
   b. No substitution allowed.

K. P02 Pressure Differential Switch:

1. General:
   a. Function: Monitor differential 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 90 percent of range.
    c. Static Pressure:
        1) Operating Static Pressure: As noted.
        2) Operating static pressure must be less than switch's rated maximum static pressure.
    d. Overpressure Proof Pressure: At least 400 percent of rated maximum static pressure.
    e. Operating Temperature Range:
        1) Dependent on actuator seal materials.
        2) Buna-N Seal: 0 to 150 degrees F.
3. Features:
    a. Actuator Seal: Buna-N, unless otherwise noted.
    b. Fixed differential, unless otherwise noted.
    c. 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, D Series.
    b. United Electric; 400 Series.

L. 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:
        1) Required, unless otherwise noted. Use the following method:
            a) Liquid filled gauge front, unless otherwise noted.
                (1) Glycerine 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.
    b. Ametek U.S. Gauge; Solfrunt Model 19XX/1981Advantage.
    c. WIKA, Type 2XX.34.
    d. No substitution allowed.

M. 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) Lower Housing: 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 noted.
2) "Or-equal."
3) 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.

N. 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.

O. 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 percent 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: 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. Direct/remote Diaphragm Seal: If and as noted.
5. Signal Interface:
    a. 4 mA dc to 20 mA dc output with digital signal based on HART protocol.
    b. Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
6. Enclosure:
    a. Type: NEMA 4X, minimum, unless otherwise noted.
    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. Endress + Hauser; PMC71B.
    b. Rosemount; Model 3051 TG.
    c. Siemens; SITRANS P310 Series.

P. 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: Buna-N, unless otherwise noted.
      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 48.
   b. Dover/OPW Engineered Systems; Iso-Ring.
   c. No substitution allowed.

Q. T4 Temperature Element and Transmitter, Thermocouple:

1. General:
   a. Function: Measure temperature of process fluid and transmit analog signal proportional to temperature.
   b. Type: Thermocouple.
   c. Parts: Element, thermowell, and transmitter.
2. Service:
   a. Process Fluid: As noted.
   b. Process Temperature Range: As noted.
3. Element:
   a. Type:
      1) Single-element, unless otherwise noted.
      2) Iron-constantan, Type J, ungrounded, unless otherwise noted.
   b. Performance:
      1) Accuracy: Plus or minus 4 degrees F or plus or minus 0.75 percent of reading, whichever is greater.
   c. Features:
      1) Dimensions (Bare Element): 1/4-inch diameter.
      2) Length to accommodate thermowell insertion and extension length.
      3) Spring-loaded element when well is used.
      4) Sheath:
         a) Type 316 stainless steel, unless otherwise noted.
         b) Process Operating Temperature:
            (1) Range: Minus 320 degrees F to 1600 degrees F, unless otherwise noted.
      5) Terminal Connection Head:
         a) General purpose, NEMA 4 weatherproof, unless otherwise noted.
         b) Maximum Temperature: 220 degrees F, unless otherwise noted.
      6) Thermowell Connection: Union coupler, stainless steel, unless otherwise noted.
      7) Sensitive Length: 1.6-inch minimum, measured from closed end.
4. Thermowell:
   a. Features:
      1) Inside Diameter: Sized to match thermocouple.
      2) Material: Type 316 stainless steel, unless otherwise noted.
      3) Insertion Length: As noted.
      4) Extension Length: 3 inches, unless otherwise noted.

b. Process Connection: 1-inch NPT connection, unless otherwise noted.
c. Well Type: Threaded straight, unless otherwise noted.

5. Transmitter:
   a. Ambient Operation Conditions:
      1) Temperature: Minus 20 degrees F to 158 degrees F, with display.
      2) Relative Humidity: 0 percent to 100 percent, noncondensing.
   b. Type: Two-wire, powered by a remote power supply.
   c. Performance:
      1) Digital Accuracy: Greater of plus or minus 0.07 degree F or plus or minus 0.01 percent of span.
      2) Response Time: 1.2 second 90 percent response time for 80 percent input step, with minimum damping.
   d. Electrical Safety: Standard unless otherwise noted.
   e. Features:
      1) Indicator: Three line LCD, unless otherwise noted.
      2) Automatic reference junction compensation.
      3) Failsafe Mode:
         a) User configurable ON, unless otherwise noted.
         b) Downscale, unless otherwise noted.
      4) Electric Damping: 1.2 seconds.
   f. Signal Interface: 4 mA to 20 mA dc.
   g. Power: 24V dc external power supply.
   h. Digital Communication: HART.
      1) One HART communicator to be supplied for all HART capable transmitters, if not already supplied under another specification section.
   i. Enclosure:
      1) Materials: Epoxy-coated, low-copper aluminum, unless otherwise noted.
      2) Type: NEMA 4X.
      3) Mounting: Wall, pipe stand, or integral to thermowell, as noted.
         a) For pipe stand, provide stainless steel mounting set, unless otherwise noted.
         b) For integral thermowell mount, provide explosion-proof connection.

6. Manufacturers and Products:
   a. Invensys/Foxboro; RTT20 Series Transmitter with MINOX MT Series Thermocouple and Thermowell.
   b. Rosemount; 78 Series Platinum RTD with Thermowell and Model 3144P Transmitter.

R. Y40 Uninterruptible Power Supply 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: Sized for connected load plus 50 percent spare capacity.
   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: 85 percent minimum, unless otherwise noted.
   e. Backup Runtime:
      1) Full Load: 9 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 6 percent or less.
   h. Input Voltage Range: Plus 15 percent, minus 20 percent.
   i. Output Voltage Regulation: Plus or minus 3 percent nominal.
   j. Operating Temperature: 32 degrees F to 104 degrees F.
   k. Operating Relative Humidity: 5 percent to 95 percent without condensation.
   l. Lightning and Surge Protection:
      1) Pass lightning standard IEEE C62.41 Categories A and B tests.
      2) 2000 to 1 attenuation of input spike.
3. Features:
   a. Bypass Switch.
   b. Monitoring Relay: Module for remote monitoring of UPS status. Minimum of two relay contacts configured for:
      1) Battery LOW.
      2) UPS Fault.
      3) Power Fail.
4. Enclosure:
   a. Tower, unless otherwise noted.
   b. If rack-mount noted, unit to be suitable for mounting in a 19-inch rack.
5. Manufacturer and Product: Eaton; 9130T.

6. Manufacturers and Products:
    a. UPS: Tripp-Lite; SU-RTXL series with relay I/O card.
    b. External Battery Pack: Tripp-Lite; BP series external battery pack.
    c. Automatic Bypass Switch: Geist Power; ATR100-103R20TL5.
    d. Manual Bypass Switch: Liebert; MicroPOD MP2-130P maintenance bypass.
    e. No substitution allowed.

S. Y50 Programmable Logic Controller System:

1. In order to maximize the Owner's investment in terms of inventory and training, it is essential that PLC units where called for in specification shall strictly conform to the following. No substitution allowed:
    a. Make: Allen Bradley.
    b. Series: Control Logix.
    c. Firmware: Version 24 or latest meeting City of Tulsa standards.
    d. Module Types:
        1) CPU: 1756-L82XT; with conformal coating.
        2) Ethernet Module: 1756-EN2TR.
        3) DI: 1756-IA16.
        4) DO: 1756-OW16I wired to PLC Interface Relays.
        5) AI: 1756-IF16IH.
        6) AO: 1756-OF8.
        7) PS: 1756-PA75.
        8) Chassis: 1756-A17.
    e. Quantity: Minimum quantity as required per IO list.

T. Y99 Industrial Ethernet Switch:

1. Function: Connect industrial control devices for Ethernet communication.
2. Performance:
    a. Operating Temperature: Minus 10 degrees C to 60 degrees C.
    b. Operating Humidity: 10 percent to 95 percent non-condensing.
    c. Operation: Plug and play.
    d. Auto Sensing: Duplex, Speed, and Cable Type.
3. Approvals:
    a. FCC Part 15 Class A.
    b. UL Listed.
    c. Noise: EN 61000-6-2 and EN 61000-6-4.
    d. RoHS Compliant.
4. Features:
    a. Ports: Eight RJ-45 Ethernet 10/100BaseTX ports, minimum.
    b. Mounting: DIN-Rail.

c. Indicators:
1) Per Switch: Power.
2) Per Port: Link and Activity.

5. Power Input: 10V dc to 30V dc.
6. Manufacturers and Products:
a. Cisco; IE 3300 Series.
b. Transceivers:
1) Multi-Mode: GLC-SX-MM-RGD=.
2) Single-Mode: GLC-ZX-SM-RGD=, or as required to match offsite networking interface.

U. Y100 Local SCS Operator Interface Computer:

1. Features:
a. Aluminum Front Bezel suitable for mounting on Panel door.
b. Fan-less operation.
2. Processor: Windows-based PC with Intel Core i7 Processor, Dual Core 1.7 GHz minimum.
3. Display:
a. Size: 17-inch diagonal, Active Matrix TFT LCD.
b. Resolution: 1280 x 1024 XGA.
c. Backlight: LED.
d. Touchscreen: Single Touch Analog Resistive Touch Technology.
e. Graphics: Intel HD graphics.
f. Expansion Slot: PCIe.
4. Mass Storage: 180 GB minimum Dual RAID 1, Solid-State Hard Disk Drive with onboard RAID controller.
5. System Memory: 8 GB DDR3L 1600 SDRAM.
6. Power Supply: 24V dc.
7. Ports:
a. Serial Ports: 1 x RS232/422/485 and 1 x RS232.
b. USB Ports: 4 x USB 3.0.
c. Ethernet Ports: 2 x RJ45, 10/100/1000 Mbps.
d. Graphics Ports: 1 X VGA and 1 x HDMI.
e. Audio: 1 x Line-In and 1 x Line-Out.
8. Environmental:
a. Degree of Protection: NEMA 4, IP66 front.
b. Ambient Temperature: 32 degrees F to 122 degrees F.
c. Relative Humidity: (Non-condensing) 30 percent to 95 percent RH at 104 degrees F.
9. Cables: As required.
10. Software: Wonderware InTouch version compatible with current plant standards and supplied with new InTouch Runtime License 64K I/O, supported by the City of Tulsa’s existing support Contract No. 21090 with Standard Automation of Houston, TX. Integrate all Operator

Control Interface functions into the plant wide Wonderware InTouch system and configure to automatically download the plant wide InTouch application into the touch screens.

11. Manufacturer and Product: American Industrial Systems; Model HMI-TPND0U-17SR-X00H.

2.05 SCADA SERVERS

A. Provide two DELL PowerEdge R660 Servers. Each server shall be complete with the following:

Description	SKU
Trusted Platform Module 2.0 V6	461-AAIG
2.5" Chassis with up to 10 Hard Drives (SAS/SATA), PERC11, 1CPU	321-BKFF
Intel Xeon Gold 6526Y 2.8G, 16C/32T, 20GT/s, 37.5M Cache, Turbo, HT (195W) DDR5-5200	338-CPBV
No Additional Processor	374-BBBX
No HBM	379-BFFD
Performance Heatsink for 1 CPU Configuration (CPU less than 250W)	412-ABEH
Performance Optimized	370-AAIP
5600MT/s RDIMMs	370-BBRX
Unconfigured RAID	780-BCDS
PERC H755 SAS Front	405-AAZB
Front PERC Mechanical Parts, rear load	750-ADRI
Performance BIOS Settings	384-BBBL
UEFI BIOS Boot Mode with GPT Partition	800-BBDM
No Energy Star	387-BBEY
4 Very High Performance Fans	384-BCUJ
Dual, Hot Plug, Power Supply, Redundant (1+1) 1400W (100-240Vac)	450-AKWT
Riser Config 4, Low Profile, 2x8 LP Slots (Gen5) + 1x16 LP Slot (Gen4), 1CPU	330-BBZB

Description	SKU
Broadcom 5720 Quad Port 1GbE BASE-T Adapter, OCP NIC 3.0	540-BCOB
Broadcom 5720 Dual Port 1GbE LOM	540-BDKD
No Cables Required	470-AEYU
PowerEdge 1U LCD Bezel	325-BEUG
Dell Luggage Tag	350-BCKC
BOSS-N1 controller card + with 2 M.2 480GB (RAID 1)	403-BCRU
BOSS Cables and Bracket for R660	470-AFMG
No Quick Sync	350-BBXM
iDRAC, Legacy Password	379-BCSG
iDRAC Group Manager, Disabled	379-BCQY
Windows Server 2025 Standard, 16CORE, FI, No Med, No CAL, Multi Language	634-CVGB
Dell Connectivity Client - Disabled	379-BFXT
Dell Connectivity Module	634-CYDF
iDRAC9, Enterprise 16G	528-CTIC
Secured Component Verification	528-COYT
Dell Secure Onboarding Client Disabled	634-CZRQ
Cable Management Arm	770-BDMT
ReadyRails Sliding Rails (A15)	770-BECD
No Systems Documentation, No OpenManage DVD Kit	631-AACK
R660 Dell label (BIS) for 2.5" Chassis	343-BBTS
PowerEdge R660 No CCC, No CE Marking	343-BBTU
ProSupport 7x24 Technical Support and Assistance 5 Years	887-1064
ProSupport Next Business Day On-Site Service After Problem Diagnosis 5 Years	887-1073
Dell Hardware Limited Warranty Plus On-Site Service - 2 -	887-1076

Description	SKU
Two each - 16GB RDIMM, 5600MT/s, Single Rank	370-BBRQ
1.92TB SSD SAS, Read Intensive, up to 24Gbps 512e 2.5in Hot-Plug, AG Drive	345-BELF
Power Cord - C13, 3M, 125V, 15A (North America)	450-AALV
C13 to C14, PDU Style, 12 AMP, 6.5 Feet (2m) Power Cord, North America	492-BBDI
Windows Server 2025 Standard, 16CORE, Media Kit, MultiLang,	634-CVGJ
Windows Server 2025 Standard, 16CORE, DF Recovery Image, Multi Lang (Downgrade not included)	528-DHTW

2.06 WORKSTATION

A. General:

1. Tower chassis workstation configured to run software shown on the Drawings and in Specifications.
2. Workstation shall be installed with HMI client node, intended for the Pre-Dewatering and Thickening area process operations.

B. One Intel Quad-Core processor, 3.0 GHz or greater, minimum of 10 MB L3 cache on chip die, 2133 MHz front side bus minimum.

C. 16 GB of RAM, 2133 MHz speed minimum, 2 DIMMS maximum.

D. Expansion Slots:

1. Two Full Height PCI slots.
2. One Full Height PCI Express slot.

E. Internal Disk: 2 TB of usable storage minimum, SATA, hard drives configured in a RAID 1 array.

F. Video graphics capable of 1920 by 1200 pixels, 70 Hz refresh rate and 32-bit true color minimum. VGA, DVI, and HDMI or Display Port outputs. 512 MB of dedicated video RAM minimum. Card must be dual monitor capable.

G. I/O Ports and Devices: Minimum of four USB 2.0 ports.

H. USB Port Blockers:

1. Unused USB ports shall have port blockers installed.
2. Port Blocker: LINDY USB Port Blockers White (Part No. 40464).

I. Interface Devices:

1. Generic USB 104 key (Windows) keyboard, no hot keys onboard.
2. Two button USB optical mouse with scroll wheel.

J. Monitor:

1. LCD 27-inch nominal size minimum.
2. Native Resolution: 1920 by1080 resolution at 70 Hz minimum.
3. 16 ms response time maximum.
4. 250 nits (cd/m²) brightness minimum.
5. 400 to 1 contrast ratio minimum.
6. Vertical viewing angle of 85 degrees minimum.
7. Horizontal viewing angle of 85 degrees minimum.
8. Analog GRB, Digital DVI-D, and HDMI or Display Port video input connector types.
9. Adjustable height stand.
10. Soundbar.

K. Networking:

1. Two network cards in addition to any onboard network interface.
2. All network interfaces shall have the following features:
    a. Support for latest Microsoft operating system.
    b. Gigabit Ethernet port, copper connection accepting standard CAT6 cables for Ethernet communications.
    c. IEEE 802.3ab support for gigabit networking standard.
    d. IEEE 802.Q VLAN support.
    e. Auto sensing 10/100/1000 Mbps.
    f. SNMP manageable.

L. Power supplies shall operate at 120V ac.

M. Operating System:

1. Latest release of 64-bit Windows 11 Professional Operating System shall be compatible with facility’s existing Wonderware HMI.
2. The system shall auto boot directly to the HMI application with secure login credentials. There shall be no Windows desktop access.

N. Other Software:

1. MS Excel.
2. MS Word.

2.07 LAPTOP

A. Provide two programming Laptops. Laptop shall be fully rugged that meets or exceeds MIL-STD-810G, while offering protection in harsh environments.

B. Each Laptop shall be set up to run Allen-Bradley Studio 5000 PLC Programming development software in addition to the other software required herein. Software shall be licensed to the Owner.

C. One Intel Snapdragon® X Plus X1P-64-100 or greater.

D. 8 GB of RAM, 1333 MHz speed minimum.

E. Storage Drives: 512 GB, M.2 2230, TLC PCIe Gen4 NVMe, SSD.

F. Integrated Qualcomm® Adreno™ GPU®, Snapdragon® X Elite X1E-80-100, 12 cores, 16GB LPDDR5x Memory.

G. I/O Ports & Devices: Minimum of four USB 2.0 ports.

H. Interface Devices:

1. Compatible Docking Station.
2. Generic USB 104 key (Windows) keyboard, no hot keys onboard.
3. Two button USB optical mouse with scroll wheel.

I. Monitor:

1. LCD 20-inch nominal size minimum.
2. Native Resolution: 1920 by 1080 resolution at 70 Hz minimum.
3. 16 ms response time maximum.
4. 250 nits (cd/m²) brightness minimum.
5. 400 to 1 contrast ratio minimum.
6. Vertical viewing angle of 85 degrees minimum.
7. Horizontal viewing angle of 85 degrees minimum.
8. Analog GRB, Digital DVI-D, and HDMI or Display Port video input connector types.
9. Adjustable height stand.

J. Primary Battery: 3 Cell, 54 Wh, ExpressCharge™, ExpressCharge™ Boost Capable.

K. Power: 65W AC adapter, USB Type-C, EcoDesign.

L. Operating System:

1. Windows 11 Pro, Copilot+ PC.
2. System shall be compatible with the supplied PLC platform and facility's existing Wonderware HMI.

M. Other Software: Microsoft Office Latest version.

N. Acceptable Manufacturers:

1. Dell Latitude 7455.
2. "Or-equal."

2.08 ACCESS SERVICE SWITCH

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. CISCO Catalyst IE3300.
2. No "or-equal."

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Power Module Requirement:

1. AC input Voltage: 100V ac to 240V ac auto ranging.
2. AC frequency: 50 Hz to 60 Hz.
3. AC input current: 1.25 A.
4. Power Output: 24V dc/2.1A.
5. Power consumption: 50W.

D. Environmental:

1. Operating Temperature: Minus 40 degrees C to plus 60 degrees C.
2. Storage Temperature: Minus 40 degrees C to plus 85 degrees C.
3. Operating Humidity: 5 percent to 95 percent non-condensing.
4. Storage Humidity: 5 percent to 95 percent non-condensing.
5. Maximum Operating Altitude: 15,000 feet.

E. Physical:

1. 256 MB DRAM.
2. Microprocessor based managed type.
3. IEEE 1588v2 FPGA.
4. 19 in. DIN Rail mount kit.
5. Mini-USB connector.

F. Functional Performance:

1. Per Port status LED indication.
2. Six, ten, or 16 10/100Base-T Ethernet ports, fixed configurations with a compact form factor.
3. One gigabit SFP (100 Mbps and 1 Gbps) or RJ45 uplink DRAM.
4. Console Ports: 1x RJ45, 1x Mini USB type B and 1 x Aux. Port-RJ45.
5. Supports: EtherNet/IP (CIP), and allow integration with existing management platforms from Rockwell, static IPv4 routing and static IPv6 routing protocols.
6. Meets AS/NZS 3548, BSMI CNS 13438, CAN/CSA-E60065-00, CISPR 22 Class A.

G. Options and Accessories Required:

1. Provide minimum 2-year warranty, and 5 years limited warranty.
2. The additional modules shall be included:
   a. IP base IOS license and Security license.
   b. All the required licenses to make the switch functional as per the Plant Standard.
   c. 10/100 Port, Ethernet Switch Interface Card to support port requirement as specified in contract document.

2.09 DISTRIBUTION SERVICE SWITCH

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. CISCO IE 5000.
2. No “or-equal.”

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Power Module Requirement:

1. AC Input Voltage: 100V ac to 240V ac auto ranging.
2. AC Frequency: 50 Hz to 60 Hz.
3. AC Input Current: 2 A (110 V).
4. Power Consumption: 90W maximum.

D. Environmental:

1. Operating Temperature: Minus 40 degrees C to plus 60 degrees C
2. Operating Humidity: 5 percent to 95 percent non-condensing.
3. Storage Temperature: Minus 40 degrees C to plus 85 degrees C.
4. Maximum Operating Altitude: 13,800 feet.

E. Physical:

1. 1 GB DRAM.
2. Microprocessor based managed type.
3. Mini-USB and traditional RJ-45 console connector.
4. 19-inches rack mount kit.

F. Functional Performance:

1. Per Port status LED indication.
2. Four gigabit SFP (100 Mbps and 1 Gbps) or RJ45 uplink DRAM.
3. 24 RJ45, or 12 RJ45 and 12 SFP Fiber ports 10/100/1000Base-T Ethernet ports, fixed configurations with a compact form factor.
4. Console Ports: 1x RJ45, 1x Mini USB type B and 1x Aux. Port-RJ45.
5. Supports: EtherNet/IP (CIP), and allow integration with existing management platforms from Rockwell, static IPv4 routing and static IPv6 routing protocols.
6. Meets AS/NZS CISPR 24, UL/CSA 60950-1, EN 60068-2-60, CISPR 22 Class A.

G. Options and Accessories Required:

1. Provide minimum 2-year full warranty, and 5 years limited warranty.
2. Two sperate Switch will be provided at each location as redundant pair.
3. The additional modules shall be included:
    a. 10/100/1000 Port, Ethernet Switch Interface Card to support port requirement as specified in contract document.
    b. All the required licenses to make the switch functional as per the Plant Standard.

2.10 CORE SERVICE SWITCH

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. CISCO Catalyst 9300 Series.
2. No “or-equal.”

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Power Module Requirement:

1. AC Input Voltage: 100V ac to 240V ac auto ranging.
2. AC Frequency: 50 Hz to 60 Hz.
3. AC Input Current: 5 A to 10 A.
4. Power Consumption: 715 W maximum.

D. Environmental:

1. Normal Operating Temperature and Altitudes: Minus 5 degrees C to plus 45 degrees C, up to 5,000 feet.
2. Short-Term* Exceptional Conditions: Minus 5 degrees C to plus 50 degrees C, up to 5,000 feet (1,500m).
3. Storage Temperature: Minus 40 degrees F to 158 degrees F (Minus 40 degrees C to 70 degrees C).
4. Operating Humidity: 5 percent to 90 percent non-condensing.
5. Maximum Operating Altitude: 15,000 feet.

E. Physical:

1. 8 GB DRAM.
2. Microprocessor based managed type.
3. 19 inches rack mount kit.

F. Functional Performance:

1. Per Port status LED indication.
2. Four gigabit SFP (100 Mbps and 1 Gbps).
3. SFP Fiber ports 10/100/1000Base-T Ethernet ports, fixed configurations with a compact form factor.
4. Console Ports: 1x RJ45, 1x Mini USB type B and 1 x Aux. Port-RJ45

5. Supports: EtherNet/IP and allows integration with existing management platforms from Rockwell, static IPv4 routing and static IPv6 routing protocols.
6. Meets AS/NZS 3548 Class A, UL 60950-1, EN 55032 Class A, CISPR 32 Class A, and IEEE 802.3.

G. Options and Accessories Required:

1. Provide minimum 2-year full warranty, and 5 years limited warranty.
2. Fiber to copper converter shall be provided as needed for communications with other devices not equipped with Fiber ports.
3. The additional modules shall be included:
   a. 10/100/1000 Port, Ethernet Switch Interface Card to support port requirement as specified in contract document.
   b. All the required licenses to make the switch functional as per the Plant Standard.

PART 3 EXECUTION

3.01 GENERAL

A. Drawings for PICS Mechanical Systems are diagrammatic and not intended to specifically define element locations or piping and tubing run lengths. Base materials and installations on field measurements.

3.02 INSTALLATION

A. Mechanical Systems:

1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
2. Plastic Tubing Support: Except as shown on the 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 all 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 900 mm 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 all 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 makeup 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 300 mm 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.

B. Wiring: Refer to Section 40 90 00, Instrumentation and Control for Process Systems, and Division 26, Electrical.

C. Electromagnetic Flowmeters:

1. Connect grounding straps to flowmeter flanges and adjoining pipe flanges or grounding rings. Connect grounding straps to a grounded metal potable water supply pipe at building entrance.
2. Install grounding rings where adjoining piping is non-metallic or lined with a non-metallic material such as mortar.

D. Ultrasonic Level Transducers:

1. Mount transducers to avoid interference of ultrasonic beam with walls, pipes, conduits, ladders, floats, cables and objects other than liquid surface to be measured.
2. Mount transducers face a minimum of 12 inches above the highest liquid level to be measured.

3. Provide aluminum support arms and stiffeners for non-flange mounted transducers and non-pendant mounted transducers.

E. Lighting Arresters: Connect lightning arrester ground terminal to main ground lug at MCC other locations prescribed by manufacturer's instructions via low resistance wiring.

F. Stilling Wells:

1. Provide all brackets, hooks, and fasteners be stainless steel or hot dipped galvanized welded pieces.
2. Provide stilling wells where indicated. Stilling wells to be Schedule 80, 12 inch diameter PVC pipe.
3. Cut bottom of stilling well on 45-degree angle.
4. Bottom of stilling well to be located at or below inlet invert to pumps. Top of stilling well to be located no less than (a) 12 inches above nearest overflow, if overflow is via a weir plate, or (b) above 24 inches above nearest overflow, if overflow is directly into an overflow pipe without a weir plate.
5. Provide a pair of hooks for storing excess cable.

G. 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.

3.03 FIELD QUALITY CONTROL

A. In accordance with Section 40 90 00, Instrumentation and Control for Process Systems.

3.04 MANUFACTURER'S SERVICES

A. Specialty Equipment:

1. For following equipment provide services of a qualified manufacturer's representative during installation, startup, demonstration testing, and Owner training. Provide original equipment manufacturer's services for:
   a. Ultrasonic Flow Measurement Instrument.

3.05 TRAINING

A. Refer to Section 40 90 00, Instrumentation and Control for Process Systems.

B. Operations Training: For Owner's operations personnel on operation of instruments and panel components.

1. Trainer: PICs supplier.
2. Training Session Duration: 2 instructor days.
3. Number of Training Sessions: Three.
4. Location: Project Site.
5. Content: Conduct training on loop-by-loop basis.
    a. Loop Functions: Understanding of loop functions, including interlocks for each loop.
    b. Loop Operation: For example, adjusting process variable set points, equipment troubleshooting, AUTO and MANUAL control, and alarm resetting.
    c. Interfaces with PICS Subsystems.

C. Maintenance Training:

1. Trainer: PICs supplier.
2. Training Session Duration: 2 instructor days.
3. Number of Training Sessions: Three.
4. Location: Project Site.
5. Content: Provide training for each type of component and function provided.
    a. Loop Functions: Understanding details of each component and how they function.
    b. Component calibration.
    c. Adjustments: For example, controller configuration, current switch trip points, and similar items.
    d. Troubleshooting and diagnosis for and components.
    e. Replacing lamps, chart paper, fuses.
    f. Instrumentation components removal and replacement.
    g. Periodic maintenance.

3.06 CLEANING

A. Prior to closing system using tubing, clear all tubing of interior moisture and debris.

B. Clean all interior and exterior surfaces of control panels and field enclosures.

C. Clean all exterior surfaces and terminal compartment of instruments.

3.07 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this specification:

1. Instrument Index.
2. PLC I/O List.
3. Control Panel Schedule.
4. Surge Suppressor Products Table.

END OF SECTION

INSTRUMENT INDEX

TAG NO	ACCESSORY TAG	DESCRIPTION	CODE	TYPE	COMPONENT OPTIONS	SURGE SUPPRESSION DETAIL	DESIGN DETAIL	P&ID	NOTES
H040-WAS1-FMT01	FE11	WAS PUMPS INTAKE FLOW INDICATOR	F04	ELECTROMAGNETIC FLOW INDICATING TRANSMITTER	Transmitter: Remote. Process Fluid: Waste Activated Sludge. Range: 100 - 1200 gpm Installation: Inline Liner: Hard Rubber Electrode: 316L Pipe Size: 8"	4091-420US	4091-222M	09-N-0001	TRANSMITTER: RACK MOUNTED, INDOOR
PI12	PE12	WAS PUMP NO. 1 DISCHARGE PRESSURE GAUGE/INDICATOR	P04	PRESSURE GAUGE, ANNULAR SEAL	**Range:** 0-20 psig	N/A	4091-304	09-N-0001	
PI14	PE14	WAS PUMP NO. 2 DISCHARGE PRESSURE GAUGE/INDICATOR	P04	PRESSURE GAUGE, ANNULAR SEAL	**Range:** 0-20 psig	N/A	4091-304	09-N-0001	
PI16	PE16	WAS PUMP NO. 3 DISCHARGE PRESSURE GAUGE/INDICATOR	P04	PRESSURE GAUGE, ANNULAR SEAL	**Range:** 0-20 psig	N/A	4091-304	09-N-0001	
PI11	PE11	WAS PUMP NO. 1 INTAKE PRESSURE GAUGE/INDICATOR	P04	PRESSURE GAUGE, ANNULAR SEAL	**Range:** 0-20 psig	N/A	4091-304	09-N-0001	
PI13	PE13	WAS PUMP NO. 2 INTAKE PRESSURE GAUGE/INDICATOR	P04	PRESSURE GAUGE, ANNULAR SEAL	**Range:** 0-20 psig	N/A	4091-304	09-N-0001	
PI15	PE15	WAS PUMP NO. 3 INTAKE PRESSURE GAUGE/INDICATOR	P04	PRESSURE GAUGE, ANNULAR SEAL	**Range:** 0-20 psig	N/A	4091-304	09-N-0001	
H040-WAS1-PRS02	PE12	WAS PUMP NO. 1 HIGH DISCHARGE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	**Seal Material:** PTFE **High Setpoint:** 11 psig **Body Material:** 316L	N/A	4091-304	09-N-0001	
H040-WAS1-PRS04	PE14	WAS PUMP NO. 2 HIGH DISCHARGE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	**Seal Material:** PTFE **High Setpoint:** 11 psig **Body Material:** 316L	N/A	4091-304	09-N-0001	
H040-WAS1-PRS06	PE16	WAS PUMP NO. 3 HIGH DISCHARGE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	**Seal Material:** PTFE **High Setpoint:** 11 psig **Body Material:** 316L	N/A	4091-304	09-N-0001	
H040-WAS1-PRS01	PE11	WAS PUMP NO. 1 LOW INTAKE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	**Seal Material:** PTFE **Low Setpoint**: 2 psig **Body Material:** 316L	N/A	4091-304	09-N-0001	
H040-WAS1-PRS03	PE13	WAS PUMP NO. 2 LOW INTAKE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	**Seal Material:** PTFE **Low Setpoint**: 2 psig **Body Material:** 316L	N/A	4091-304	09-N-0001	
H040-WAS1-PRS05	PE15	WAS PUMP NO. 3 LOW INTAKE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	**Seal Material:** PTFE **Low Setpoint**: 2 psig **Body Material:** 316L	N/A	4091-304	09-N-0001	
H050-FCL1-LIT01		SCUM TANK RADAR LEVEL INDICATOR	L07	RADAR LEVEL INDICATING TRANSMITTER	Transmitter: Integral. Power: 24VDC (loop powered). Beam Angle: 4 degrees. Instrument Range: 131 feet. Instrument Span: 0 to 16 feet. Blanking Distance: 15 inch. Mount: Cantilever Arm. Accessories: Sunshield. Stainless Steel Tag.	N/A	4091-251	09-N-0002	
LSH21		SCUM TANK HIGH FLOAT LEVEL SWITCH	L18	FLOAT LEVEL SWITCH	**Setpoint**: 596.50 feet.	N/A	4091-249	09-N-0002	
LSHH21		SCUM TANK HIGH HIGH FLOAT LEVEL SWITCH	L18	FLOAT LEVEL SWITCH	**Setpoint**: 596.75 feet.	N/A	4091-249	09-N-0002	
LSLL21		SCUM TANK LOW LOW FLOAT LEVEL SWITCH	L18	FLOAT LEVEL SWITCH	**Setpoint**: 593.50 feet.	N/A	4091-249	09-N-0002	
H050-FCL1-PTM01	PE21	SECONDARY SCUM PUMP NO. 1 PRESSURE INDICATING TRANSMITTER	P09, P15	PRESSURE INDICATING TRANSMITTER, ANNULAR SEAL	**Range:** 0-20 psig	N/A	4091-304	09-N-0002	
H050-FCL1-PTM02	PE22	SECONDARY SCUM PUMP NO. 2 PRESSURE INDICATING TRANSMITTER	P09, P15	PRESSURE INDICATING TRANSMITTER, ANNULAR SEAL	**Range:** 0-20 psig	N/A	4091-304	09-N-0002	
H050-FCL1-PRS01	PE21	SECONDARY SCUM PUMP NO. 1 HIGH DISCHARGE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	**Seal Material:** PTFE **High Setpoint:** 16 psig **Body Material:** 316L	N/A	4091-304	09-N-0002	
H050-FCL1-PRS02	PE22	SECONDARY SCUM PUMP NO. 2 HIGH DISCHARGE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	**Seal Material:** PTFE **High Setpoint:** 16 psig **Body Material:** 316L	N/A	4091-304	09-N-0002	
H070-RDT1-FMT01		RDT BYPASS CONTROL VALVE BOX FLOW INDICATOR	F04	ELECTROMAGNETIC FLOW INDICATING TRANSMITTER	**Transmitter**: Integral **Process Fluid**: Sludge. **Range**: 0 - 1200 gpm **Installation**: Inline **Liner**: Hard Rubber **Electrode**: 316L **Pipe Size**: 6"	4091-420US	4091-222M	09-N-0004	Located in vault subject to flooding.
H090-DEW1-LIT01		SLUDGE HOLDING TANK NO. 1 RADAR LEVEL INDICATOR	L07	RADAR LEVEL INDICATING TRANSMITTER	**Transmitter**: Integral. **Power**: 24VDC (loop powered). **Beam Angle**: 4 degrees. **Instrument Range**: 131 feet. **Instrument Span**: 0 to 20 feet. **Blanking Distance**: 15.75 inch **Mount**: Cantilever Arm. **Accessories**: Sunshield. Stainless Steel Tag.	4091-420US	4091-251	09-N-0004	
PI31	PE31	BLOWER NO. 1 DISCHARGE PRESSURE GAUGE	P04	PRESSURE GAUGE	**Range:** 0-20 psig	N/A	4091-304B	09-N-0004	
PI32	PE32	BLOWER NO. 2 DISCHARGE PRESSURE GAUGE	P04	PRESSURE GAUGE	**Range:** 0-20 psig	N/A	4091-304B	09-N-0004	
PI33	PE33	BLOWER NO. 3 DISCHARGE PRESSURE GAUGE	P04	PRESSURE GAUGE	**Range:** 0-20 psig	N/A	4091-304B	09-N-0004	
H090-DEW2-PRS01	PE31	BLOWER NO. 1 HIGH DISCHARGE PRESSURE SWITCH	P08	PRESSURE SWITCH	**Seal Material:** PTFE **High Setpoint:** 13.5 psig **Body Material:** 316L	N/A	4091-304B	09-N-0004	
H090-DEW2-PRS02	PE32	BLOWER NO. 2 HIGH DISCHARGE PRESSURE SWITCH	P08	PRESSURE SWITCH	**Seal Material:** PTFE **High Setpoint:** 13.5 psig **Body Material:** 316L	N/A	4091-304B	09-N-0004	
H090-DEW2-PRS03	PE33	BLOWER NO. 3 HIGH DISCHARGE PRESSURE SWITCH	P08	PRESSURE SWITCH	**Seal Material:** PTFE **High Setpoint:** 13.5 psig **Body Material:** 316L	N/A	4091-304B	09-N-0004	
H090-DEW2-PTM03	PE35	RECIRCULATION PUMP NO. 1 DISCHARGE PRESSURE INDICATING TRANSMITTER	P09, P15	PRESSURE INDICATING TRANSMITTER, ANNULAR SEAL	**Process Fluid**: Sludge. **Range**: 0 - 25 psi. **Size**: 2 inch	4091-415AG	4091-304	09-N-0004	
H090-DEW2-PTM04	PE36	RECIRCULATION PUMP NO. 2 INTAKE PRESSURE INDICATING TRANSMITTER	P09, P15	PRESSURE INDICATING TRANSMITTER, ANNULAR SEAL	**Process Fluid**: Sludge. **Range**: -15 - 25 psi. **Size**: 2 inch.	4091-415AG	4091-302	09-N-0004	
H090-DEW2-PTM05	PE37	RECIRCULATION PUMP NO. 2 DISCHARGE PRESSURE INDICATING TRANSMITTER	P09, P15	PRESSURE INDICATING TRANSMITTER, ANNULAR SEAL	**Process Fluid**: Sludge. **Range**: 0 - 25 psi. **Size**: 2 inch	4091-415AG	4091-302	09-N-0004	
H090-DEW2-PTM01		SLUDGE HOLDING TANK NO. 1 PRESSURE INDICATING TRANSMITTER	P8, P09	PRESSURE INDICATING TRANSMITTER	Process Fluid: Air. Range: 0 - 13.5 psig Size: 12" Type: Off-line.	4091-415AG	4091-302	09-N-0004	
H090-DEW2-PTM02	PE34	RECIRCULATION PUMP NO. 1 INTAKE PRESSURE INDICATING TRANSMITTER	P8, P09	PRESSURE INDICATING TRANSMITTER	**Process Fluid**: Sludge. **Range**: -15 - 25 psi. **Size**: 2 inch.	4091-415AG	4091-304	09-N-0004	
H090-DEW2-PRS05	PE35	RECIRCULATION PUMP NO. 1 HIGH DISCHARGE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	**Seal Material:** PTFE **High Setpoint:** 23 psi **Body Material:** 316L	N/A	4091-304	09-N-0004	
H090-DEW2-PRS07	PE37	RECIRCULATION PUMP NO. 2 HIGH DISCHARGE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	**Seal Material:** PTFE **High Setpoint:** 23 psi **Body Material:** 316L	N/A	4091-304	09-N-0004	
H090-DEW2-PRS04	PE34	RECIRCULATION PUMP NO. 1 LOW INTAKE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	**Seal Material:** PTFE **Low Setpoint**: -5 psi **Body Material:** 316L	N/A	4091-304	09-N-0004	
H090-DEW2-PRS06	PE36	RECIRCULATION PUMP NO. 2 LOW INTAKE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	**Seal Material:** PTFE **Low Setpoint**: -5 psi **Body Material:** 316L	N/A	4091-304	09-N-0004	
H090-DEW1-MTR01	AI41	SLUDGE FEED PUMP GRINDER NO. 1 SUSPENDED SOLIDS ANALYZER	D07	ANALYZING INDICATING TRANSMITTER	Enclosure: NEMA 4X Dual Digital Channel Analytical Indicating Transmitter Digital Communication: Modbus RTU / RS-485. Contacts: 4 SPDT. Process Fluid: Sludge Range: Turbidity - 0 to 20,000 NTU. Installation: Interconnecting cable, 25 feet or longer.	4091-420US	4091-400	09-N-0005	Analytical Indicating Transmitter mounted on equipment rack on Clarifier No. 4 walkway, mounted in 316 Stainless Steel, NEMA 4X enclosure (powder coated white) mounted under a 316 stainless steel sun shield (powder coated white) with glare shield and type "SS-4" surge suppression. 4–20 mA dc/Digital HART® Protocol.
H090-DEW1-FMT01	FE41	SUPPLEMENTAL SLUDGE/POLYMER MIXER NO. 1 FLOW INDICATOR	F04	ELECTROMAGNETIC FLOW INDICATING TRANSMITTER	Transmitter: Remote Process Fluid: Sludge. (2.5-5% TS) Range: 0-300 gpm Installation: Inline Liner: Hard Rubber Electrode: 316L Pipe Size: 4"	4091-420US	4091-222M	09-N-0005	TRANSMITTER: RACK MOUNTED, INDOOR

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TAG NO	ACCESSORY TAG	DESCRIPTION	CODE	TYPE	COMPONENT OPTIONS	SURGE SUPPRESSION DETAIL	DESIGN DETAIL	P&ID	NOTES
H090-DEW1-FMT02	FE42	SUPPLEMENTAL SLUDGE/POLYMER MIXER NO. 2 FLOW INDICATOR	F04	ELECTROMAGNETIC FLOW INDICATING TRANSMITTER	Transmitter: Remote Process Fluid: Sludge. (2.5-5% TS) Range: 0-300 gpm Installation: Inline Liner: Hard Rubber Electrode: 316L Pipe Size: 4"	4091-420US	4091-222M	09-N-0005	TRANSMITTER: RACK MOUNTED, INDOOR
H090-DEW1-FMT03	FE43	SUPPLEMENTAL SLUDGE/POLYMER MIXER NO. 3 FLOW INDICATOR	F04	ELECTROMAGNETIC FLOW INDICATING TRANSMITTER	Transmitter: Remote Process Fluid: Sludge. (2.5-5% TS) Range: 0-300 gpm Installation: Inline Liner: Hard Rubber Electrode: 316L Pipe Size: 4"	4091-420US	4091-222M	09-N-0005	TRANSMITTER: RACK MOUNTED, INDOOR
LSH41		DEWATERING BUILDING BASEMENT SUMP FLOODING LEVEL SWITCH	L08	LEVEL SWITCH, CAPACITANCE TYPE	Setpoint: 2 inch.	N/A	4091-027	09-N-0005	
PI42	PE42	SLUDGE FEED PUMP NO. 1 DISCHARGE PRESSURE GAUGE	P04	PRESSURE GAUGE, ANNULAR SEAL	Range: 0-100 psig	N/A	4091-304	09-N-0005	
PI44	PE44	SLUDGE FEED PUMP NO. 2 DISCHARGE PRESSURE GAUGE	P04	PRESSURE GAUGE, ANNULAR SEAL	Range: 0-100 psig	N/A	4091-304	09-N-0005	
PI46	PE46	SLUDGE FEED PUMP NO. 3 DISCHARGE PRESSURE GAUGE	P04	PRESSURE GAUGE, ANNULAR SEAL	Range: 0-100 psig	N/A	4091-304	09-N-0005	
PI41	PE41	SLUDGE FEED PUMP NO. 1 INTAKE PRESSURE GAUGE	P04	PRESSURE GAUGE, ANNULAR SEAL	Range: 0-100 psig	N/A	4091-304	09-N-0005	
PI43	PE43	SLUDGE FEED PUMP NO. 2 INTAKE PRESSURE GAUGE	P04	PRESSURE GAUGE, ANNULAR SEAL	Range: 0-100 psig	N/A	4091-304	09-N-0005	
PI45	PE45	SLUDGE FEED PUMP NO. 3 INTAKE PRESSURE GAUGE	P04	PRESSURE GAUGE, ANNULAR SEAL	Range: 0-100 psig	N/A	4091-304	09-N-0005	
H090-DEW1-PRS02	PE42	SLUDGE FEED PUMP NO. 1 HIGH DISCHARGE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	Seal Material: PTFE High Setpoint: 95 psi Body Material: 316L	N/A	4091-304	09-N-0005	
H090-DEW1-PRS04	PE44	SLUDGE FEED PUMP NO. 2 HIGH DISCHARGE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	Seal Material: PTFE High Setpoint: 95 psi Body Material: 316L	N/A	4091-304	09-N-0005	
H090-DEW1-PRS06	PE46	SLUDGE FEED PUMP NO. 3 HIGH DISCHARGE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	Seal Material: PTFE High Setpoint: 95 psi Body Material: 316L	N/A	4091-304	09-N-0005	
H090-DEW1-PRS01	PE41	SLUDGE FEED PUMP NO. 1 LOW INTAKE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	Seal Material: PTFE Low Setpoint: 5 psig Body Material: 316L	N/A	4091-304	09-N-0005	
H090-DEW1-PRS03	PE43	SLUDGE FEED PUMP NO. 2 LOW INTAKE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	Seal Material: PTFE Low Setpoint: 5 psig Body Material: 316L	N/A	4091-304	09-N-0005	
H090-DEW1-PRS05	PE45	SLUDGE FEED PUMP NO. 3 LOW INTAKE PRESSURE SWITCH	P8, P15	PRESSURE SWITCH, ANNULAR SEAL	Seal Material: PTFE Low Setpoint: 5 psig Body Material: 316L	N/A	4091-304	09-N-0005	
H090-DEW1-PRS21		ODOROUS AIR FAN NO. 1 PRESSURE DIFFERENTIAL SWITCH	P02	PRESSURE AND PRESSURE DIFFERENTIAL SWITCH	Process Fluid: Air Range: 0 - 10" W.C.	N/A	4091-300	09-N-0006	
H090-DEW1-FMT04		CENTRIFUGE NO. 1 FLOW INDICATOR FROM POLYMER BLENDING UNITS	F04	ELECTROMAGNETIC FLOW INDICATING TRANSMITTER	Transmitter: Integral Process Fluid: Polymer. Range: 0-100 gpm Installation: Inline Liner: PTFE Electrode: 316L Pipe Size: 2 1/2"	4091-420US	4091-222M	09-N-0008	
H090-DEW1-FMT05		CENTRIFUGE NO. 2 FLOW INDICATOR FROM POLYMER BLENDING UNITS	F04	ELECTROMAGNETIC FLOW INDICATING TRANSMITTER	Transmitter: Integral Process Fluid: Polymer. Range: 0-100 gpm Installation: Inline Liner: PTFE Electrode: 316L Pipe Size: 2 1/2"	4091-420US	4091-222M	09-N-0008	
H090-DEW1-FMT06		CENTRIFUGE NO. 3 FLOW INDICATOR FROM POLYMER BLENDING UNITS	F04	ELECTROMAGNETIC FLOW INDICATING TRANSMITTER	Transmitter: Integral Process Fluid: Polymer. Range: 0-100 gpm Installation: Inline Liner: PTFE Electrode: 316L Pipe Size: 2 1/2"	4091-420US	4091-222M	09-N-0008	
H090-DEW1-LIT02	LE62	POLYMER BULK STORAGE TANK RADAR LEVEL INDICATOR	L07	RADAR LEVEL INDICATING TRANSMITTER	Transmitter: Integral. Power: 24VDC (loop powered). Beam Angle: 4 degrees. Instrument Range: 131 feet. Instrument Span: 0 to 12.25 feet. Blanking Distance: 15 inch Mount: 6 inch, 316 Stainless Steel flange. Accessories: Sunshield. Stainless Steel Tag.	4091-415AG	4091-257	09-N-0008	
LSH61		POLYMER CONTAINMENT AREA FLOOD LEVEL SWITCH	L08	LEVEL SWITCH, CAPACITANCE TYPE	Setpoint: 2 inch.	N/A	4091-027	09-N-0008	
PI68	PE68	POLYMER RECIRCULATION PUMP NO. 1 DISCHARGE PRESSURE GAUGE	P04	PRESSURE GAUGE, DIAPHRAGM SEAL	Range: 0-20 psig	N/A	4091-302	09-N-0008	
PI67	PE67	POLYMER RECIRCULATION PUMP NO. 1 INTAKE PRESSURE GAUGE	P04	PRESSURE GAUGE, DIAPHRAGM SEAL	Range: 0-20 psig	N/A	4091-302	09-N-0008	
H090-DEW1-PRS08	PE68	POLYMER RECIRCULATION PUMP NO. 1 HIGH DISCHARGE PRESSURE SWITCH	P08, P06	PRESSURE SWITCH, DIAPHRAGM SEAL	Process Fluid: Polymer. High Setpoint: 15 psi	N/A	4091-302	09-N-0008	
H090-DEW1-PRS07	PE67	POLYMER RECIRCULATION PUMP NO. 1 LOW INTAKE PRESSURE SWITCH	P08, P06	PRESSURE SWITCH, DIAPHRAGM SEAL	Process Fluid: Polymer. Low Setpoint: 0 psi	N/A	4091-302	09-N-0008	
H090-DEW1-FMT07	FE57	CENTRATE WET WELL DISCHARGE FLOW INDICATOR	F04	ELECTROMAGNETIC FLOW INDICATING TRANSMITTER	Transmitter: Remote Process Fluid: Centrate. Range: 0-750 gpm Installation: Inline Liner: Hard Rubber Electrode: 316L Pipe Size: 6"	4091-420US	4091-222M	09-N-0009	RACK MOUNTED, INDOOR
LSH55		DEWATERING FACILITY BASEMENT FLOOD LEVEL SWITCH	L08	LEVEL SWITCH, CAPACITANCE TYPE	Setpoint: 2 inch.	N/A	4091-027	09-N-0009	
LSH54		CENTRATE WET WELL HIGH FLOAT LEVEL SWITCH	L18	FLOAT LEVEL SWITCH	Setpoint: 599.35 feet.	N/A	4091-249	09-N-0009	
LSHH54		CENTRATE WET WELL HIGH HIGH FLOAT LEVEL SWITCH	L18	FLOAT LEVEL SWITCH	Setpoint: 600.75 feet.	N/A	4091-249	09-N-0009	
LSL54		CENTRATE WET WELL LOW FLOAT LEVEL SWITCH	L18	FLOAT LEVEL SWITCH	Setpoint: 594.9 feet.	N/A	4091-249	09-N-0009	
LSLL54		CENTRATE WET WELL LOW LOW FLOAT LEVEL SWITCH	L18	FLOAT LEVEL SWITCH	Setpoint: 593.5 feet.	N/A	4091-249	09-N-0009	
H090-DEW1-LIT03		CENTRATE WET WELL SUBMERSIBLE LEVEL INDICATOR	L42	LEVEL ELEMENT, SUBMERSIBLE	Transmitter: Integral. Power: 24VDC (loop powered). Instrument Span: 0 to 10 feet. Mount: 6 inch, 316 Stainless Steel flange. Cable, approximately 30.5 feet. Accessories: Stainless Steel Tag. Indicator: Local.	N/A	4091-266AG 4091-267AG	09-N-0009	
PI56	PE56	CENTRATE PUMP NO. 1 DISCHARGE PRESSURE GAUGE	P04	PRESSURE GAUGE, DIAPHRAGM SEAL	Range: 0-50 psig	N/A	4091-302	09-N-0009	
PI58	PE58	CENTRATE PUMP NO. 2 DISCHARGE PRESSURE GAUGE	P04	PRESSURE GAUGE, DIAPHRAGM SEAL	Range: 0-50 psig	N/A	4091-302	09-N-0009	
PI50	PE50	CENTRATE PUMP NO. 3 DISCHARGE PRESSURE GAUGE	P04	PRESSURE GAUGE, DIAPHRAGM SEAL	Range: 0-50 psig	N/A	4091-302	09-N-0009	
PI55	PE55	CENTRATE PUMP NO. 1 INTAKE PRESSURE GAUGE	P04	PRESSURE GAUGE, DIAPHRAGM SEAL	Range: 0-50 psig	N/A	4091-302	09-N-0009	
PI57	PE57	CENTRATE PUMP NO. 2 INTAKE PRESSURE GAUGE	P04	PRESSURE GAUGE, DIAPHRAGM SEAL	Range: 0-50 psig	N/A	4091-302	09-N-0009	
PI59	PE59	CENTRATE PUMP NO. 3 INTAKE PRESSURE GAUGE	P04	PRESSURE GAUGE, DIAPHRAGM SEAL	Range: 0-50 psig	N/A	4091-302	09-N-0009	
H090-DEW1-PRS16	PE56	CENTRATE PUMP NO. 1 HIGH DISCHARGE PRESSURE SWITCH	P08, P06	PRESSURE SWITCH, DIAPHRAGM SEAL	Seal Material: PTFE High Setpoint: 21 psig Body Material: 316L	N/A	4091-302	09-N-0009	
H090-DEW1-PRS18	PE58	CENTRATE PUMP NO. 2 HIGH DISCHARGE PRESSURE SWITCH	P08, P06	PRESSURE SWITCH, DIAPHRAGM SEAL	Seal Material: PTFE High Setpoint: 21 psig Body Material: 316L	N/A	4091-302	09-N-0009	
H090-DEW1-PRS20	PE50	CENTRATE PUMP NO. 3 HIGH DISCHARGE PRESSURE SWITCH	P08, P06	PRESSURE SWITCH, DIAPHRAGM SEAL	Seal Material: PTFE High Setpoint: 21 psig Body Material: 316L	N/A	4091-302	09-N-0009	
H090-DEW1-PRS15	PE55	CENTRATE PUMP NO. 1 LOW INTAKE PRESSURE SWITCH	P08, P06	PRESSURE SWITCH, DIAPHRAGM SEAL	Seal Material: PTFE Low Setpoint: 0 psig Body Material: 316L	N/A	4091-302	09-N-0009	
H090-DEW1-PRS17	PE57	CENTRATE PUMP NO. 2 LOW INTAKE PRESSURE SWITCH	P08, P06	PRESSURE SWITCH, DIAPHRAGM SEAL	Seal Material: PTFE Low Setpoint: 0 psig Body Material: 316L	N/A	4091-302	09-N-0009	
H090-DEW1-PRS19	PE59	CENTRATE PUMP NO. 3 LOW INTAKE PRESSURE SWITCH	P08, P06	PRESSURE SWITCH, DIAPHRAGM SEAL	Seal Material: PTFE Low Setpoint: 0 psig Body Material: 316L	N/A	4091-302	09-N-0009	
H095-COM2-FMT01		BIOFILTER FAN NO. 1 DISCHARGE FLOW INDICATOR	F51	FLOW ELEMENT AND TRANSMITTER, THERMAL MASS FLOW	Transmitter: Remote Process Fluid: Foul Air Range: 0 - 25,000 scfm Installation: Probe Pipe Size: 30"	4091-420US	4091-217 4091-380	09-N-0013	

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TAG NO	ACCESSORY TAG	DESCRIPTION	CODE	TYPE	COMPONENT OPTIONS	SURGE SUPPRESSION DETAIL	DESIGN DETAIL	P&ID	NOTES
H095-COM2-FMT02		BIOFILTER FAN NO. 2 DISCHARGE FLOW INDICATOR	F51	FLOW ELEMENT AND TRANSMITTER, THERMAL MASS FLOW	**Transmitter:** Remote **Process Fluid:** Foul Air **Range:** 0 - 25,000 scfm **Installation:** Probe **Pipe Size:** 30"	4091-420US	4091-217 4091-380	09-N-0013	
H095-COM2-PTM01		BIOFILTER FAN NO. 1 DISCHARGE PRESSURE INDICATING TRANSMITTER	P09, P06	PRESSURE INDICATING TRANSMITTER, DIAPHRAGM SEAL	**Process Fluid:** Foul Air **Range:** 0 - 11" W.C.	4091-415AG	4091-302	09-N-0013	
H095-COM2-PTM02		BIOFILTER FAN NO. 2 DISCHARGE PRESSURE INDICATING TRANSMITTER	P09, P06	PRESSURE INDICATING TRANSMITTER, DIAPHRAGM SEAL	**Process Fluid:** Foul Air **Range:** 0 - 11" W.C.	4091-415AG	4091-302	09-N-0013	
H095-COM2-TTM31		BIOFILTER FAN NO. 1 DISCHARGE TEMPERATURE INDICATOR	T4	TEMPERATURE INDICATING TRANSMITTER	**Process Fluid:** Foul Air **Range:** 0 - 140 degrees F	4091-420US	4091-068	09-N-0013	
H095-COM2-TTM32		BIOFILTER FAN NO. 2 DISCHARGE TEMPERATURE INDICATOR	T4	TEMPERATURE INDICATING TRANSMITTER	**Process Fluid:** Foul Air **Range:** 0 - 140 degrees F	4091-420US	4091-068	09-N-0013	
LSH91		SANITARY LIFT STATION HIGH FLOAT LEVEL SWITCH	L18	FLOAT LEVEL SWITCH	**Setpoint:** 581.5 feet.	N/A	4091-249	09-N-0015	
LSHH91		SANITARY LIFT STATION HIGH HIGH FLOAT LEVEL SWITCH	L18	FLOAT LEVEL SWITCH	**Setpoint:** 583.25 feet.	N/A	4091-249	09-N-0015	
LSL91		SANITARY LIFT STATION LOW FLOAT LEVEL SWITCH	L18	FLOAT LEVEL SWITCH	**Setpoint:** 580 feet.	N/A	4091-249	09-N-0015	

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID NO.
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AI	H095-COM1	MXR01-WI	COMPOST MIXER NO. 1 WEIGHT	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AI	H095-COM1	MXR02-WI	COMPOST MIXER NO. 2 WEIGHT	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	CNV01-IR	COMPOST CONVEYOR NO. 1 "IN REMOTE" STATUS	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	CNV01-MN	COMPOST CONVEYOR NO. 1 "RUNNING" STATUS	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI		HS79-ES	COMPOST CONVEYOR NO. 1 EMERGENCY STOP	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	CNV01-XF	COMPOST CONVEYOR NO. 1 FAIL	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	CNV02-IR	COMPOST CONVEYOR NO. 2 "IN REMOTE" STATUS	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	CNV02-MN	COMPOST CONVEYOR NO. 2 "RUNNING" STATUS	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI		HS80-ES	COMPOST CONVEYOR NO. 2 EMERGENCY STOP	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	CNV02-XF	COMPOST CONVEYOR NO. 2 FAIL	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	MXR01-IR	COMPOST MIXER NO. 1 "IN REMOTE" STATUS	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	MXR01-MN	COMPOST MIXER NO. 1 "RUNNING" STATUS	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI		HS77-ES	COMPOST MIXER NO. 1 EMERGENCY STOP	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	MXR01-XF	COMPOST MIXER NO. 1 FAIL	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	MXR02-IR	COMPOST MIXER NO. 2 "IN REMOTE" STATUS	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	MXR02-MN	COMPOST MIXER NO. 2 "RUNNING" STATUS	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI		HS78-ES	COMPOST MIXER NO. 2 EMERGENCY STOP	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	MXR02-XF	COMPOST MIXER NO. 2 FAIL	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	CNV01-MD	COMPOST CONVEYOR NO. 1 RUN COMMAND	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	CNV02-MD	COMPOST CONVEYOR NO. 2 RUN COMMAND	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	MXR01-MD	COMPOST MIXER NO. 1 RUN COMMAND	09-N-0011

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID NO.
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	MXR02-MD	COMPOST MIXER NO. 2 RUN COMMAND	09-N-0011
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM1	FAN01-SI	COMPOST FAN NO. 1 SPEED FEEDBACK	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM1	FAN10-SI	COMPOST FAN NO. 10 SPEED FEEDBACK	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM1	FAN02-SI	COMPOST FAN NO. 2 SPEED FEEDBACK	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM1	FAN03-SI	COMPOST FAN NO. 3 SPEED FEEDBACK	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM1	FAN04-SI	COMPOST FAN NO. 4 SPEED FEEDBACK	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM1	FAN05-SI	COMPOST FAN NO. 5 SPEED FEEDBACK	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM1	FAN06-SI	COMPOST FAN NO. 6 SPEED FEEDBACK	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM1	FAN07-SI	COMPOST FAN NO. 7 SPEED FEEDBACK	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM1	FAN08-SI	COMPOST FAN NO. 8 SPEED FEEDBACK	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM1	FAN09-SI	COMPOST FAN NO. 9 SPEED FEEDBACK	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM1	FAN01-SI	COMPOST FAN NO. 1 SPEED COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM1	FAN10-SI	COMPOST FAN NO. 10 SPEED COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM1	FAN02-SI	COMPOST FAN NO. 2 SPEED COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM1	FAN03-SI	COMPOST FAN NO. 3 SPEED COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM1	FAN04-SI	COMPOST FAN NO. 4 SPEED COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM1	FAN05-SI	COMPOST FAN NO. 5 SPEED COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM1	FAN06-SI	COMPOST FAN NO. 6 SPEED COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM1	FAN07-SI	COMPOST FAN NO. 7 SPEED COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM1	FAN08-SI	COMPOST FAN NO. 8 SPEED COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM1	FAN09-SI	COMPOST FAN NO. 9 SPEED COMMAND	09-N-0012

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID NO.
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN01-IR	COMPOST FAN NO. 1 "IN REMOTE" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN01-MN	COMPOST FAN NO. 1 "RUNNING" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN01-XF	COMPOST FAN NO. 1 FAIL	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN10-IR	COMPOST FAN NO. 10 "IN REMOTE" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN10-MN	COMPOST FAN NO. 10 "RUNNING" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN10-XF	COMPOST FAN NO. 10 FAIL	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN02-IR	COMPOST FAN NO. 2 "IN REMOTE" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN02-MN	COMPOST FAN NO. 2 "RUNNING" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN02-XF	COMPOST FAN NO. 2 FAIL	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN03-IR	COMPOST FAN NO. 3 "IN REMOTE" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN03-MN	COMPOST FAN NO. 3 "RUNNING" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN03-XF	COMPOST FAN NO. 3 FAIL	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN04-IR	COMPOST FAN NO. 4 "IN REMOTE" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN04-MN	COMPOST FAN NO. 4 "RUNNING" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN04-XF	COMPOST FAN NO. 4 FAIL	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN05-IR	COMPOST FAN NO. 5 "IN REMOTE" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN05-MN	COMPOST FAN NO. 5 "RUNNING" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN05-XF	COMPOST FAN NO. 5 FAIL	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN06-IR	COMPOST FAN NO. 6 "IN REMOTE" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN06-MN	COMPOST FAN NO. 6 "RUNNING" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN06-XF	COMPOST FAN NO. 6 FAIL	09-N-0012

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID NO.
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN07-IR	COMPOST FAN NO. 7 "IN REMOTE" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN07-MN	COMPOST FAN NO. 7 "RUNNING" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN07-XF	COMPOST FAN NO. 7 FAIL	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN08-IR	COMPOST FAN NO. 8 "IN REMOTE" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN08-MN	COMPOST FAN NO. 8 "RUNNING" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN08-XF	COMPOST FAN NO. 8 FAIL	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN09-IR	COMPOST FAN NO. 9 "IN REMOTE" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN09-MN	COMPOST FAN NO. 9 "RUNNING" STATUS	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN09-XF	COMPOST FAN NO. 9 FAIL	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN01-TH	COMPOST FAN NO. 1 HIGH MOTOR TEMPERATURE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN02-TH	COMPOST FAN NO. 2 HIGH MOTOR TEMPERATURE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN03-TH	COMPOST FAN NO. 3 HIGH MOTOR TEMPERATURE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN04-TH	COMPOST FAN NO. 4 HIGH MOTOR TEMPERATURE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN05-TH	COMPOST FAN NO. 5 HIGH MOTOR TEMPERATURE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN06-TH	COMPOST FAN NO. 6 HIGH MOTOR TEMPERATURE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN07-TH	COMPOST FAN NO. 7 HIGH MOTOR TEMPERATURE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN08-TH	COMPOST FAN NO. 8 HIGH MOTOR TEMPERATURE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN09-TH	COMPOST FAN NO. 9 HIGH MOTOR TEMPERATURE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM1	FAN10-TH	COMPOST FAN NO. 10 HIGH MOTOR TEMPERATURE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM1	FAN01-MD	COMPOST FAN NO. 1 RUN COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM1	FAN10-MD	COMPOST FAN NO. 10 RUN COMMAND	09-N-0012

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID NO.
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM1	FAN02-MD	COMPOST FAN NO. 2 RUN COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM1	FAN03-MD	COMPOST FAN NO. 3 RUN COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM1	FAN04-MD	COMPOST FAN NO. 4 RUN COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM1	FAN05-MD	COMPOST FAN NO. 5 RUN COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM1	FAN06-MD	COMPOST FAN NO. 6 RUN COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM1	FAN07-MD	COMPOST FAN NO. 7 RUN COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM1	FAN08-MD	COMPOST FAN NO. 8 RUN COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM1	FAN09-MD	COMPOST FAN NO. 9 RUN COMMAND	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM01-TI	COMPOST BAY NO. 1 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM02-TI	COMPOST BAY NO. 1 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM03-TI	COMPOST BAY NO. 1 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM28-TI	COMPOST BAY NO. 10 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM29-TI	COMPOST BAY NO. 10 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM30-TI	COMPOST BAY NO. 10 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM04-TI	COMPOST BAY NO. 2 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM05-TI	COMPOST BAY NO. 2 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM06-TI	COMPOST BAY NO. 2 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM07-TI	COMPOST BAY NO. 3 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM08-TI	COMPOST BAY NO. 3 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM09-TI	COMPOST BAY NO. 3 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM10-TI	COMPOST BAY NO. 4 TEMPERATURE PROBE	09-N-0012

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID NO.
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM11-TI	COMPOST BAY NO. 4 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM12-TI	COMPOST BAY NO. 4 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM13-TI	COMPOST BAY NO. 5 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM14-TI	COMPOST BAY NO. 5 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM15-TI	COMPOST BAY NO. 5 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM16-TI	COMPOST BAY NO. 6 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM17-TI	COMPOST BAY NO. 6 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM18-TI	COMPOST BAY NO. 6 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM19-TI	COMPOST BAY NO. 7 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM20-TI	COMPOST BAY NO. 7 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM21-TI	COMPOST BAY NO. 7 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM22-TI	COMPOST BAY NO. 8 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM23-TI	COMPOST BAY NO. 8 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM24-TI	COMPOST BAY NO. 8 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM25-TI	COMPOST BAY NO. 9 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM26-TI	COMPOST BAY NO. 9 TEMPERATURE PROBE	09-N-0012
ACTIVE COMPOSTING BLOWER SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM1	TTM27-TI	COMPOST BAY NO. 9 TEMPERATURE PROBE	09-N-0012
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AI	H095-COM1	DMP01-ZI	AIR INTAKE VALVE POSITION FEEDBACK	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AI	H095-COM1	DMP02-ZI	AIR INTAKE VALVE POSITION FEEDBACK	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AI	H095-COM1	FAN11-SI	BIOFILTER FAN NO. 1 SPEED FEEDBACK	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AI	H095-COM1	FAN12-SI	BIOFILTER FAN NO. 2 SPEED FEEDBACK	09-N-0013

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID NO.
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AI	H095-COM1	FMT01-FI	BIOFILTER FAN NO.1 FLOW	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AI	H095-COM1	PTM01-PI	BIOFILTER FAN NO.1 PRESSURE	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AI	H095-COM1	TTM01-TI	BIOFILTER FAN NO.1 TEMPERATURE	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AI	H095-COM1	FMT02-FI	BIOFILTER FAN NO.2 FLOW	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AI	H095-COM1	PTM02-PI	BIOFILTER FAN NO.2 PRESSURE	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AI	H095-COM1	TTM02-TI	BIOFILTER FAN NO.2 TEMPERATURE	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AO	H095-COM1	DMP01-ZC	AIR INTAKE VALVE POSITION COMMAND	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AO	H095-COM1	DMP02-ZC	AIR INTAKE VALVE POSITION COMMAND	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AO	H095-COM1	FAN11-SC	BIOFILTER FAN NO. 1 SPEED COMMAND	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	AO	H095-COM1	FAN12-SC	BIOFILTER FAN NO. 2 SPEED COMMAND	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI		HS82-IR	AIR INTAKE VALVE "IN REMOTE" STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI		HS83-IR	AIR INTAKE VALVE "IN REMOTE" STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	FAN11-XF	BIOFILTER FAN NO. 1 "FAULT" STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	FAN11-IR	BIOFILTER FAN NO. 1 "IN REMOTE" STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	FAN11-MN	BIOFILTER FAN NO. 1 "RUNNING" STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	DMP04-IR	BIOFILTER FAN NO. 1 DOWNSTREAM VALVE "IN REMOTE" STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	DMP04-ZL	BIOFILTER FAN NO. 1 DOWNSTREAM VALVE CLOSE STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	DMP04-ZH	BIOFILTER FAN NO. 1 DOWNSTREAM VALVE OPEN STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	DMP03-IR	BIOFILTER FAN NO. 1 UPSTREAM VALVE "IN REMOTE" STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	DMP03-ZL	BIOFILTER FAN NO. 1 UPSTREAM VALVE CLOSE STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	DMP03-ZH	BIOFILTER FAN NO. 1 UPSTREAM VALVE OPEN STATUS	09-N-0013

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID NO.
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	FAN12-XF	BIOFILTER FAN NO. 2 "FAULT" STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	FAN12-IR	BIOFILTER FAN NO. 2 "IN REMOTE" STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	FAN12-MN	BIOFILTER FAN NO. 2 "RUNNING" STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	DMP06-IR	BIOFILTER FAN NO. 2 DOWNSTREAM VALVE "IN REMOTE" STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	DMP06-ZH	BIOFILTER FAN NO. 2 DOWNSTREAM VALVE OPEN STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	DMP06-ZL	BIOFILTER FAN NO. 2 DOWNSTREAM VALVECLOSE STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	DMP05-IR	BIOFILTER FAN NO. 2 UPSTREAM VALVE "IN REMOTE" STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	DMP05-ZL	BIOFILTER FAN NO. 2 UPSTREAM VALVE CLOSE STATUS	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	DMP05-ZH	BIOFILTER FAN NO. 2 UPSTREAM VALVE OPEN STATUS	09-N-0013
BIOFILTER	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	FAN11-TH	BIOFILTER FAN NO. 1 HIGH MOTOR TEMPERATURE	09-N-0013
BIOFILTER	H095-COM1-MCP01	H095-COM1-PLC01	DI	H095-COM1	FAN12-TH	BIOFILTER FAN NO. 2 HIGH MOTOR TEMPERATURE	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	DMP04-ZB	BIOFILTER FAN NO. 1 DOWNSTREAM VALVE CLOSE COMMAND	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	DMP04-ZD	BIOFILTER FAN NO. 1 DOWNSTREAM VALVE OPEN COMMAND	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	FAN11-MD	BIOFILTER FAN NO. 1 START/STOP	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	DMP03-ZB	BIOFILTER FAN NO. 1 UPSTREAM VALVE CLOSE COMMAND	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	DMP03-ZD	BIOFILTER FAN NO. 1 UPSTREAM VALVE OPEN COMMAND	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	DMP06-ZB	BIOFILTER FAN NO. 2 DOWNSTREAM VALVE CLOSE COMMAND	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	DMP06-ZD	BIOFILTER FAN NO. 2 DOWNSTREAM VALVE OPEN COMMAND	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	FAN12-MD	BIOFILTER FAN NO. 2 START/STOP	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	DMP05-ZB	BIOFILTER FAN NO. 2 UPSTREAM VALVE CLOSE COMMAND	09-N-0013
COMPOSTING BIOFILTER SYSTEM	H095-COM1-MCP01	H095-COM1-PLC01	DO	H095-COM1	DMP05-ZD	BIOFILTER FAN NO. 2 UPSTREAM VALVE OPEN COMMAND	09-N-0013
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM3	FAN01-SI	CURING FAN NO. 1 SPEED FEEDBACK	09-N-0014

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID NO.
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM3	FAN02-SI	CURING FAN NO. 1 SPEED FEEDBACK	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM3	FAN03-SI	CURING FAN NO. 1 SPEED FEEDBACK	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AI	H095-COM3	FAN04-SI	CURING FAN NO. 1 SPEED FEEDBACK	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM3	FAN01-SC	CURING FAN NO. 1 SPEED COMMAND	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM3	FAN02-SC	CURING FAN NO. 1 SPEED COMMAND	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM3	FAN03-SC	CURING FAN NO. 1 SPEED COMMAND	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	AO	H095-COM3	FAN04-SC	CURING FAN NO. 1 SPEED COMMAND	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN01-IR	CURING FAN NO. 1 "IN REMOTE" STATUS	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN01-MN	CURING FAN NO. 1 "RUNNING" STATUS	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN01-XF	CURING FAN NO. 1 FAIL	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN02-IR	CURING FAN NO. 2 "IN REMOTE" STATUS	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN02-MN	CURING FAN NO. 2 "RUNNING" STATUS	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN02-XF	CURING FAN NO. 2 FAIL	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN03-IR	CURING FAN NO. 3 "IN REMOTE" STATUS	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN03-MN	CURING FAN NO. 3 "RUNNING" STATUS	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN03-XF	CURING FAN NO. 3 FAIL	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN04-IR	CURING FAN NO. 4 "IN REMOTE" STATUS	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN04-MN	CURING FAN NO. 4 "RUNNING" STATUS	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN04-XF	CURING FAN NO. 4 FAIL	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN01-TH	CURING FAN NO. 1 HIGH MOTOR TEMPERATURE	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN02-TH	CURING FAN NO. 2 HIGH MOTOR TEMPERATURE	09-N-0014

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID NO.
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN03-TH	CURING FAN NO. 3 HIGH MOTOR TEMPERATURE	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DI	H095-COM3	FAN04-TH	CURING FAN NO. 4 HIGH MOTOR TEMPERATURE	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM3	FAN01-MD	CURING FAN NO. 1 RUN COMMAND	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM3	FAN02-MD	CURING FAN NO. 2 RUN COMMAND	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM3	FAN03-MD	CURING FAN NO. 3 RUN COMMAND	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	DO	H095-COM3	FAN04-MD	CURING FAN NO. 4 RUN COMMAND	09-N-0014
ALT03: STORAGE BAYS	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM12-TI	ALTERNATE STORAGE BAY NO. 4 TEMPERATURE PROBE	09-N-0014
ALT03: STORAGE BAYS	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM13-TI	ALTERNATE STORAGE BAY NO. 5 TEMPERATURE PROBE	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM01-TI	CURING BAY NO. 1 TEMPERATURE PROBE	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM02-TI	CURING BAY NO. 1 TEMPERATURE PROBE	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM03-TI	CURING BAY NO. 2 TEMPERATURE PROBE	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM04-TI	CURING BAY NO. 2 TEMPERATURE PROBE	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM05-TI	CURING BAY NO. 3 TEMPERATURE PROBE	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM06-TI	CURING BAY NO. 3 TEMPERATURE PROBE	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM07-TI	CURING BAY NO. 4 TEMPERATURE PROBE	09-N-0014
SCREENING AND CURING SYSTEM	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM08-TI	CURING BAY NO. 4 TEMPERATURE PROBE	09-N-0014
STORAGE BAYS	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM09-TI	STORAGE BAY NO. 1 TEMPERATURE PROBE	09-N-0014
STORAGE BAYS	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM10-TI	STORAGE BAY NO. 2 TEMPERATURE PROBE	09-N-0014
STORAGE BAYS	H095-COM1-CPL01	H095-COM1-PLC01	ETH	H095-COM3	TTM11-TI	STORAGE BAY NO. 3 TEMPERATURE PROBE	09-N-0014
SANITARY LIFT STATION	H095-COM1-MCP01	H095-COM1-PLC01	DI		LSHH91-LH	SANITARY LIFT STATION HIGH HIGH LEVEL ALARM	09-N-0015
SANITARY LIFT STATION	H095-COM1-MCP01	H095-COM1-PLC01	DI		LSH91-LH	SANITARY LIFT STATION HIGH LEVEL ALARM	09-N-0015
SANITARY LIFT STATION	H095-COM1-MCP01	H095-COM1-PLC01	DI		LSL91-LL	SANITARY LIFT STATION LOW LEVEL ALARM	09-N-0015
SANITARY LIFT STATION	H095-COM1-MCP01	H095-COM1-PLC01	DI	H110-LFT1	PMP01-XF	SANITARY PUMP NO. 1 "FAULT" STATUS	09-N-0015
SANITARY LIFT STATION	H095-COM1-MCP01	H095-COM1-PLC01	DI	H110-LFT1	PMP01-XA	SANITARY PUMP NO. 1 HIGH MOISTURE ALARM	09-N-0015
SANITARY LIFT STATION	H095-COM1-MCP01	H095-COM1-PLC01	DI	H110-LFT1	PMP01-TH	SANITARY PUMP NO. 1 HIGH MOTOR TEMPERATURE ALARM	09-N-0015
SANITARY LIFT STATION	H095-COM1-MCP01	H095-COM1-PLC01	DI	H110-LFT1	PMP02-XF	SANITARY PUMP NO. 2 "FAULT" STATUS	09-N-0015
SANITARY LIFT STATION	H095-COM1-MCP01	H095-COM1-PLC01	DI	H110-LFT1	PMP02-XA	SANITARY PUMP NO. 2 HIGH MOISTURE ALARM	09-N-0015
SANITARY LIFT STATION	H095-COM1-MCP01	H095-COM1-PLC01	DI	H110-LFT1	PMP02-TH	SANITARY PUMP NO. 2 HIGH MOTOR TEMPERATURE ALARM	09-N-0015
SANITARY LIFT STATION	H095-COM1-MCP01	H095-COM1-PLC01	DO	H110-LFT1	PMP01-MN	SANITARY PUMP NO. 1 "RUNNING" STATUS	09-N-0015

AREA	PANEL NO	PLC NO	TYPE	IO TAG PRE-FIX	IO TAG	SERVICE	P&ID NO.
SANITARY LIFT STATION	H095-COM1-MCP01	H095-COM1-PLC01	DO	H110-LFT1	PMP02-MN	SANITARY PUMP NO. 2 "RUNNING" STATUS	09-N-0015
COMPOSTING AREA		H095-COM1-PLC01	AI		TT01-TI	ROOM TEMPERATURE	09-N-0020
COMPOSTING AREA		H095-COM1-PLC01	AI		TT02-TI	ROOM TEMPERATURE	09-N-0020
COMPOSTING AREA	H095-COM1-ACP01	H095-COM1-PLC01	DI		ACU01-XA1	ACU01 GENERAL ALARM	09-N-0020
COMPOSTING AREA	H095-COM1-ACP01	H095-COM1-PLC01	DI		ACU01-XA2	ACU01 FAIL	09-N-0020
COMPOSTING AREA		H095-COM1-PLC01	DI		SD01-XA01	SMOKE DETECTOR EXHAUST AIR ALARM	09-N-0020
COMPOSTING AREA		H095-COM1-PLC01	DI		SD01-XA02	SMOKE DETECTOR SUPPLY AIR ALARM	09-N-0020
COMPOSTING AREA	H095-COM1-MCP01	H095-COM1-PLC01	DI		UPS01-JA1	UPS01 POWER FAIL	09-N-0020
COMPOSTING AREA	H095-COM1-MCP01	H095-COM1-PLC01	DI		UPS01-OB	UPS01 BATTERY LOW	09-N-0020
COMPOSTING AREA	H095-COM1-MCP01	H095-COM1-PLC01	DI		UPS01-JA2	UPS01 FAIL	09-N-0020
COMPOSTING AREA	H095-COM1-MCP01	H095-COM1-PLC01	DI		XS71-XA	PANEL INTRUSION ALARM	09-N-0020
TOTAL ETH:	**43**						
TOTAL AI:	**28**						
TOTAL AO:	**18**						
TOTAL DI:	**111**						
TOTAL DO:	**30**						

CONTROL PANEL SCHEDULE

TAG NO.	DESCRIPTION	PANEL OPTIONS	INSTALLATION DETAIL	PLC	P&ID	NOTES
H040-WAS1-CPL01	WAS FEED PUMP PANEL	**TYPE:** FREESTANDING **MATERIAL:** 316L **NEMA RATING:** 4X **FINISH** **OPTIONS:**	4091-402D 4091-452D	H040-WAS1-PLC01	09-N-0001	
H050-FCL1-CPL01	SCUM WET WELL PANEL	**TYPE:** **MATERIAL: 316L** **NEMA RATING: 4X** **FINISH** **OPTIONS:**	4091-402D 4091-452D	H050-FCL1-PLC01	09-N-0002	
H050-FCL1-CPL02	SCUM WET WELL LOCAL PANEL				09-N-0002	VENDOR SUPPLIED PANEL
H090-DEW3-MCP01	SLUDGE HOLDING TANKS AREA	**TYPE:** FREESTANDING **MATERIAL: 316L** **NEMA RATING: 4X** **FINISH** **OPTIONS:**	4091-402D 4091-452D	H090-DEW3-PLC01	09-N-0004	
H090-DEW2-CPL01	SLUDGE HOLDING TANK BLOWER NO. 1				09-N-0004	VENDOR SUPPLIED PANEL
H090-DEW2-CPL02	SLUDGE HOLDING TANK BLOWER NO. 2				09-N-0004	VENDOR SUPPLIED PANEL
H090-DEW2-CPL03	SLUDGE HOLDING TANK BLOWER NO. 3				09-N-0004	VENDOR SUPPLIED PANEL
H090-DEW1-MCP01	DEWATERING AREA PANEL	**TYPE:** FREESTANDING **MATERIAL: CS** **NEMA RATING: 12** **FINISH GREY** **OPTIONS:**	4091-139 4091-452D	H090-DEW1-PLC01	09-N-0005 09-N-0006 09-N-0007 09-N-0008 09-N-0009 09-N-0010 09-N-0011	
H090-DEW1-CPL01	GRINDER NO. 1 PANEL				09-N-0005	VENDOR SUPPLIED PANEL
H090-DEW1-CPL02	CENTRIFUGE NO. 1 OPERATOR PANEL				09-N-0006	VENDOR SUPPLIED PANEL
H090-DEW1-MDP01	CENTRIFUGE NO. 1 STARTER PANEL				09-N-0006	VENDOR SUPPLIED PANEL
H090-DEW1-CPL03	CENTRIFUGE NO. 2 OPERATOR PANEL				09-N-0007	VENDOR SUPPLIED PANEL
H090-DEW1-CPL04	CENTRIFUGE NO. 3 OPERATOR PANEL				09-N-0007	VENDOR SUPPLIED PANEL
H090-DEW1-MDP02	CENTRIFUGE NO. 2 STARTER PANEL				09-N-0007	VENDOR SUPPLIED PANEL
H090-DEW1-MDP03	CENTRIFUGE NO. 3 STARTER PANEL				09-N-0007	VENDOR SUPPLIED PANEL

TAG NO.	DESCRIPTION	PANEL OPTIONS	INSTALLATION DETAIL	PLC	P&ID	NOTES
H090-DEW1-CPL06	POLYMER RECIRCULATION PUMP NO. 1				09-N-0008	VENDOR SUPPLIED PANEL
H090-DEW1-CPL07	POLYMER BLENDING UNIT NO. 1 CONTROL PANEL				09-N-0008	VENDOR SUPPLIED PANEL
H090-DEW1-CPL08	POLYMER BLENDING UNIT NO. 2 CONTROL PANEL				09-N-0008	VENDOR SUPPLIED PANEL
H090-DEW1-CPL09	POLYMER BLENDING UNIT NO. 3 CONTROL PANEL				09-N-0008	VENDOR SUPPLIED PANEL
H090-DEW1-PNL01	POLYMER FILL PANEL	**TYPE:** WALL-MOUNTED **MATERIAL:** 316L **NEMA RATING:** 4X **FINISH** **OPTIONS:**	09-N-0030		09-N-0008	
H090-DEW1-CPL05	SLUDGE CONVEYOR CONTROL PANEL				09-N-0010	VENDOR SUPPLIED PANEL
H095-COM2-CPL01	COMPOST MIXER NO. 1 & 2; COMPOST SCALE NO. 1 & 2; COMPOST CONVEYOR NO. 1 & 2				09-N-0011	VENDOR SUPPLIED PANEL
H095-COM2-CPL02	COMPOST SCALE NO. 1 WEIGHT DISPLAY				09-N-0011	VENDOR SUPPLIED PANEL
H095-COM2-CPL03	COMPOST SCALE NO. 2 WEIGHT DISPLAY				09-N-0011	VENDOR SUPPLIED PANEL
H095-COM1-CPL01	REOTEMP PANEL			H095-COM2-PLC01	09-N-0012 09-N-0014	VENDOR SUPPLIED PANEL
H095-COM1-MCP01	COMPOST AREA MASTER PLC	**TYPE:** FREESTANDING **MATERIAL:** 316L **NEMA RATING:** 4X **FINISH** **OPTIONS:**		H095-COM2-PLC01	09-N-0011 09-N-0013 09-N-0015	VENDOR SUPPLIED PANEL
H110-LFT01-CPL01	SANITARY LIFT STATION LOCAL CONTROL PANEL				09-N-0015	VENDOR SUPPLIED PANEL

SURGE SUPPRESSOR PRODUCTS TABLE

SS Type	Application	Enclosure/ Mounting	Manufacturer/ Model	Principle of Operation/ Performance Criteria	Comments/ Performance Criteria
2	Protect analog signals within control panels	NEMA Rating: None Locate inside panel	Emerson EDCO, PC-642 or SRA-64; "or-equal"	Principle of Operation: Two-Stage 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device	Tested and rated for 50 occurrences of 2,000-amp peak test waveform. Provide as needed
2	Protect analog signals within control panels	NEMA Rating: None Locate inside panel	Phoenix Contact; TT-2-PE-24DC	Principle of Operation: Three Stage 1) Gas-filled arrestors for coarse protection 2) Medium protection varistors 3) Final stage suppressor diodes	Nominal discharge surge current when subject to 8/20 wave form testing: 5kA per path
3	Analog signal of 2-wire transmitters	Field installed in stainless steel pipe nipple adjacent to 2-wire transmitter	Emerson EDCO, SS64 Series; "or-equal"	Principle of Operation: Two-Stage 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device	
3	Analog signal of 2-wire transmitters	Field installed in stainless steel pipe nipple adjacent to 2-wire transmitter	Phoenix Contact, S-PT1-2PE-24DC	Principle of Operation: Two-Stage 1) Gas-filled electrode 2) Suppressor Diode	Nominal discharge current when subject to 8/20 waveform: 10kA
4	Both analog signal and 120V ac power of 4-wire transmitter	NEMA Rating: 316 Stainless Steel, NEMA 4X Field installed; adjacent to 4-wire transmitter	Emerson EDCO, SLAC-12036; "or-equal"	Principle of Operation: Two-Stage 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device Performance Criteria: 1) With 120V AC outlet and AC circuit breaker in a weatherproof enclosure	Tested and rated for 50 occurrences of 2,000-amp peak test waveform. Provide as needed
4	Both analog signal and 120V ac power of 4-wire transmitter	NEMA Rating: 316 Stainless Steel, NEMA 4X Field installed; adjacent to 4-wire transmitter	Phoenix Contact, Type 1 plus PT 1X2-24VDC-ST	Nominal discharge current of PT unit when subject to 8/20 wave form: 10kA testing	

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. BICSI: Building Industry Consulting Services, International.
2. Electronic Components, Assemblies, and Materials Association (ECA): 310-E, Cabinets, Racks, Panels, and Associated Equipment.
3. Institute of Electrical and Electronic Engineers, Inc. (IEEE): 802.3, Telecommunications and Information Exchange Between Systems—Local and Metropolitan Networks.
4. 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.
5. International Organization for Standardization (ISO): 9001, Quality Management Systems—Requirements.
6. International Telecommunication Union (ITU): T G.652, Characteristics of a Single-mode Optical Fibre and Cable.
7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
8. QuEST Forum (QF): TL 9000, Quality Management Systems.
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 Text 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 62.5-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. UL: 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 DEFINITIONS

A. Definitions of terms and abbreviations used:

1. CAT6: Category 6 Network Cable.
2. dB: Decibel.
3. EMB: Effective Modal Bandwidth.
4. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.
5. FOCS: Fiber Optic Communication System.
6. FPP: Fiber Patch Panel.
7. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.
8. Gbps: Gigabits per second.

9. LAN: Local Area Network.
10. LIMS: Laboratory Information Management System.
11. m: Meter.
12. Mbps: Megabits per second.
13. Mechanical Splice: Connecting ends of two fibers together by means other than fusion.
14. MHz: Megahertz.
15. micro: x 10^{-6}.
16. Micron: Micrometer or one millionth meter.
17. n, nano: x 10^{-9}.
18. N: Newton.
19. nm: Nanometer—unit of measure equal to one billionth meter.
20. OFL: Over-filled Launch.
21. OFN: Nonconductive Optical Fiber Cable.
22. OFNP: Nonconductive Optical Fiber Plenum Cable.
23. OFNR: Nonconductive Optical Fiber Riser Cable.
24. OLTS: Optical Loss Test Sets.
25. OTDR: Optical Time Domain Reflectometer.
26. PIC: Process Instrumentation and Control.
27. Plenum: Air return path of central air handling system, such as open space above suspended ceiling.
28. Plant Control System: Plant Supervisory Control and Data Acquisition System.
29. UPS: Uninterruptible Power Supply.
30. V ac: Volts Alternating Current.
31. WAN: Wide Area Network.

1.03 SYSTEM DESCRIPTION

A. Function of FOCS is to transmit digital data between network nodes. Requirements listed identify minimum acceptable system performance.

B. System includes network panel, fiber optic cable, patch panels, network switches and transceivers, patch cords, and accessories. Provide all components and work necessary for a complete fiber optic communication system.

C. Provide a FOCS based on referenced standards to establish process control system communication between the existing Treatment Plant Control Building and the Blower Building Control Room. Conduit requirements are shown on Electrical Drawings. Network(s) will be used to distribute data and coordinate Owner’s operations.

1.04 SUBMITTALS

A. Action Submittals:

1. Site Layout Diagram Showing:
   a. Access holes, with identification.
   b. Belowgrade conduit routings between access holes and buildings, with conduit counts and identification.
   c. Cable routings to patch panels, or network nodes, with cable and node identification.
2. Detailed panel drawings. Drawings shall include:
   a. Elevation drawings showing all component locations within cabinets, terminal blocks, power supplies, and accessories. Components on elevation drawing shall reference on page bill of material that provides the following information as a minimum:
      1) Item number.
      2) Part description.
      3) Manufacturer.
      4) Manufacturers part number.
      5) Quantity.
   b. Cabinet power distribution, including voltage and power requirements, panel mounted breaker and fuse ratings, and power supply ratings. Distribution drawings shall also include interconnecting wiring and associated tag numbers and terminal numbers.
3. Schematics including tag number designations for all network nodes as shown on Drawings. Schematics shall include terminal numbers, individual fiber and copper wire numbers and colors at all termination locations. Communication channel type shall be clearly differentiated by line type and defined in a legend on each associated drawing.
4. Cable Schedule Showing:
   a. Cable identification.
   b. Fiber counts for each cable and identification of used fiber pairs.
   c. Cable length and attenuation, with two connector pairs and no splice(s), based on TIA 568-C.3, Annex H.
5. Component Data:
   a. Manufacturer and model number.
   b. General data and description.
   c. Engineering specifications and data sheet.
   d. Scaled drawings and mounting arrangements.

B. Informational Submittals:

1. FOCS Provider 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.
   c. System block diagram.
   d. Dates of installation, testing, and system operation.
   e. Qualification of Personnel: Resumes identifying technical qualifications of key personnel. Include specified certifications.
2. Testing and acceptance plan, 30 days prior to beginning of testing.
3. Test Documentation:
   a. Fiber factory test results. Documentation covering fiber facility testing, not later than 2 days after testing, showing manufacturer's test of attenuation per fiber as recorded from OTDR reading before shipment.
   b. Attenuation of each fiber plus connector after installation as recorded from OTDR with tracing.
   c. Flux Budget calculations with comparison to measured attenuation for each run verifying adequate optical signal strength.
4. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirement.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Optical Fiber Cable:

1. Outside, Underground: 0 degree F to 104 degrees F.
2. Outside, Overhead: Minus 10 degrees F to 122 degrees F.
3. Outside, Aboveground in Conduit: Minus 10 degrees F to 140 degrees F.
4. Inside: 32 degrees F to 104 degrees F.

B. Equipment:

1. Outside, Aboveground: 0 degree F to 113 degrees F.
2. Control Rooms, Equipment Rooms, and Telecommunications Closets: 30 percent to 55 percent relative humidity, 55 degrees F to 85 degrees F.
3. Other Interior Areas: 0 percent to 100 percent relative humidity, 40 degrees F to 104 degrees F.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Cable:
   a. ISO 9001 or QF TL 9000 registered, whichever applies to material.
   b. Minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance.
2. Patch Cords, Connectors, and Jumper Cable: ISO 9001 and QF TL 9000 registered.

B. Installer Qualifications:

1. FOCS Provider: Minimum of 5 years' experience providing, integrating, installing, and commissioning of similar systems.
2. Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.
3. Certified by fiber optic cable manufacturer.
4. Lead cabling installation personnel shall have BICSI Installer 2, Optical Fiber (INSTF) certification.

C. Tester Qualifications:

1. Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.
2. BICSI Certification: BICSI Installer 2, Optical Fiber or Technician certification.
3. Successfully attended training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof.

D. Provide connectors/coupling, enclosures, mounting hardware, and miscellaneous accessories for fibers by same manufacturer.

1.07 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts:

1. Fiber Patch Cords: Three, minimum, of longest length used.

PART 2 PRODUCTS

2.01 NETWORK PANEL

A. Tag Number: H0X0-XXX1-XXXX.

B. Panel shall include the following. Refer to the Drawings, Network Schematic Diagram:

1. SCADA Ethernet switch.
2. Single mode fiber patch panel for termination of 12 strands.
3. Power distribution to accept 120V ac UPS supply from PLC panel, including receptacle for plug-connected devices.
4. Mounting hardware and appurtenances. Provide either rack-mount or DIN-rail mounting system to match mounting requirements of devices.

C. Features:

1. Wall mount.
2. Fiber optic cable support.
3. Maximum Dimensions: 24 inches W, 18 inches D, 36 inches H.

D. Manufacturers:

1. Hoffman.
2. Panduit.
3. Chatsworth.
4. Or equal.

2.02 SINGLE MODE FIBER OPTIC CABLE

A. Type: Indoor/Outdoor, tight buffer, dielectric armor fiber optic cable for Underground Conduit and Building Riser Installation.

B. Fiber Characteristics:

1. Single Mode Type: OS2 9/125 μm.
2. Comply with TIA/EIA 568 C.3.
3. Tight-Buffered:
   a. Coating to 250 μm diameter: Acrylate, UV-cured, soft.
   b. Buffer to 900 μm diameter: PVC, elastomeric, hard.
4. Maximum Attenuation:
   a. 1310 nm: 0.7 dB/km.
   b. 1550 nm: 0.7 dB/km.
5. Color-coded buffer.
6. Minimum Bend Radius, Buffered Fiber: 32 mm.

C. Cable:

1. Fiber Count: 12 strands cable minimum.
2. All Dielectric Construction: No electrically conductive components in fiber optic cable are allowed.
3. Helically Wound: Buffered fibers helically wound; approximately 5 turns per meter.
4. Gel-Free: Fibers tight-buffered, gel-free loose-tube.
5. Core-Locked with no separator tape.
6. Strength Member:
   a. Nonconductive; integral part of cable; supports stress of installation and load during use.
   b. Fiberglass epoxy rod, aramid fiber, Kevlar.
   c. Minimum Tensile Strength: 150 lbf short term, 45 lbf long term.
7. Protective Covering:
   a. Plenum rated flame-retardant.
   b. Continuous and free from holes, splices, blisters, and other imperfections.
8. Minimum Bend Radius:
   a. Short-term Under Tension: 20 times cable diameter.
   b. Long-term Without Tension: 15 times cable diameter.
9. Identification:
   a. Identify with labels matching submitted drawings.
   b. Use waterproof tags and identifications.

D. Manufacturers:

1. Corning Cable Systems.
2. Commscope.
3. Panduit.

2.03 SCADA ETHERNET SWITCH

A. Function: Interconnect SCADA Ethernet nodes.

B. Standards and Compliance:

1. Electrical Safety: UL 60950-1, CSA C22.2 No. 60950-1.
2. EMC: FCC part 15, CFR 47, Class A.
3. RoHS 6 compliant.
4. MTBF: Over 500,000 hours.

C. Management:

1. Type: Advanced Layer 2 and Layer 3 Managed.
2. Devices Supported: All IEEE 802.3 compliant devices.

3. Protocols: SNMPv1/v2/v3, RMON, DHCP, SNTP, TFTP, STP, RSTP, QoS/CoS/ToS/DS, IGMPv1/v2, VLAN (tag and port based), HTTP, HTTPS (SSL and TSL), telnet and SSH.
4. Industrial Connectivity Protocols Supported: Modbus/TCP, EtherNet/IP, PROFInet and Foundation Fieldbus HSE.
5. Standards: IEEE 802.3, 802.3u, 802.3z, 802.1D, 802.1p, 802.1Q.
6. Management and Operations: Cisco Network PnP, and Cisco Catalyst Smart Operations.
7. Management Interfaces: Text (Telnet and SSH), CLI (command line interface) and SNMP.

D. Environmental:

1. Operating Temperature: Minus 5 degrees C to 45 degrees C.
2. Storage Temperature: Minus 25 degrees C to 70 degrees C.
3. Humidity: 5 percent to 95 percent relative humidity, non-condensing.

E. Features:

1. Ports:
   a. 2- SFP, 1G uplink SFP transceiver ports.
   b. 2- RJ-45, 1G uplink copper ports.
   c. 8- RJ-45, 10/100/1000-Mbps PoE/PoE+ copper ports.
2. Flow Control:
   a. Half-duplex: Back pressure.
   b. Full-duplex: IEEE 802.3x.
3. MAC Addresses: 2048.
4. Forwarding Bandwidth: 16 Gbps.
5. Switching Bandwidth: 32 Gbps at full duplex.
6. Memory:
   a. DRAM: 512 MB.
   b. Flash: 128 MB.
7. Mounting: DIN-rail or rack mount.
8. Indicators:
   a. Per Switch: Power; Link; Duplex; Speed.
   b. Per Port: Link integrity; Disabled; Activity; Speed; Duplex.
9. Power: 120V ac, 60 Hz.

F. Accessories:

1. Mounting Hardware: DIN-rail or Rack-mount kit, to suit panel mounting requirements.
2. SFP Transceiver: Provided by Owner.

G. Manufacturer and Product: Cisco; Model WS-C3560CX-8PC-S.

2.04 FIBER PATCH PANEL

A. Function: Provides secure place to terminate fiber optic cables. Terminate all fiber strands in patch panel.

B. Features:

1. Compartments: Two; one for fiber optic cable, one for jumpers to individual equipment.
2. Coil Former: Former to wind slack cable around, provides controlled long radius bends.
3. Connectors: SC-APC single mode connectors.
4. Construction: 1.5-mm steel with corrosion proof finish.
5. Mounting: Inside network panel, DIN-rail or rack-mount, to suit panel mounting requirements.
6. Doors: Separate doors for cable and jumper terminations.

C. Manufacturers:

1. Corning.
2. Commscope.
3. Panduit.

2.05 CONNECTORS

A. General:

1. Comply with TIA/EIA 604-2, TIA/EIA 604-3, TIA/EIA 604-12, and TIA 568-C.3.
2. SC-APC connectors, except match device termination for devices with differing connector type. Do not connect APC style connector to a non-APC style device.
3. Pull Strength: 0.2 N minimum.
4. Durability: Sustain minimum 500 mating cycles without violating other requirements.
    a. Ferrules: Free-floating low loss ceramic.
    b. Polarizing key on duplex connector systems.
5. Attenuation:
    a. In accordance with TIA 568-C.3.
    b. Maximum of 0.75 dB per connector pair.
6. Manufacturer: AMP.

2.06 PATCHCORDS

A. General:

1. In accordance with TIA 568-C.3.
2. Function: Connect Patch Panels to network nodes, such as computer workstations.
3. Fiber Characteristics: In accordance with requirements for fiber optic cable.
4. Cable Configuration:
   a. Individual tight-buffer thermoplastic, fibers single or multimode, to match fibers being jumpered on.
   b. Protected with Kevlar strength members and enclosed in thermoplastic jacket.
5. Length: Standard, to meet requirements, minimum 2 meters.
6. Connectors:
   a. As required by Article Connectors.
   b. Match connector type to the device connection. Do not mate APC connectors to non-APC connectors.
   c. On-axial Pull Strength: 33 N.
   d. Normal-to-Axial Pull Strength: 22 N.
7. Cable Rating: OFNR or OFNP.
8. Color: Per standards or as indicated.
9. Measured for insertion loss with the following values for each connector:
   a. Typical of 0.3 dB and maximum of 0.5 dB (SC typical of 0.1 dB and maximum of 0.3 dB).
10. Provide all fiber patch cords that are from a manufacturer and factory tested.

2.07 CONDUIT

A. In accordance with Section 26 05 33, Raceway and Boxes.

2.08 ACCESSORIES

A. Hardware: Provide mounting hardware, cable clamps, strain reliefs, blocking and grommet kits, closures, and fan outs for complete installation.

PART 3 EXECUTION

3.01 PREPARATION

A. Conduit:

1. Ensure installed conduit system conforms to fiber optic system requirements, including:
   a. Conduits and Innerducts: Size and number.
   b. Access Holes, Handholes, and Pull Boxes: Location and size, to ensure cables and innerducts 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. Ensure duct bank, conduit, and other confined routing is free and clear of debris before cable placement.

3.02 INSTALLATION

A. Fiber Optic Cable:

1. Specified fiber counts, routing, origination, and terminating points are indicated on the Drawings.
2. Installation by manufacturer's certified installer.
3. Install cables in accordance with manufacturer's requirements.
4. Install cables in accordance with Building Industry Consulting Services, International (BICSI) standards.
5. 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.
6. Cables per Conduit or Innerduct: In accordance with NFPA 70 NEC conduit fill limitations.
7. If calculation indicates cable will attenuate signals more than 8 dB, reroute may be allowed if approved by Engineer.
8. Splices: Install fiber optic cables in unspliced lengths from Patch Panels to switches or hubs.
9. Connector: Insertion loss on single mode connections exceeding 0.5 dB not permitted.

10. Identification:
    a. Identify cable on both ends, in access holes, and pull points.
    b. In accordance with TIA 606.
11. Arrange cable, equipment, and hardware to provide neat appearance and accessibility for servicing.
12. 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. Patch Panel, Fiber Distribution Frame, Housing, Panel, Splice Tray: Install securely in field panels or enclosures as shown on the Drawings.

C. 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. Patch Panels, 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.

D. Ethernet Fiber-to-Copper Transceivers:

1. Install transceivers in accordance with manufacturer’s instructions.
2. Location: Install transceivers securely in field panels, close to network nodes and Patch Panels.
3. Power: Energize each transceiver from its field panel’s UPS, if applicable.
4. Connections:
    a. Connect transceiver to fiber optics and network node.
    b. Lace fiber optics neatly in place, routed through wireways.

E. Category 6 UTP Cable Installation:

1. Comply with TIA-568.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
3. Each run of UTP cable may not exceed 300 feet.
4. The entire link length of a cable run (including patch cords) may not exceed 328 feet.

F. Conduit: Install in accordance with Section 26 05 33, Raceway and Boxes.

3.03 LABELING CONVENTIONS

A. Conform to TIA 606 or to requirements specified by Owner or Owner's representative.

B. Backbone (Riser) Cables:

1. Multiconductor cables connecting main distribution field to an intermediate distribution field, usually a wiring closet or cabinet, and are labeled at each terminating end. Label name identifies each endpoint, cable medium, and number of conductors as follows:
   a. Copper: IDF-MDF-C-PPP-N.
   b. Fiber: IDF-MDF-F-SSS-N.
   c. Where:

1)	IDF code	The 3-5 position IDF/wiring closet/building
2)	MDF	The 3-5 position MDF (or IDF) code
3)	F	Fiber
4)	PPP	Pair count of a copper cable
5)	SSS	Single-mode fiber strand count
6)	N	A sequential number

C. Horizontal (Station) Cables:

1. Connect jack stations to wiring closets or cabinets and are labeled at each end to identify wiring closet they connect to and sequential jack station number as follows:
   a. Data: IDF-D-NNN-A/B.
   b. Voice: IDF-V-NNN-A/B.
   c. Where:

1)	IDF code	The 3-5 position IDF/wiring closet/building
2)	D	Data cable (green)
3)	V	Voice cable (gray)

4) NNN The sequence number
5) A/B Indicates left or right port in faceplate

3.04 FIELD QUALITY CONTROL

A. General:

1. Advise Engineer at least 48hours in advance of each test. Engineer shall have option to witness and participate actively in tests.
2. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.
3. Provide equipment, instrumentation, supplies, and skilled staff necessary to perform testing.
4. Outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.
5. Testing performed on incomplete systems shall be redone on completion of the Work.
6. Document Test Results: Confirm each cable has at least specified number of fibers that meet standards, in accordance with As-Built Fiber Optic Cable Installation form included as Supplement to this section.
7. Confirm quantities and sizes of conduit and innerduct, in accordance with As-Built Conduit/Innerduct Installation form included as Supplement to this section.

B. Test Equipment:

1. Field test instruments shall have latest software and firmware installed.
2. Optical Fiber Cable Testers:
   a. Field test instrument shall be within calibration period recommended by manufacturer.
   b. Optical Loss Test Set (OLTS):
      1) Single-mode Optical Fiber Light Source:
         a) Provide dual laser light sources with central wavelengths of 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
         b) Output Power: Minus 10 dBm, minimum.
         c) Manufacturer: Fluke Networks.
      2) Single mode Optical Fiber Light Source:
         a) Provide dual LED light sources with central wavelengths of 1,310 nm (plus or minus 30 nm) and 1,550 nm (plus or minus 20 nm).
         b) Output Power: Minus 20 dBm minimum.
         c) Meet launch requirements of TIA/EIA 455-78. This launch condition can be achieved either within the field test equipment or by use of an external mandrel

wrap, as described in Clause 11 of TIA 568-C.3, with Category 1 light source.

d) Manufacturer: Fluke Networks.

3) Power Meter:

a) Provide 850 nm, 1,300/1,310 nm, and 1,550 nm wavelength test capability.

b) Power Measurement Uncertainty: Plus or minus 0.25 dB.

c) Store reference power measurement.

d) Save at least 100 results in internal memory.

e) PC interface (serial or USB).

f) Manufacturer: Fluke Networks.

4) Optional Length Measurement: Capable of measuring optical length of fiber using time-of-flight techniques.

3. Optical Time Domain Reflectometer (OTDR):
   a. Bright, color transmissive LCD display with backlight.
   b. Rechargeable for 8 hours of normal operation.
   c. Weight with battery and module of not more than 4.5 pounds and volume of not more 200 cubic inches.
   d. Internal nonvolatile memory and removable memory device with at least 16 MB capacity for results storage.
   e. Serial and USB ports to transfer data to PC.
   f. Single mode OTDR:
      1) Wavelengths: 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
      2) Event Dead Zone: 1 meter maximum at 1,310 nm and 2 meters maximum at 1,550 nm.
      3) Attenuation Dead Zone: 6 meters maximum at 1,310 nm and 15 meters maximum at 1,550 nm.
      4) Distance Range: 2,000 meters minimum.
      5) Dynamic Range: Minimum 10 dB at 1,310 nm and 1,660 nm.
   g. Manufacturer: Fluke Networks.
4. Fiber Microscope:
   a. Magnification: 250X or 400X for end-face inspection.
   b. Manufacturer: Fluke Networks.
5. Integrated OLTS, OTDR, and Fiber Microscope:
   a. Test equipment that combines into one instrument such as OLTS, OTDR, and fiber microscope may be used.
   b. Manufacturer: Fluke Networks.

C. Conduit Test:

1. Test and seal spare conduits.
2. Documentation: Confirm conduit test As-Built Conduit/Innerduct Installation form documentation includes details of innerducts.

D. Cable Testing:

1. Test procedures and field test instruments shall comply with applicable requirements of:
   a. LIA Z136.2.
   b. TIA/EIA 455-78.
   c. TIA/EAI 455-133.
   d. TIA 526-7.
   e. TIA 526-14.
   f. TIA 568-C.1.
   g. TIA 568-C.3.
   h. TIA TSB 140.
2. Test attenuation and polarity of installed cable plant with OLTS and installed condition of cabling system and its components with OTDR.
3. Verify condition of fiber end face.
4. Perform on each cabling link (connector to connector).
5. Perform on each cabling channel (equipment to equipment).
6. Do not include active devices or passive devices within link or channel other than cable, connectors, and splices. For example, link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
7. Document Tests:
   a. OLTS dual wavelength attenuation measurements for Single mode links and channels.
   b. OTDR traces and event tables for single mode links and channels.

E. Fiber Testing Parameters:

1. Each cabling link shall be in compliance with the following test limits:
   a. Optical Loss Testing:
      1) Backbone (single-mode) Link:
         a) Calculate link attenuation by the formulas specified in TIA 568-C.1.
         b) Values for Attenuation Coefficient (dB/km) not to exceed 0.4 dB/km for single mode fiber.
   b. OTDR Testing:
      1) Reflective Events: Maximum 0.75 dB.
      2) Nonreflective Events: Maximum 0.3 dB.

c. Magnified Endface Inspection:
   1) Visually inspect fiber connections for end-face quality.
   2) Scratched, pitted, or dirty connectors shall be diagnosed and corrected.

F. Diagnosis and Correction:

1. Installed cabling links and channels shall be field tested and pass test requirements and analysis as described herein.
2. Link or channel that fails these requirements shall be diagnosed and corrected.
3. Document corrective action and follow with new test to prove corrected link or channel meets performance requirements.
4. Provide final and passing result of tests for links and channels.

G. Acceptance: Acceptance of test results shall be given in writing after Project is tested and completed in accordance with Contract Documents and satisfaction of Owner.

H. Test Execution:

1. Optical Fiber Cable Testing:
   a. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with LIA Z136.2.
   b. 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.
      1) Record end-face images in memory of test instrument for subsequent uploading to a PC and reporting.
   c. Perform Testing:
      1) On each cabling segment (connector to connector).
      2) On each cabling channel (equipment to equipment).
      3) Using high-quality test cords of same fiber type as cabling under test.
         a) Test cords for OLTS testing shall be between 1 meter and 5 meters in length.
         b) Test cords for OTDR testing shall be approximately 100 meters for launch cable and at least 25 meters for receive cable.
2. Optical Loss Testing (OLTS):
   a. Backbone Link:
      1) Test single-mode at 1,310 nm and 1,550 nm in accordance with TIA 526-7, Method A.1, One Reference Jumper or equivalent method.

2) Test multimode at 850 nm and 1,300 nm in accordance with TIA 526-14A, Method B, One Reference Jumper or equivalent method.
3) Perform tests in both directions.

3. OTDR Testing:
   a. Test backbone, horizontal, and centralized links at appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
      1) Single-mode: 1,310 nm and 1,550 nm.
      2) Multimode: 850 nm and 1,300 nm.
   b. Test each fiber link and channel in one direction.
   c. Install launch cable between OTDR and first link connection.
   d. Install receive cable after last link connection.
4. Length Measurement:
   a. Record length of each fiber.
   b. Measure optical length using OLTS or OTDR.
5. Polarity Testing:
   a. Test paired duplex fibers in single fiber cables to verify polarity in accordance with subclause 10.3 of TIA/EIA 568-C.1.
   b. Verify polarity of paired duplex fibers using OLTS.
6. Test Results Documentation:
   a. Test results saved within field-test instrument shall be transferred into Windows-based database utility that allows for maintenance, inspection, and archiving of test records. These test records shall be uploaded to the PC unaltered. For example, “as saved in the field-test instrument.” The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
   b. Available for inspection by Owner or Owner’s representative during installation period. Submit within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling.
   c. Database for Project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to Owner acceptance of building. CD-ROM shall include software tools required to view, inspect, and print test reports.
   d. Circuit IDs reported by test instrument shall match specified label identification.
   e. Provide in electronic database for each tested optical fiber with the following information:
      1) Identification of Site.
      2) Name of test limit selected to execute stored test results.
      3) Name of personnel performing test.
      4) Date and time test results were saved in memory of tester.

5) Manufacturer, model, and serial number of field test instrument.
6) Version of test software and version of test limit database held within test instrument.
7) Fiber identification number.
8) Length for Each Optical Fiber: Optionally the index of refraction used for length calculation when using a length capable OLTS.
9) Test results to include OLTS attenuation link and channel measurements at appropriate wavelength and margin; difference between measured attenuation and test limit value.
10) Test results to include OTDR link and channel traces, and event tables at appropriate wavelength.
11) Length for each optical fiber as calculated by the OTDR.
12) Overall pass/fail evaluation of link-under-test for OLTS and OTDR measurements.
13) Magnified Endface Inspection:
    a) Picture or image of each fiber end-face.
    b) Pass/fail status of end-face based upon visual inspection.

7. UTP Copper Cabling:
   a. The Contractor shall test all cables and submit all horizontal copper cable test result data in electronic format, with the resulting file formatted with one test result per 8.5-inch by 11 inch page. Provide the test results in an acceptable format:
      1) Export or download the test results from the cable tester to a *.txt format.
      2) Then open the *.txt file in Microsoft Word and save the fileas a *.docx file.

I. Drawings:

1. Record Copy: Provide at end of Project on CD-ROM.
   a. CAD format and include notations reflecting as-built conditions of additions and variations from the Drawings provided, such as to cable path and termination point.
   b. CAD drawings are to incorporate test data imported from test instruments.
2. As-built Drawings:
   a. Include, but not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts, and frame installation details.

b. Include field changes made up to construction completion:
   1) Field directed changes to pull schedule.
   2) Field directed changes to cross connect and patching schedule.
   3) Horizontal cable routing changes.
   4) Backbone cable routing or location changes.
   5) Associated detail drawings.

3.05 WORK IN EXISTING FACILITIES.

A. Install Single Mode Fiber Optic Cable in underground conduit from the newly installed Network panel in the Blower Building to the existing Control Building (Operations Center).

B. The fiber termination in the existing Control Building will be carried out by an Owner appointed contractor. The Installing Contractor for this Project shall coordinate with the Client for scheduling and fiber testing.

C. The existing conditions shall be clarified during the Mandatory Site Visit.

3.06 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this specification:

1. As-Built Fiber Optic Cable Installation Form.

END OF SECTION

PROJECT: Haikey Creek WWTP, Activated Sludge Management Rehabilitation

Contractor: _____

Signed by: _____

AS-BUILT FIBER OPTIC CABLE INSTALLATION

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/Innerduct Installation forms for identification of conduits/innerducts cable is routed through.

Acceptable Attenuation:
Multimode Fibers

			cable length*
850 nm:	3.5 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

END OF SUPPLEMENT

SECTION 40 96 00
APPLICATIONS SOFTWARE

PART 1 GENERAL

1.01 WORK INCLUDED

A. General: Work includes design, furnishing, testing, documenting, training, and starting up the Process Instrumentation and Control (PIC) Applications software, complete.

B. Major applications software work items include:

1. Work sequence and schedule.
2. Applications software workshops.
3. Applications software submittals.
4. Applications software development, including:
    a. Allen-Bradley PLC programming for new H0X0-XXX1-PLC01.
    b. PLC and SCADA interface with new PLC's provided under this Contract.
    c. Wonderware Intouch SCADA system upgrades and modifications, including new tags, new displays, I/O driver configuration, and updates to alarms and historian.
    d. Integration of new Operator Interface Terminal (OIT) at main PLC panel.
5. Software testing.
6. Software installation.
7. Software documentation.
8. O&M development.
9. Owner training.
10. Startup.

1.02 DIVISION OF WORK

A. Software Supplier: Employ a Software Supplier as part of the PIC scope indicated in Section 40 90 00, Instrumentation and Control for Process Systems, to implement the applications software specified herein.

B. Contractor: The Contractor shall have overall system responsibility and shall provide all additional materials and work necessary to supplement the work provided by the Software Supplier and thereby satisfy all requirements of this section.

1.03 OWNER ICS STANDARDS AND SITE ACCESS

A. Site Access: Access to site and to existing SCADA system hardware and networks is restricted to qualified companies and individuals as specified in Section 40 90 00, Instrumentation and Control for Process Systems. Obtain specified certifications and approvals for work on site.

B. Perform all work in accordance with Owner standards specified in Section 40 90 00, Instrumentation and Control for Process Systems.

1.04 DEFINITIONS

A. Abbreviations:

1. HMI: Human Machine Interface.
2. I&C: Instrumentation and Control.
3. I/O: Inputs and Outputs.
4. O&M: Operation and Maintenance.
5. ORT: Operational Readiness Test.
6. P&ID: Process and Instrument Diagram.
7. PC: Personal Computer.
8. PIC: Process Instrumentation and Control.
9. PLC: Programmable Logic Controller.
10. PAT: Performance Acceptance Test.
11. SCADA: Supervisory Control and Data Acquisition System (i.e., Wonderware InTouch).
12. SDT: Software Demonstration Test.
13. SLC: Single Loop Controller.

B. Instructor Day: 8 hours of actual instruction time.

C. Loop Specifications: Lists and descriptions in Article Supplements, giving additional requirements for individual control loops.

D. Software:

1. Programming of digital devices 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.

E. Types of Software:

1. Standard Software: Software packages that are independent of project on which they are used. Standard software includes system software and SCADA development and view software.
    a. System Software: Application independent software developed by Microsoft. Includes, but is not limited to, Microsoft's NT operating system; file management utilities; text editors; debugging aids; and diagnostics.
    b. SCADA Development and View Software: 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. Application Software:
    a. Software to provide functions unique to this Project and that are not provided by standard software alone.
    b. Developing SCADA HMI graphic display screens, active screen objects, and screen navigation. Configuring alarm and historical tags, alarm notification, historical logging and trending.
    c. Configuring databases, tables, displays, reports, parameter lists, programming ladder logic and control strategies required to implement functions unique to this Project.

1.05 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. Milestone Breakdown (MB): Summarize the major milestones for work provided along with the major milestones.

C. System Delivery Plan (SDP):

1. The intent of the SDP is to:
    a. Coordinate and communicate applications software design and testing activities.
    b. Coordinate interactions with the Owner regarding workshops, submittal reviews, work progress, test witnessing, training, etc.
    c. Communicate and clarify required work sequences and major milestones.
2. Minimum Content:
    a. Work sequence and schedule.
    b. Applications software workshops.

c. Applications software submittals.
d. Applications software development.
e. Software testing.
f. Software installation.
g. O&M development.
h. Owner training.
i. Startup.

1.06 SOFTWARE DESIGN WORKSHOPS

A. Location: Owner's facility during the course of the Project.

B. Kick off Meeting Objective: To enable the Owner communicate with the Integrator/Programmer (Software Suppler) about the expectations as well to share the existing software details including System Graphics to provide direction for Program development to ensure compatibility with existing System.

C. Subsequent meetings to oversee the progress of applications software development.

D. Documentation: Software Supplier summarize resolutions reached in each workshop and distribute copies to Owner and Engineer.

E. Order and minimum topics to be covered in each Software Design Workshop as follows. Some workshops may be combined with Owner approval.

1. Applications Software Design Workshop (kick off) that establishes project processes, including:
   a. Software Supplier and Contractor organization and reporting procedures.
   b. Workshop objectives.
   c. Submittal process.
   d. Review work sequence and schedule.
   e. Share details of existing systems.
   f. Review Owner's Standards.
2. Software Standards Workshop:
   a. Objective: To review and develop PLC and SCADA standards in a participative workshop with Owner.
   b. Design products and topics to be finalized:
      1) Existing SCADA system integration.
      2) Tag Naming Conventions: Provide initial list of PLC and HMI tags for Owner to review. Final tag assignments will be made by Owner.
      3) Process graphic standards object symbols, colors, fonts, etc.
      4) Display paging and navigation methods.
      5) Equipment control through popup windows.

6) Display philosophy, organization, and operation.
7) General data entry through the HMI.
8) Security.
9) Alarm Management: Operation of the alarms, alarm areas, alarm filtering.
10) Trending.
11) Historical data storage and retrieval. Define which tags will be assigned to historical tagging.
12) File naming convention.
13) Network IP addressing.

3. Control Narrative, P&ID Review Workshop: Software Supplier uses P&IDs and Control Narrative to present how the proposed control system design and Applications Software will meet the functional requirements specified.
4. Software Pre-Development Workshops:
   a. Objectives: To present to Engineer and Owner how Applications Software Supplier will implement functional requirements of this section.
   b. Present information on:
      1) Program Flow Diagram(s) showing all software sections, subsections, function blocks, subprograms, and their interrelationships.
      2) SCADA/PLC I/O Database listing.
      3) SCADA Screen sketches that illustrate dynamic objects, how control functions are controlled and monitored, how equipment is controlled and SCADA screen navigation.

1.07 SUBMITTALS

A. Action Submittals:

1. Software Standards Submittals: Developed in a Software Workshop, Documented and Submitted as software standards.
2. Control Narrative Submittal:
   a. Timing: Following Control Narrative and P&ID Review Workshop.
   b. Content: Updated version of control narratives.
3. Software Pre-Development Submittal:
   a. Application Software Functional Documentation: Functional diagram following ISO 31320-1 IDEF0.
   b. Submit sample Graphics for review. These shall be prepared based on information received in the Kick off Coordination meeting.
   c. A list of planned tags with clear descriptions. The Owner will assign final tags based on the submitted list.

4. Software Design Submittal: Detailed description of SCADA Configuration and PLC program on a Unit Operation Basis. Submit this during program development stage.
    a. An updated version of all information presented in Software Pre-Development Submittal.
    b. Documented PLC Program.
    c. Print out of SCADA screens.

B. Informational Submittals:

1. Applications 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 and test witnessing.
    c. Prior to this acceptance, Engineer will not review Submittals or witness tests.
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.
    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 Standard Software packages.
        2) Licensed copies of Standard Software packages.
        3) Updated versions of material provided under Shop Drawing Submittals for Applications Software Design and Development.
        4) Applications software source files in native electronic format.

PART 2 PRODUCTS

2.01 PLC APPLICATION SOFTWARE DESIGN CRITERIA

A. All PLC code shall be developed in LADDER logic except where infeasible to do so (no function block, structured text, etc., allowed). Use Rockwell Studio 5000 software for programming.

B. PLC Program Design:

1. The programmable logic controller system (PLC) shall be used to provide facility automatic control, alarm functions, and continuous loop control. Specific PLC functional requirements are described in the Control Narrative attached as Supplement to this specification.
2. No control routines, control algorithms, or control logic shall be implemented in SCADA.
3. Break PLC applications software into:
    a. Sections:
        1) Contains all logic for a specific unit operation.
        2) Each section consists of a general logic subsections and, followed by unit operation subsections.
    b. Subsections: Contains logic for specific equipment such as a pump, valve, or loop.
4. Standard Functions:
    a. Program all standard functions in the same manner, using the same logic, program order, and documentation nomenclature.
    b. Standard functions are specified in Supplement PCN, Process Control Narratives.
5. Program Documentation:
    a. Note and describe start of a new program section.
    b. Briefly describe control objectives.
    c. Identify subsections.
    d. Subsection documentation includes brief description of control objective followed by a description and tag of the equipment being controlled.

C. PLC Program Documentation:

1. Ladder Diagram Description:
    a. Written overview description of each ladder logic program.
    b. Lead user through sections, subsections, and functions of programs.
    c. Generally describe functions being implemented including software used to implement functional requirements of this specification.
2. Ladder Diagram Logic Listings:
    a. Include a description for each element (input, output, or special function).
    b. Comments that describes function of ladder rungs. Average of one 60-character comment line per ladder rung.
    c. Complete ladder diagram logic listings.

2.02 SCADA APPLICATION SOFTWARE DESIGN REQUIREMENTS

A. General:

1. The Applications Software Supplier shall develop SCADA design to 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.
2. SCADA system is existing Wonderware InTouch. Integrate the work associated with this project to match appearance, color and style, navigation, and graphical symbols.
3. The following outlines key objectives in designing SCADA graphics displays:
    a. Familiar format, look and feel for plant operation staff.
    b. Easily navigated menus.
    c. Provide no more than three mouse actions to navigate to any control display.
    d. Maintain consistency in graphic display and controls design.
    e. Maintain consistent and predictable window operations.
    f. Accurate representation of the plant and its operations.
    g. Represent control options in an easily understood fashion.
    h. Develop help screens to provide additional information to help the operations staff understand the control options where complex operations are required.
    i. Where possible, design overview displays similar to the physical layout of the facility. The perspective to the physical layout should be from the local main control room.
    j. Provide operator access to process and alarm setpoints, including the following:
        1) Process alarms (HIGH-HIGH, HIGH, LOW, and LOW-LOW).
        2) Pump and equipment control setpoints.
        3) Process timer setpoints.
        4) Sequence setpoints.

2.03 SCADA/PLC I/O DATABASE

A. SCADA/PLC I/O Database:

1. The Software Supplier shall update the Owner’s existing Database with all existing attributes and the following features:
    a. Coordinate, manage and document all SCADA database points including those communicated between the PLCs and SCADA.

b. The database shall contain all the fields necessary to configure the various points including:
   1) Tag Name.
   2) PLC Address and Node.
   3) Data Format: Real (floating point), Integer, Discrete (Boolean).
   4) Access Type: Read/Write or Read Only.
   5) Scale Range for analog values.
   6) Zero and One State for discrete values, e.g., ON/OFF, or OPEN/CLOSE.
   7) Point Description.
   8) Engineering Units.

2.04 PLC AND SCADA FUNCTIONS

A. Refer to Supplement PCN, Process Control Narratives.

PART 3 EXECUTION

3.01 TESTING

A. General:

1. Test software to demonstrate that the applications software satisfies requirements outlined in the Control Narratives, and described in submittals, and workshops.
2. Test Format:
   a. Cause and Effect:
      1) Person conducting test initiates input (cause).
      2) Specific test requirement is satisfied if correct result (effect), occurs.
3. Procedures, Forms, and Checklists:
   a. Perform testing on a unit operation and loop basis that is coordinated with the PIC testing and startup.
   b. The Software Supplier shall generate testing forms, and checklists from the SCADA/PLC database and Control Narratives.
   c. Have space after each test item description for sign off by appropriate party after satisfactory completion.

B. Software Demonstration Tests (SDT):

1. Scope: Test new PLC and SCADA equipment and functions to demonstrate that it is operational. The SDT shall be successfully completed to the satisfaction of the Engineer before the software is loaded on to the Plant SCADA and PLC.
2. Location: Software Suppliers facility.

3. SCADA Display Tests: The Object of the test is to verify all SCADA database points and points communicated between SCADA and PLC. Test and verify each SCADA display and dynamic object on that display and control. Provide a test form for each display that lists all of dynamic objects, controls, pop-up windows and their associated database tags and corresponding PLC address. The test form shall provide a place for a sign off for the Software Supplier and Engineer.
4. SCADA Display Navigation Test: The Objective of the test is to verify all the display navigation controls.
5. Loop-Specific Functions: Demonstrate functions shown on P&IDs, specified in the Control Narratives, described in submittals, and workshops. This test shall not be started until the Display and Display navigation tests have been successfully completed. This test shall verify all SCADA and PLC functions through indications on SCADA and the PLC programming software. The Applications Software Supplier shall develop a test form for each unit or loop. The form shall list all controlled equipment, control routines, alarm points, status points, setpoints, controllers, and sequences. The test shall demonstrate all manual and automatic functions are operating as specified and verify that the outputs and inputs are configured to the correct PLC I/O point.
6. Make following documentation available to Owner at Test Site both before and during SDT:
    a. Control Narratives.
    b. Software Pre-Development submittal.
    c. Software design submittal.
    d. O&M material.
    e. Master copy of SDT sign off sheets.
    f. Applications software documentation.
    g. IDEF0 Diagrams

C. Phase 1 Operational Readiness Test Provided by the Contractor: Prior to Phase 2 ORT, startup test period and PAT, inspect, test, and document that entire PIC is ready for operation. Performed by PIC Contractor to test and document PIC, excluding Software Supplier provided PLC and SCADA applications software.

D. Phase 2 Operational Readiness:

1. Phase 2 ORT: Combined effort between Contractor and Software Supplier to confirm that PIC, including applications software, is ready for operation.
    a. Prerequisite: Completion of Phase 1 ORT.
    b. Joint test with Software Supplier. Repeat of Software Supplier’s SDT, except using real field sensors and equipment. Plant interlocking and communications with PLCs and SCADA shall be tested on loop-by-loop basis.
    c. Test procedures provided by Software Supplier based on Loop Specifications.

E. Performance Acceptance Tests (PAT): These are the activities that Section 01 91 14, Equipment Testing and Facility Startup, refers to as performance testing.

1. Once ORT Phase 1 and Phase 2 has been completed and facility has been started up, perform a witnessed PAT on complete PIC and software to demonstrate that it is operating as required by the Contract Documents and control narratives. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop basis.
2. Loop-specific and non-loop-specific tests same as required for SDT except that entire installed PIC tested using actual process variables and all 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 PAT available to Owner at Site, both before and during tests.
6. Make one copy of all software O&M manuals available to the Owner at the Site both before and during testing.

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 videotapes of all training sessions.

B. Operations:

1. Provide a minimum of 2 days of training at the Site indicated by the Owner for Owner's personnel in the operation of the new SCADA upgrades and new PLC. Training shall include:
   a. Standard operational features of PLC equipment provided.
   b. Specific features provided for this project including:
      1) General Loop functions.
      2) Operation of Each Loop: For example, AUTO/MANUAL control, control setpoint settings, control mode selection, alarm acknowledgment.
      3) Operation of each new and revised SCADA HMI screen display, dynamic objects, and controls associated with each display.
2. Alarm Summary:
   a. Describe each SCADA alarm, including SCADA tag name, detailed description of the alarm, probable cause, suggested operator action(s).
   b. The Alarm summary shall be configured in Microsoft Excel.

C. Software Maintenance:

1. Provide a minimum of 5 days of training at the Site indicated by the Owners for personnel in the maintenance of the PLC and SCADA software.
2. Software functions review.
3. HMI Screens.
4. Documented ladder diagrams.
5. SCADA/PLC I/O Database.

3.03 O&M MANUALS

A. General:

1. Provide the following:
   a. Suggested startup procedures.
   b. Training material.
   c. Alarm summaries.

B. Software:

1. Provide the following:
   a. Finalized Loop Specifications.
   b. Program flow diagrams.
   c. Documented ladder programs.
   d. PLC/SCADA I/O database, forms, queries, and reports.

END OF SECTION

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 (1000 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. UL: 508A, Standards for Safety, Industrial Control Panels.

1.02 SYSTEM DESCRIPTION

A. This specification details control and panel requirements for the vendor panel included for the Project.

B. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer’s factories.

C. 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.
2. Catalog information on electrical devices furnished with system.
3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
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.

5. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.
6. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.
7. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.
8. Seismic anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Programmable Controller Submittals:
   a. Complete set of user manuals.
   b. Fully documented ladder logic listings. Include descriptions for each task, ladder rung, and program element.
   c. Functional diagram in accordance with ISO 31320-1 IDEF0.
3. Final electronic copy of PLC program for each PLC provided, for onsite backup.
4. Manufacturer's list of proposed spares, expendables, and test equipment.
5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' 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, two minimum, of each type used.
3. Fuse: 100 percent, five minimum, of each type used.
4. Surge Suppressors: 20 percent, one minimum, of each type used.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instrumentation items in accordance with specifications in Section 40 91 00, Instrumentation and Control Components.

2.02 SIGNAL CHARACTERISTICS

A. Analog Signals:

1. 4 mA dc 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.

D. As defined in Section 40 90 00, Instrumentation and Control for Process Systems.

2.03 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering; Model A-HCI.

2.04 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:

1. Three-point latching mechanisms in accordance with NEMA 250 Type 1 and 12 panels with doors higher than 18 inches.
2. For other doors, stainless steel quick release clamps.

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. Furnish cooling fans with air filters if required to dissipate heat.
3. For panels outdoors or in unheated areas, furnish thermostatically 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 100-watt incandescent 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. H.F. Cox.

N. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.

1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

2.05 CONTROL PANEL ELECTRICAL

A. UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.

B. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

C. Control Panels without Motor Starters:

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. Breaker Manufacturers and Products:
      1) Heineman Electric Co.; Series AM.
      2) Airpax/North American Philips Controls Corp.; Series 205.

D. Control Panels with Three-Phase Power Supplies and Motor Starters:

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. 18,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified.
   c. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
   d. 42,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified in package system equipment specification sections.
   e. 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. 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.
3. Terminal Block, 120-Volt Power:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30 amp.
   c. Wire Size: 22 through 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.

f. Spacing: 0.25 inch, maximum.
g. Manufacturer and Product: Entrelec; Type M4/6.

4. Terminal Block, Ground:
   a. Wire Size: 22 through 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. Manufacturer and Product: Entrelec; Type M4/6.P.
5. Terminal Block, Blade Disconnect Switch:
   a. Use: Provide one for each discrete input and output field interface wire.
   b. Rated Voltage: 600V ac.
   c. Rated Current: 10 amp.
   d. Wire Size: 22 through 12 AWG.
   e. Rated Wire Size: 12 AWG.
   f. Color: Gray body, orange switch.
   g. Spacing: 0.25 inch, maximum.
   h. Manufacturer and Product: Entrelec; Type M4/6.SN.
6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   b. Rated Current: 6.3 amp.
   c. Wire Size: 22 through 12 AWG.
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
   h. Indication: LED diode 24V dc.
   i. Leakage Current: 5.2 mA, maximum.
   j. Spacing: 0.32 inch, maximum.
   k. Manufacturer and Product: Entrelec; Type M4/6.SFD.
7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 6.3 amp.
   c. Wire Size: 22 through 12 AWG
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
   h. Indication: Neon lamp 110V ac.
   i. Leakage Current: 1.8 mA, maximum.

j. Spacing: 0.32 inch, maximum
k. Manufacturer and Product: Entrelec; Type M4/6.SFL.

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. 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 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.
3. 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.
4. PLC Interface Relay:
   a. Type: Narrow design for high density and direct connection of field wiring to relay terminals.
   b. Function: Covert PLC input to dry contact for isolated discrete signal interface.
   c. Relay Mounting: Plug into terminal block style socket.
   d. Socket Mounting: DIN rail.
   e. Socket Width: 0.25 inch nominal.
   f. Coil Voltage: 120V ac or 24V dc to suit application.

g. Coil Power: 0.5 VA.
h. Expected Mechanical Life: 10,000,000 operations.
i. Operating Indicator: LED lights when coil is energized.
j. Contact Arrangement: One Form C, SPDT contact.
k. Contact Rating: 5A, at 24V dc and 250V ac.
l. Connection Type: Screw compression clamp.
m. Terminal Marking: Numbered with preprinted or field-marked tags.
n. Manufacturers and Products:
1) Phoenix Contact; PLC-RSC Series.
2) Allen-Bradley; Bulletin 700-HL Terminal Block Relays.
3) Idec; RV8H Series.

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.
d. Contact Material: Silver cadmium oxide alloy.
e. Coil Voltage: As specified 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 to 80 percent or range.
i. Time Delay Setpoint: As specified or shown.
j. Mode of Operation: As specified or shown.
k. Adjustment Type: Integral potentiometer with knob external to dust cover.
l. Manufacturer and Products: Potter and Brumfield.
1) Series CB for 0.1-second to 100-minute delay time ranges.
2) Series CK for 0.1- to 120-second delay time ranges.

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.
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.

K. Programmable Controllers:

1. Solid state units capable of performing same function as conventional relays, timers, counters, drum sequencers, arithmetic, and other special functions necessary to perform required control functions.
2. Analog Inputs and Outputs: Isolated 4 mA dc to 20 mA dc per channel.

3. Discrete Inputs: 120V ac or 24V dc via contact closure.
4. Discrete Outputs: Isolated dry contacts or voltage outputs driving a PLC relay. Discrete output contacts shall be rated for 2 amps minimum at 120V ac.
5. Each input and output shall have an LED ON/OFF status indicator.
6. Minimum of 25 percent excess capacity for inputs, outputs, internal memory, and other necessary functions.
7. Capable of operating in a hostile industrial environment (for example, heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering. Units operate from 0 degrees C to 60 degrees C and up to 95 percent humidity, noncondensing.
8. Program using conventional relay ladder diagram notation.
9. Manufacturers:
    a. Allen-Bradley, ControlLogix, L7x or L8x series CPU, firmware version 24 or latest Owner standard.
    b. Contractor shall provide copy of Allen-Bradley Rockwell Studio 5000 licensable to “the City of Tulsa Water Pollution Control Section” to facilitate future maintenance of the PLCs provided in this Project.

L. Operator Interface Unit:

1. Color LCD display with graphics and text displays, screen navigation, status and alarm indication, and operator control and setpoint adjustment.
2. Touch screen or membrane keypad interface.
3. Size: 12-inch diagonal minimum.
4. Manufacturers and Products:
    a. Allen Bradley; Panelview Plus 6.
    b. Configuration Software: Developed with Rockwell Software FactoryTalk View Studio for Machine Edition, v8.1 or higher.

M. Communication with Facility PLC and Plant SCADA:

1. Method: PLC data communicated over Ethernet network via EtherNet/IP.
2. IP Addresses: Assigned during construction to integrate into plant subnet.
3. Connection: Provide an independent Ethernet copper connection directly from the PLC, Ethernet module, or industrial Ethernet switch. Connection must be separate from any other internal I/O network.
4. Communication Method: Communicate via Allen-Bradley EtherNet/IP to allow messaging reads and writes initiated by plant PLC and/or SCADA.
5. Provide detailed data listing with all available data points and tag.

6. Communicated Data:
    a. All alarm conditions.
    b. All equipment running status.
    c. Process data such as level, flow, pressure.
    d. Additional data as specified in specific vendor specification sections.
    e. UPS Status:
        1) Battery Low.
        2) UPS Fault (information to be communicated from Section 40 91 00, Instrumentation and Control Components).

N. Industrial Ethernet Switch:

1. Function: Connect industrial control devices for Ethernet communication.
2. Performance:
    a. Operating Temperature: Minus 10 degrees C to 60 degrees C.
    b. Operating Humidity: 10 percent to 95 percent non-condensing.
    c. Operation: Plug and play.
    d. Auto Sensing: Duplex, Speed, and Cable Type.
3. Approvals:
    a. FCC Part 15 Class A.
    b. UL Listed.
    c. Noise: EN 61000-6-2 and EN 61000-6-4.
    d. RoHS Compliant.
4. Features:
    a. Ports: RJ-45 Ethernet 10/100BaseTX ports, quantity as required plus minimum one spare.
    b. Mounting: DIN-Rail.
    c. Indicators:
        1) Per Switch: Power.
        2) Per Port: Link and Activity.
5. Power Input: 10V dc to 30V dc.
6. Manufacturers and Products:
    a. N-TRON; 300TX series.
    b. Phoenix Contact; FL Switch SFNB TX series.

O. 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, 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.
    c. Manufacturers and Products:
        1) Eaton/Cutler-Hammer; Type 10250T.
        2) General Electric; CR2940U.
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-Idec; Standard Cam Switch.
        2) Electroswitch; 31.

P. 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, 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.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
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.

2.06 INSTRUMENT TAG NUMBERS

A. As shown on P&IDs.

2.07 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

A. Nametags: Permanently mounted bearing entire ISA 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. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
2. Color: White with black letters.
3. Letter Height: 3/16 inch.
4. For each panel, face mounted laminated nameplate inscribed with the panel name and tag number. Color shall be white with black letters 1/2 inch high.

C. Standard Light Colors and Inscriptions:

1. 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	Green
MANUAL	MANUAL	Red
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

Tag	Inscription(s)	Color
FORWARD	FORWARD	Red
REVERSE	REVERSE	Blue

2. Lettering: Black on white and amber lenses; white on red and green lenses.
3. Standard Pushbutton Colors and Inscriptions:
   a. Use following unless otherwise noted in Instrument List:

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: Emerson Edco PC-642 or SRA-64 series.
2. 120V ac Lines: Emerson Edco HSP-121.

3. 480-Volt, Three-Phase Power Supplies: Square D Model SDSA3650.
4. Field Mounted at Two-Wire Instruments:
   a. Encapsulated in stainless steel pipe nipples.
   b. Emerson Edco SS64 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.

G. Grounding:

1. Coordinate surge suppressor grounding in field panels and field instrumentation as specified in Section 26 05 26, Grounding and Bonding for Electrical Systems, and suppressor manufacturer's requirements.
2. 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.

END OF SECTION

SECTION 41 61 29
FRONT END LOADER

PART 1 GENERAL

1.01 SUMMARY

A. This section includes furnishing, delivering, and placing into service two new Front End Loader (FEL)s complete with an operating cab, bucket, and appurtenances necessary for a fully functioning unit.

B. Equipment shall be suitable for continuous operation at a wastewater treatment facility, including biosolids, and general material handling. The loader work environment shall be similar to fertilizer plants, chemical industries, and agricultural facilities. The loader shall be a corrosion resistant configuration capable of long-term facility operations.

C. All equipment furnished under this Contract shall be new, unused, and the same as the manufacturer’s most current production model. Accessories not specifically mentioned herein, but necessary to furnish a complete unit ready to use, shall be all-inclusive. The unit shall conform to the highest standards of overall design, quality of workmanship and materials. All assemblies, sub-assemblies and components parts shall be standard and interchangeable throughout the entire quantity of units as is specified in these bid specifications.

D. Loader shall be suitable for high-production speed operations with low cycle times maintainable under turning and lifting under heavy loads simultaneously.

1.02 DEFINITIONS

A. Dump Clearance: The vertical distance measured from finished grade to the lowest point of the bucket bolt-on edge at full lift and 45-degree dump angle.

B. FEL: Front End Wheel Loader.

C. Tipping Load: The maximum load that causes the loader to pivot about its front axle.

1.03 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s technical data sheet for the proposed FEL includes engine, drivetrain, hydraulic system, rated operating capacity, dimensions, and dump clearance.
    a. Dimensional drawings showing overall height, width, turning radius, maximum dump clearance, and reach lengths.
    b. Factory engine horsepower and torque curves and data sheets for lifting capacity and cycle times.
2. Manufacturer’s ejector bucket and hydraulics to control bucket.
3. Manufacturer’s catalog information, description literature, specifications, and materials of construction.
4. Manufacturer’s tire specifications and data sheet of tire size, ply rating, tread pattern, and suitability for specific site terrain.
5. Manufacturer’s coupler specifications and data sheet with attachment compatibility.

B. Informational Submittals:

1. Operation and maintenance manual.
2. Warranty documentation.
3. Emission certifications for EPA and local regulatory certification documents providing engine emission tier compliance.

1.04 QUALITY ASSURANCE

A. Equipment is required to be new, from a manufacturer regularly engaged in the production of heavy construction equipment.

B. Manufacturers shall have a minimum of 5 years of experience producing machines of similar size and capacity.

C. Equipment shall comply with applicable OSHA, SAE, ISO, and EPA requirements.

D. Service center shall be within 100 miles of the Site’s location.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Loaders shall be packaged and shipped to the facility for possible temporary storage. Weatherproofing and sealing shall have a shrink wrap encapsulation with appropriate ventilation and access panels. Include any means required for temporary storage up to 18 months in an unprotected outdoor environment.

B. Deliver equipment is fully assembled, serviced, and ready for operations.

C. Delivery and acceptance shall have an Owner, Owner's Representative, or Engineer onsite prior to bill of lading, delivery acceptance, or similar being approved.

1.06 WARRANTY

A. Provide a full manufacturer's warranty covering the entire machine for a minimum period of 12 months or 2,000 operating hours, whichever occurs first, starting from the official date of machine commissioning at the project site.

B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers and Products:

1. John Deere; 644P.
2. Case; IH 821G.
3. Hitachi; ZW220-7.
4. Cat; 950 NextGen.

2.02 SERVICE CONDITIONS

A. Material Conveyed: Dewatered sludge (cake), shredded wood chip amendment, blending sludge and woodchips as a feedstock, finished compost material.

B. Material Bulk Density:

1. Woodchip Amendment: Approximately 550 pounds per cubic yard.
2. Compost Feed Stock: Approximately 800 pounds per cubic yard.
3. Dewatered Sludge: 1,250 to 1,650 pounds per cubic yard.
4. Compost: Approximately 900 pounds per cubic yard.

C. Operational Hours: 8 hours per day, 5 days per week.

D. Environment: The material to be hauled, loaded, or moved will come from a municipal wastewater treatment composting facility.

2.03 MATERIALS OF CONSTRUCTION

A. All loader materials of construction shall be suitable for corrosive environments.

B. Hinges, pins, bushings, and any linkages utilized on the loader shall have appropriate preventive measures to provide corrosive resistance.

C. All bucket bolt-on cutting edges must be secured using Grade 8 plow bolts and heavy-duty mechanical locking nuts.

2.04 FRONT END LOADER REQUIREMENTS

A. Engine:

1. The wheel loader shall be powered by a heavy-duty, turbocharged, charge-air-cooled diesel engine. The engine must deliver a net flywheel power output of no less than 200 hp(149 kW) and no greater than 250 hp (186 kW) at rated engine speed, measured in accordance with ISO 9249 or SAE J1349 standards.
2. The engine must be fully certified by the manufacturer to meet United States Environmental Protection Agency (EPA) Tier 4 Final emission regulations.
3. The fuel and Diesel Exhaust Fluid (DEF) filler necks must be easily accessible from ground level. The fuel tank must include an integrated water separator and a multi-stage micron fuel filtration system to protect the high-pressure common-rail injection system from site contaminants.
4. The engine shall include an automatic glow-plug or intake air heater cold-start aid system, and the engine control module (ECM) must feature automatic derating protections for low oil pressure or high coolant temperatures.

B. Operating Weight Minimum: 40,000 pounds to 45,000+ pounds.

C. Height to Hinge Pin: Minimum 13 feet.

D. Overall Operating Height with Bucket Fully Raised: 20 feet.

E. Transmission: Power shift or automatic transmission with minimum four forward and three reverse speeds.

1. The wheel loader shall be equipped with a heavy-duty, fully automatic countershaft powershift transmission, a hydrostatic transmission, or a continuously variable transmission (CVT) engineered for high-production loading applications.

2. The transmission must feature a minimum of four forward gears and three reverse gears. The shifting logic must be electronically controlled with smooth, proportional modulation to eliminate severe driveline shock during directional changes.
3. The transmission must feature integrated Forward-Neutral-Reverse (F-N-R) electronic directional switches located simultaneously on both the main steering control (steering wheel pod or steering joystick) and the primary hydraulic loader joystick for immediate thumb access.
4. The transmission control module (TCM) must include built-in electronic protection to prevent rapid downshifting or high-RPM directional reversals that could cause mechanical over-speed or transmission failure.

F. Hydraulics:

1. Load-sensing or pressure compensated with auxiliary hydraulic capabilities. The system must automatically balance and distribute hydraulic flow to allow simultaneous, unhindered operation of lift, tilt, and steering functions under full payload.
2. The wheel loader shall feature a high-efficiency hydraulic system capable of a total laboratory-tested Hydraulic Cycle Time (Raise, Dump, and Float Down combined) not to exceed 10.2 seconds while handling the maximum rated payload.

G. Operable minus 20 degrees F to 115 degrees F; sealed harnessing; corrosion-resistant coatings; cyclonic pre-cleaner; cold-start aids as required.

2.05 LOADER AND BUCKET

A. The primary bulk handling bucket shall be a hydraulically actuated, heavy-duty High-Dump/Ejector style bucket designed for quick-coupler integration. The bucket must utilize dual, fully enclosed hydraulic cylinders to mechanically discharge or roll out material, maximizing dump clearance height and eliminating sticky material carry-back.

B. Bucket: General purpose bolt-on edge 7 cubic yards with ejector bucket.

C. Cutting edge shall be a flat, singular, bolt-on reversible style blade.

D. Dumping Clearance: 11 feet.

E. Z-bar or equivalent heavy-duty loader linkage.

F. The wheel loader shall be equipped with a factory-installed, hydraulically actuated quick-coupler system to allow the operator to change attachments rapidly from within the cab

2.06 CAB AND OPERATOR ENVIRONMENT

A. The operators cab shall be fully enclosed roll-over protective structure (ROPS) and falling-object protective structure (FOPS) certified cab.

B. The cab shall include a heavy-duty HVAC system with an integrated multi-stage air filtration system. Because the machine will operate in a corrosive environment, the intake must utilize a HEPA and activated carbon filtration element to protect internal electronics and the operator from airborne chemical dust.

C. Primary mirrors equipped with dual, heavy-duty, heated exterior rearview mirrors. The mirrors must feature electronic remote adjustments form the operators cab.

D. Spot or auxiliary mirrors integrated onto the lower portion of the primary mirror assemblies or mounted independently to eliminate blind spots along the flanks or rear tires of the machine.

E. A wide-angle interior rearview mirror shall be mounted inside the cab windshield to provide immediate visibility of the rear deck area.

F. The cab operators seat shall feature a premium heavy-duty air-suspension system with an integrated 12V or 24V electric compressor. The adjustable suspension seat to provide multi-axis movements. The seat upholstery shall be heavy-duty, moisture-resistant, and high durability vinyl or heavy-weave industrial cloth that is non-porous and easily cleaned. The safety belt equipped with a high-visibility, retractable belt compliant with industry standards.

G. The loader shall utilize low-effort, multi-axis electro-hydraulic joystick controls for all boom and bucket functions. The primary control joysticks, transmission directional switch (F-N-R), and auxiliary hydraulic controls shall be fully integrated into, and move synchronously with, the adjustable right-hand seat armrest console.

H. An electro-hydraulic steering wheel system with variable ratio sensing to optimize maneuvering speed during tight loading cycles.

I. The operator cab shall be equipped with a high-resolution, full-color, multifunction touchscreen display monitor. The diagonal screen dimension shall be no less than 7 inches and no greater than 12 inches, optimized for visibility under direct sunlight conditions without glare.

J. Maximum Sound Emission:

1. In-Cab: 68 dBA to 73 dBA.
2. External: 104 dBA to 109 dBA.

2.07 TIRES

A. General: Tires shall be suitable for mixed industrial operations that range from paved to agricultural chipping pad. Paved operations have wastewater sludge that create slick surfaces. Chipping pad areas have ground wood waste that can create sharp stubs. Tires must be puncture-prone and provide traction in mixed surface conditions.

B. 23.5R25 L3 or heavy-duty industrial rated tires for mixed surface operation.

C. Approved Tire Manufacturers: Michelin, Bridgestone, Goodyear.

2.08 STANDARD EQUIPMENT

A. A heavy-duty, electric warning horn integrated into the steering console.

B. Standard front and rear work lights. See Article Safety Features for additional lighting requirements.

2.09 SAFETY FEATURES

A. The machine shall be equipped with an electronic, weatherproof back-up alarm that automatically activates whenever the transmission is placed in Reverse (R). The alarm must utilize modern white-noise (multi-frequency) acoustic technology to localize the sound hazard to immediate ground personnel and must automatically adjust its decibel output (minimum 97 dB(A)) based on ambient site noise levels.

B. Rear-view camera with a cab mounted screen to provide operators visibility behind the machine.

C. High-powered LED light mounted rack providing wide visual coverage during low-light or nighttime operations.

1. Minimum of four chassis or cab-mounted LED work lights projecting forward to completely illuminate the bucket path and dump zone.
2. Minimum of two cab or rear enclosure-mounted LED work lights projecting rearward.
3. All light housings must feature impact-resistant polycarbonate lenses and heavy-duty, vibration-isolated mounting brackets.

D. The loader shall be equipped with a 10-pound ABC dry chemical fire extinguisher compliant with NFPA 10 standards, charged and certified at the time of delivery. The extinguisher shall be mounted internally behind the operators cab seat and in a location that does not obstruct line of sight.

2.10 SPARE PARTS

A. One 5-cubic yard capacity bucket.

B. Provide a spare set of factory-programmed and functional ignition keys/fobs for each loader.

C. Provide a complete set of replacement grease seals, shims, and retaining hardware (bolts, snap rings, and cotter pins) for the primary bucket linkage. Heavy structural hinge pins are excluded from this spare parts package and shall be supported via the local dealer's parts inventory.

D. Two complete sets of all engine air filters (primary and safety elements), engine fuel filters, water separators, transmission oil filters, hydraulic system return/charge filters, and cab fresh-air/recirculation HVAC filters.

E. One complete set of all engine serpentine, alternator, and accessory drive belts.

F. One complete set of replacement bucket bolt-on cutting edges (including all necessary heavy-duty mounting hardware, nuts, and bolts) matching the specified bucket configuration

G. Provide one complete, fully assembled spare tire and wheel assembly per wheel loader, resulting in a total of two identical spare mounted wheel assemblies delivered with the procurement package. The spares shall be covered in heavy duty plastic wrap for long-term storage and prevent the rubber from drying out or cracking.

PART 3 EXECUTION

3.01 DELIVERY

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

B. Deliver unit to Site and store at a location approved by onsite personnel. The unit shall be tarp covered, wrapped, or protected from outside elements until composting facility startup has begun.

3.02 FIELD QUALITY CONTROL

A. Functional Test: Operate FEL with Owner’s operators to demonstrate capabilities.

3.03 MANUFACTURER’S SERVICES

A. See Section 01 43 33, Manufacturers’ Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

SECTION 43 22 23
DEWATERING CENTRIFUGES

EQUIPMENT AND COMPONENT NUMBER(S)

Dewatering Centrifuge 1: H090-DEW1-CEN01.
Dewatering Centrifuge 2: H090-DEW1-CEN02.
Dewatering Centrifuge 3: H090-DEW1-CEN03.
Dewatering Centrifuge 1: Operator Panel: H090-DEW1-CPL02.
Dewatering Centrifuge 1: Starter Panels: H090-DEW1-MDP01.
Dewatering Centrifuge 2: Operator Panel: H090-DEW1-CPL03.
Dewatering Centrifuge 2: Starter Panels: H090-DEW1-MDP02.
Dewatering Centrifuge 3: Operator Panel: H090-DEW1-CPL04.
Dewatering Centrifuge 3: Starter Panels: H090-DEW1-MDP03.

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. This section covers the work necessary to provide three dewatering centrifuges, including centrifuge control panels, centrifuge electrical panels, and all appurtenances as specified herein.

1.02 GENERAL

A. Unit Responsibility: A single centrifuge manufacturer shall be responsible for supplying the dewatering centrifuges, complete with all accessories and appurtenances (including, but not necessarily limited to, electric motors and power packs, control panels, electrical panels with adjustable frequency drives (AFDs), shafting, safety guards, speed reducers, and spare parts) and for the design, assembly, delivery, installation supervision, startup, and testing of the centrifuges. The centrifuge manufacturer shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions. The centrifuges shall be produced and assembled by the manufacturer at a facility owned and operated by the manufacturer and under the direct supervision and control of the manufacturer.

B. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturers' services.

C. AC Induction Motor Requirements: Conform to the requirements of Section 26 20 00, Low-Voltage AC Induction Motors.

D. Adjustable Frequency Drive Requirements: Conform to the requirements of Section 26 29 23, Low-Voltage Adjustable Frequency Drive System. Coordination shall include a letter verifying the compatibility of the AFDs with the motor and coordination of AFD sizing requirements.

E. General Requirements: See Division 01, General Requirements, which contains information and requirements that apply to the Work specified herein and are mandatory for this Project.

F. Control System Requirements: Conform to the requirements of Section 40 99 90, Package Control Systems, and related sections.

G. The control functions contained and described herein are intended to provide proposed minimum performance requirements. They do not necessarily identify each and every control function, connection, communications, or equipment to achieve the requirements. Additional specificity and details shall be coordinated at time of submittals.

H. The Contractor shall install the system components furnished by the system supplier, with installation assistance from the system supplier.

I. The system supplier shall perform factory testing as specified herein.

J. The system supplier and Contractor shall jointly perform field performance testing as specified herein.

K. The Contractor shall flush and clean all existing process drains, wet wells, and other associated piping reused in this Project (as shown on the Drawings).

L. Existing 2-ton dewatering building crane can be used during construction but must be recertified before and after use to verify crane can be used for centrifuge rotating assembly maintenance after startup. Contractor shall provide separate crane for centrifuge installation.

1.03 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. 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 America (ISA).
11. National Electric Code (NEC).
12. National Electrical Manufacturers Association (NEMA): MG 1, Motors and Generators.
13. Occupational Safety and Health Act (OSHA).
14. Society of Protective Coatings (SSPC).
15. UL.

1.04 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00, Submittal Procedures. In addition, the following specific information shall be provided:

1. Shop Drawings:
   a. Documentation of modifications to the manufacturer's standard design to meet the requirements specified in this section.
   b. Document where the manufacturer's design does not comply with the specified performance, features, functions, and materials of construction specified herein by submitting a copy of this specification with notation of the specific clarifications, deviations, substitutions, and exceptions to these Specifications.
   c. Make, model, weight, and horsepower of each equipment assembly.
   d. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction for the centrifuge, main drive motor, backdrive motor, adjustable frequency drives, control panel, electrical panel, power supply, lubrication system, and flexible connectors. Provide listing of materials of construction to match the listing in Article Materials.
   e. Data on the characteristics and performance of the units to indicate ability to meet the system performance specified herein, including back drive gear box rated torque capacity and torque capacity required to meet performance requirements.
   f. Detailed mechanical drawings showing the equipment fabrications and interface with other items. Include:
      1) Dimensions, size, and locations of connections to other work, and weights of equipment associated therewith. Provide drawings in electronic AutoCAD format.
      2) Foundation drawings showing anchor bolt layouts and locations. Provide drawings in electronic AutoCAD format.
      3) Equipment anchorage and support drawings and/or cut sheets indicating size, material, spacing, embedment and

edge distances of anchors and other relevant information. Drawings should reflect the results of the calculations submitted below.

4) Weights of individual pieces of equipment and live (dynamic loads) created by the total weight of each centrifuge and ancillary equipment. Indicate maximum static and dynamic loads generated by the equipment, percent of loads dampened by vibration isolators, and final loads imparted to facility structure.
5) Scroll hard surfacing materials and coverage.
6) Sizes and locations of space for incoming and outgoing conduits.
7) Minimum clearance distances around equipment required to access equipment for service/repair/removal.

g. Bill of materials listing major system components, special tools, and spare parts.
h. Required pressure for sludge and polymer at unit's feed connection.
i. Outside utility requirements such as air, venting, water (flow and pressure), power, drain, etc., for each component.
j. Calculated ABMA L-10 bearing life or DIN ISO 281 L-10 bearing life, and type of lubrication recommended for all equipment.
k. Design data for the following:
   1) Main drive motor sizing.
   2) Backdrive motor sizing.
   3) Main drive sheave and belt sizing.
   4) Adjustable frequency drive sizing.
   5) Main bearings.
   6) Maximum measured sound power levels, octave frequency band data at 3 feet, all sides of equipment.
l. Motor submittals in conformance with Section 26 20 00, Low-Voltage AC Induction Motors.
m. Certificate(s) demonstrating that the centrifuge production and assembly facilities are currently ISO 9001 certified.
n. Instrumentation and Control Submittals: In conformance with Section 40 99 90, Package Control Systems.
o. AFD submittals in conformance with Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
p. Power and control wiring diagrams including terminals and numbers.
q. Shop and Field Painting Systems Proposed: Include Manufacturer's descriptive technical catalog literature and specifications, hazardous communication data sheets, and written

certification that the factory-applied coating system(s) is identical to the requirements specified.

1) Where system proposed is different from that specified or where, in the manufacturer's opinion, the coating system(s) exceed(s) the requirements specified, submit complete technical literature of the proposed system(s) to the Engineer for review.

2. Samples:
   a. Submit the following items with Shop Drawings:
      1) Scroll abrasive resistant tile, quantity of two.
3. 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) Vibration Test Reports and Certificates.
      3) Noise Test Reports and Certificates.
      4) 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 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.
      5) Certified Scratch Abrasion Test results of the abrasion protection tiles.
   d. Submit certified copies of mill test results for the stainless-steel castings and abrasion-resistant materials to be used. The test reports shall certify that the materials supplied are in accordance with the applicable standards and shall include:
      1) The actual material analysis.
      2) Applicable standards.
      3) Date of manufacture.
      4) Place of manufacture.
      5) Manufacturer's name.
      6) Markings on the materials to denote the batch number.
      7) Mechanical property test for rotating parts.
   e. Test results of the control panel and electrical panel 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.

4. Operation and Maintenance Manual with Maintenance Summary Form shall be provided 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. Refer to Section 40 99 90, Package Control Systems, for additional requirements.
    d. Index of all equipment suppliers listing current names, addresses, and telephone numbers of those who should be contacted 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.
    g. Listing of normal values and abnormal value settings for all monitored vibration and bearing temperatures.
    h. Bill of materials for all components, including part numbers, description, manufacturer, quantity, and seller.
5. Equipment Testing Procedure Submittals:
    a. Centrifuge manufacturer shall submit test procedures for the following tests for review, comment, and approval at least 30 days in advance of the notice to conduct the performance testing:
        1) Functional Testing.
        2) Pre-Performance Testing.
        3) Performance Testing.
6. Field Quality Control Submittals:
    a. Obtain Engineer’s review and approval of the information listed below prior to project completion. Centrifuge manufacturer shall submit test reports within 20 days after completing field testing.
    b. Field test results, reports, and certifications. Include the following:
        1) Functional Test Report and Certificates.
        2) Manufacturer’s Certificate of Equipment Installation Services.
        3) Pre-Performance Test Report and Certificates.
        4) Performance Test Report and Certificates.
        5) Vibration Test Certificates.

1.05 EXTRA MATERIALS

A. Spare Parts (as applicable):

Item	Quantity
Feed Nozzles	One set
Matched Drive Belts	One complete set
O-Rings	One complete set
Bearings, Seals, and Stabilizing Members	One complete set
Cake Discharge Ports	One set
Sheaves	One set (if required)
Fasteners (used on centrifuge bowl)	Ten of each type
Indicator Lights	One complete set
Oil, grease, and hydraulic fluids required for initial operation (for performing service for 2 years estimated at 2,500 hours per year of operation per machine)	One set
PLC I/O Module	One of each type furnished
Master Control Panel pre-programmed PLC processor module	One

B. Tools:

1. Provide manufacturer's recommended special tools, one complete set, required to assemble and disassemble the centrifuges, including the minimum following items:
   a. Scroll and Bowl lifter, including spreader beam, shackles, and ratchet strap, suitable for bowl removal and replacement from the existing building using the overhead monorail hoists.
   b. Straps for lifting of machine top case.
   c. Straps for lifting of drive motor assembly.
   d. Straps for lifting of gearbox or alternate backdrive system.
   e. Scroll / bowl dolly.
   f. Tools for removal/installation of conveyor and thrust bearings.
   g. Tools for plate dam adjustment/replacement.
   h. Lifting eyes for hoisting of main drive pillow block bearings.
   i. If required, dowel pin sleeve extractor.
   j. If required, plate dam puller.

C. In addition, provide any other tools required for maintenance with the exception of standard English unit mechanics tools.

D. Bowl Cart: Provide one bowl cart.

E. Lubricants: All necessary lubricants shall be provided for the initial startup of the centrifuges. Lubricants and filters shall be provided and changed by the manufacturer as frequent as required during the period between successfully completed functional testing and equipment acceptance, up to a maximum period of 12 months, for a total of four trips. New lubricants and filters shall be provided and be put into the equipment by manufacturer at Substantial Completion.

F. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

1.06 SAFETY REQUIREMENTS

A. All equipment furnished shall be designed and manufactured with due regard to safety of operation, accessibility, and durability of parts, and shall comply with all applicable Occupational Health and Safety Act, federal, state, and local safety regulations.

1.07 WARRANTY

A. Provide warranty for a period of 24 months after the final acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the owner.

B. Spare parts identified within this specification shall not be used to address warranty repairs.

C. Manufacturer to include a 2-year maintenance contract in bid package.

1. Maintenance contract shall include coverage of gearboxes (if included), bearings, brushings, spray showers, and any wear items.
2. Contract shall also include all parts and labor for repairing or replacing components to maintain the centrifuge minimum performance requirements listed within this specification.
3. Contract shall include all parts and labor to perform required maintenance to maintain the centrifuge minimum performance requirements listed within this specification.

4. Contract to include semi-annual maintenance inspections performed by manufacturer during 2-year contract duration.

D. Inspection:

1. The centrifuge shall be inspected at the end of the warranty period by representatives of the Owner and the Contractor to identify any failures that may have occurred. The Contractor shall establish the date of the inspection and shall notify the Owner at least 30 days in advance. The scheduled inspection shall NOT relieve the Contractor from the obligation to perform corrective work whenever needed.
2. The manufacturer shall prepare and deliver to the Owner an inspection report covering the inspection, indicating the number and type of failures observed, material and part where materials have failed, the percentage of the surface area where corrosion protection system failure has occurred, and the names of the persons making the inspection. Color photographs illustrating the type of failure shall be included in the report.
3. A separate inspection shall be scheduled by the Owner to coincide with the hard surfacing guarantee period. The inspection shall be attended by the Contractor and the Owner.

1.08 SCROLL EXCHANGE PROGRAM

A. Manufacturer shall provide a cost for a verifiable scroll exchange and refurbishment program on Proposal Form. The scroll shall be refurbished and certified to be the same dimensions and design as the scroll for the proposed unit. The scroll to be exchanged shall be independently balanced at full operational speeds prior to shipment. Certification of the balancing procedure shall be provided from a professional engineer licensed in the United States. Manufacturer shall provide verifiable references (three minimum) that has benefitted from the supplying manufacturer’s scroll exchange program.

PART 2 PRODUCTS

2.01 GENERAL

A. Each centrifuge system shall consist of a solid bowl, horizontal, continuous feed, scroll type unit, and shall be specifically designed to handle the sludges specified herein. Each unit shall be capable of continuous operations with a minimum of maintenance.

B. Each centrifuge system shall be equipped with:

1. Adjustable speed electric main drive motor assembly.
2. Adjustable speed electric backdrive motor assembly or alternative hydraulic backdrive system.
3. Belt guards.
4. Lubrication system for the rotating assembly's main bearings.
5. Vibration isolators.
6. Flexible connectors.
7. Centrate sampling provisions.
8. Main drive and backdrive adjustable frequency drives or backdrive starter for alternate backdrive system.
9. Control panels and electrical panel and instrumentation and controls.

2.02 MANUFACTURER

A. Centrifuge manufacturer's production facilities shall be ISO 9001 certified.

B. Modifications to Standard Equipment Model Offerings:

1. Listing of a centrifuge manufacturer within this section shall not be justification for acceptance of the manufacturer's standard centrifuge model offering.
2. Equipment provided by a listed manufacturer shall be furnished, modified as necessary, to conform to the performance, functions, features, and materials of construction as specified herein.

C. The dewatering centrifuges shall not utilize hydraulic drive systems.

D. The dewatering centrifuge shall be from one of the following listed manufacturers:

1. GEA-Westfalia Separator, Inc.
2. Andritz Separation, Inc.

E. Design of the centrifuge dewatering system layout shown on the Drawings is based on the model CF8000 from GEA-Westfalia.

F. Contractor shall be responsible for any design or construction modifications that may be necessary for implementation of the centrifuge equipment and it's related components, including but not limited to additional electrical, structural, mechanical, or construction costs associated with redesign involving piping, hoses, structural supports, conveyors, cooling, if required.

2.03 SERVICE CONDITIONS

A. The centrifuges, control panels, electrical panels, and appurtenances shall be suitable for exposure to continuous 95 percent relative humidity conditions, for operation in ambient air temperature from 50 degrees F to 104 degrees F, and for exposure to intermittent water or sludge splash and spill conditions.

B. The material to be dewatered is sludge resulting from rotary drum thickened waste activated sludge (TWAS), from biological treatment of municipal wastewater by an activated sludge process.

Parameter	**Sludge**
Sludge Composition, Total Dry Solids Weight Basis	100% TWAS
Sludge Feed Concentration, % Total Dry Solids Exclusive of Polymer	2.5 to 5.0 (Avg 3.75%)
Sludge Volatile Solids Concentration, % Volatile Solids Dry Weight Basis	70 to 80 (Avg 75)

C. The sludge to be dewatered will be fed to each centrifuge system from a dedicated variable speed progressing cavity pump. Polymer solution will be pumped by a dedicated polymer feed pump and injected into one of the following locations:

1. Polymer injection port at the centrifuge feed tube (initial polymer injection ring as shown in P&IDs).
2. Polymer injection at sludge feed piping approximately 30 feet upstream of centrifuge (supplemental polymer injection ring as shown in P&IDs).

2.04 PERFORMANCE REQUIREMENTS

A. The centrifuge shall continuously receive, condition, and dewater the feed sludge specified herein, and continuously discharge the dewatered solids onto a belt conveyor. Each unit shall be able to operate continuously on demand; shall be suitable for dewatering the specified sludge continuously for up to 8 hours per day, 5 days per week; and shall operate without spillage of sludge beyond the nominal solids discharge chute and piping envelope or spillage of centrate beyond the liquid (centrate) discharge chute and piping envelope.

B. Manufacturer shall guarantee that the centrifuges shall each be capable of the minimum performance requirements specified below, to be confirmed via the field performance testing specified herein. In addition, each centrifuge shall be capable of stable dewatering operations while processing the machine sizing throughput criteria specified below. Feed hydraulic loading rates for sludge dry solids concentrations that differ from or fall between points specified

below will be linearly proportioned from or linearly interpolated between the points specified (i.e., maintaining the specified feed dry solids loading rates).

Parameter	Guaranteed Performance	Machine Sizing Throughput Criteria
Feed Solids Loading Rate[(1)], lbs/hr, Total Dry Solids Basis	3,000	5,000
Feed Hydraulic Loading Rates[(1)(2)], gpm	170 at 3.5% TWAS 140 at 4.25% TWAS 120 at 5.0% TWAS	285 at 3.5% TWAS 235 at 4.25% TWAS 200 at 5.0% TWAS
Minimum Dewatered Sludge Cake Concentration, % Total Dry Solids	16	Range 16 to 18
Minimum Total Solids Capture, %	95	Range 94 to 98
Maximum Emulsion Polymer Dose, lbs. Active per Dry Ton of Feed Solids	40	Range 25 to 45

Notes:
(1) The range of feed hydraulic loading rates are calculated based on the total dry solids dry mass loading rate at the expected range of total dry solids concentrations and are exclusive of polymer solution.
(2) TBS = Thickened Blended Sludge.

C. Solids Capture:

$$\%\,\text{Capture}: \frac{T}{F} \times \frac{F\text{-}C}{T\text{-}C} \times 100$$

where: T = Cake total solids concentration (mg/L).
F = Feed sludge total solids concentration, excluding any dilution due to polymer solution addition (mg/L).
C = Centrate total suspended solids concentration, excluding any dilution due to polymer solution addition and centrifuge purge water (mg/L).

D. Polymer: Make-down of a polymer solution will be from only bulk emulsion, high molecular weight cationic polymers.

2.05 EQUIPMENT DESCRIPTION

A. The centrifuge shall be of the high-speed, dry solids, solid bowl horizontal, continuous feed, scroll conveyor type specifically configured for dewatering only applications and intended to produce a dewatered cake with a higher

solids content than produced with conventional centrifuges. No disc type or nozzle bowl type or basket type centrifuges will be allowed. The centrifuge design shall limit air leakage from the body of the centrifuges by providing gaskets on the casing flange and labyrinth-type seals on both hub ends. The centrifuge equipment shall be designed and built to operate continuously. An adjustable frequency drive (AFD) main drive system shall be provided to drive the centrifuge rotating assembly. An AFD backdrive system shall be supplied with the centrifuge to provide speed variation between the scroll conveyor and the centrifuge bowl. The centrifuge shall be designed to be mounted on a steel frame allowing discharge into discharge chutes directly beneath the centrifuge bowl.

2.06 MATERIALS

A. Materials of Construction:

1. Unless otherwise specified, materials shall conform to the following:
   a. Bowl: Stainless steel, ANSI SC2205 or ANSI SC2304 duplex stainless steel centrifugal castings.
   b. Bowl Wear Strips: Stainless steel, Type 316, minimum 3 mm thickness.
   c. Scroll Conveyor: Stainless steel, ANSI SC2205 or ANSI SC2304 duplex stainless steel or Type 316 stainless steel.
   d. Scroll Conveyor Tips: Sintered Tungsten Carbide tiles, from the second flight beyond the feed zone to the solids discharge end.
   e. Feed Tube: Type 316 stainless steel.
   f. Upper Case: Type 316 stainless steel.
   g. Bottom Case: Fabricated carbon steel or cast steel, with all surfaces in contact with process material coated with epoxy or Type 316 stainless liner.
   h. Main Centrifuge Bearings: Lubricated with grease, or forced oil, or oil mist system, L-10 life of 100,000 hours minimum.
   i. Scroll Conveyor Bearings: Grease lubricated, L-10 life of 100,000 hours minimum.
   j. Feed Compartment: Type 316 stainless steel, with feed compartment breaker or feed compartment liner.
   k. Feed Compartment Liner: Field replaceable inserts of tungsten carbide, Adiprene, or Urethane, with Flame Sprayed Coast 53C, or Devcon paste.
   l. Feed Compartment Breaker: Type 316 stainless steel.
   m. Sludge Feed Nozzles: Replaceable sintered tungsten carbide(1).
   n. Solids Discharge Nozzles: Replaceable sintered tungsten carbide(1).
   o. Case Protection, Solids Discharge End: Field replaceable Adiprene, Urethane, or Type 316 stainless steel liner, or-equal.

p. Internal fasteners, subject to contact with sludge, centrate, or vapors of wash water and wastewater, shall be minimum Type 316 stainless steel.

q. All sintered tungsten carbide abrasion resistant materials shall be tested in accordance with the ASTM G65, Procedure A, Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests with volume loss less than 3 cubic millimeters.

2.07 BOWL

A. The bowl shall be designed to withstand all forces encountered during operation. The bowl shall be supported on each end by pillow block bearings.

1. Bowl Inside Diameter: Minimum 29.5 inches.
2. Bowl Inside Length: Minimum 118 inches.
3. Normal Operating Speed: As required to produce 3,000 g force at bowl wall, with maximum speed of 2,900 rpm.
4. Bowl wall thickness shall be determined by centrifuge manufacturer. All surfaces shall be examined for cracks, shrinkage, porosity, or other defects by means of a liquid penetrant test.
5. Pool depth level must be readily adjustable via weir plates (dams) or power tubes, located at the large diameter end of the bowl where liquid is discharged.
6. Centrate discharges shall be provided with deflector plates or nozzles to redirect and assist in turning the bowl to reduce overall centrifuge electrical power consumption.
7. Solids shall be conveyed through a conical section of the bowl and discharged from the small diameter end of the bowl through multiple solids discharge ports spaced evenly around the bowl end. Solids discharge ports shall be protected against abrasion by field replaceable, weight balanced, mechanically attached wear nozzles.
8. Centrifugally cast bowls shall be 100 percent dye penetrant inspected. Rolled and welded or statically cast bowls shall not be allowed.
9. Bowl shall be provided with a minimum of eight evenly spaced longitudinal bowl strips the entire length of the bowl, or longitudinal grooves the entire length of the bowl, to trap solids and form a layer to protect the bowl from wear.
10. Material to be processed shall be introduced to the bowl through a compartment which shall evenly distribute the feed.

2.08 SCROLL CONVEYOR

A. Centrifuge shall include a horizontal cylindrical-conical scroll conveyor supported by anti-friction bearings and equipped with helical flights independently mounted concentrically within the centrifuge bowl. Bearings shall have externally greased fittings.

B. Conveyor shall include solids feed ports protected against abrasion by field replaceable, weight balanced, mechanically attached wear nozzles.

C. The conveyor edge and face of the flights shall be protected against abrasion by a series of welded-on sintered tungsten carbide tile assemblies, multiple welds per tile, with minimum coverage extending from two wraps beyond the feed zone (towards the liquids discharge end) through to the solids discharge end. Each tile assembly shall be weight correct and consist of a solid sintered tungsten carbide wear part attached to a stainless steel backup holder. Spray hard surfacing applied to a backup plate is not allowed. Each assembly shall be individually replaceable and shall include the ability to monitor wear by means of visual inspection. The tile assemblies shall extend a minimum of 0.3 inch beyond the radial edge of the conveyor flight. The remaining scroll conveyor edge and face shall be protected from abrasion by flame sprayed hard surfacing containing a minimum of 40 percent tungsten carbide particles.

D. All sintered tungsten carbide tiles shall be able to meet ASTM G65 Test Procedure A with a volume loss as specified in Article Factory Tests.

2.09 CASE

A. Centrifuge shall be enclosed in a fabricated case, the purpose of which shall be to contain and direct the solids and liquid discharge from the centrifuge, to act as a protective guard, and to provide complete enclosure for noise reduction and odor control. Case shall be protected at the solids discharge end with a field replaceable liner. Upper case shall be Type 316 stainless steel, specifically designed for rigidity and noise reduction. Lower case shall be fabricated carbon steel or cast steel, with all surfaces in contact with process material coated with epoxy, or Type 316 stainless steel inserts. Provide Type 316 stainless steel, liner in centrate discharge chamber. The case top shall be bolted in place. Lifting eyes shall be provided for lifting of the case top.

B. A flanged and gasketed seal shall be provided between the upper- and lower-case components. Flange bolts shall be Type 316 stainless steel.

C. Top case shall have hydraulic hinges to allow for ease of opening during maintenance or inspection. See the Drawings for rotation direction.

2.10 FRAME

A. The centrifuge shall be supported on a fabricated carbon steel or combination cast iron and steel base which shall in turn be mounted on vibration isolators.

B. Vibration Isolators:

1. Vibration isolators shall be capable of dampening vibration in all directions and shall be a combination of metal springs, or rubber dampeners and/or viscous dampening fluid.
2. The number, capacity, and vibration constant of the isolators shall be as recommended by the manufacturer for the load and impact resulting from operation of the centrifuge provided.
3. Isolators shall be designed to limit dynamic loads imparted to foundation to 10 percent of the static load of empty machine in the vertical direction and 5 percent of the static load of empty machine in the horizontal direction.
4. Housing shall be welded steel and springs shall be high carbon steel.
5. Centrifuge shall be levelled by metal shims inserted between vibration isolator mounting plates and equipment support base (provided by others).

C. The bottom portion of the frame shall be provided with machined outlets for the attachment of the solids and centrate flexible connectors.

D. Lifting eyes or solid lifting bars shall be provided for lifting of the frame.

2.11 MAIN DRIVE SYSTEM

A. The bowl drive system shall consist of an electric main drive motor with adjustable frequency drive and V-belt drive system complete with necessary vibration isolators for the individual support of the motor and centrifuge. The belt drive system shall consist of multiple V-belts as required to provide full load capacity and to withstand the full starting torque of the system.

2.12 GEAR BOX

A. Gear Box: Either 1) a two-gear conveyor drive system consisting of a primary cyclo gear and a secondary cyclo gear; or 2) a multi-stage or four-stage planetary gear unit shall maintain a differential speed between the conveyor and bowl. Each of the above devices shall be suitable for 24-hour per day continuous service. The gear box shall have a torque capacity to meet the specified service conditions and performance requirements with the design required torque not to exceed 80 percent of the gear box full rated torque capacity. Gear boxes shall be capable of withstanding a 200 percent momentary overload and 150 percent intermittent overload. A torque overload control shall be provided to initiate centrifuge shutdown in the event of conveyor overload. Manufacturer shall select the reduction gear ratio as required for the solids to be handled and to be consistent with satisfactory operation. The gear unit shall be oil lubricated with its housing serving as a lubricant reservoir.

2.13 BACKDRIVE SYSTEMS

A. Provide an adjustable frequency drive (AFD) backdrive system for each centrifuge. If a regenerative type backdrive system is provided, the motor sizes specified herein may change as well as the associated electrical supply.

B. Adjustable Frequency Drive Backdrive System: An inverter duty backdrive motor shall be supplied and connected to the pinion shaft of the differential gear box. Backdrive system shall provide step-wise or infinite speed variation between the conveyor and the bowl shell of the centrifuge.

C. The backdrive system shall be capable of operating in a DIFFERENTIAL or TORQUE control mode that provides for operation at specific adjustable scroll/bowl differential speeds or backdrive torque values. In the DIFFERENTIAL control mode, the backdrive system shall provide for operation at a specific, adjustable scroll differential speed with internal torque allowed to vary up to the maximum allowable scroll shaft torque. In the TORQUE control mode, the backdrive system shall continuously monitor changes in internal torque created by variations in influent feed solids and automatically maintain a preset torque input to the scroll by allowing the differential speed to vary. Backdrive torque controller shall incorporate an auto-tuning feature to automatically adjust the proportional, integral, and derivative constants in order to automatically adjust to sludge and scroll conveyor torque feedback changes.

D. The backdrive system shall provide for automatic shutdown in the event that excessive torque is detected. Torque shall be measured as a function of input in the drive unit. In the event that torque exceeds the normal operating range, monitoring instrumentation shall detect this condition and stop the sludge feed to allow the machine to clear itself. The torque monitoring system shall automatically reset when the torque approaches the normal operating range. In the event that the torque approaches the limit of the backdrive, the centrifuge’s controller shall initiate centrifuge shutdown and initiate stop of both sludge and polymer feeds.

2.14 BEARINGS

A. The entire rotating assembly of each centrifuge shall be supported by two main bearings. Each main bearing shall be lubricated ball or cylindrical roller type bearings. Main bearings shall be housed in one-piece pillow blocks with dowel pins for proper alignment. Provide each pillow block bearing with a threaded female connection to permit the use of a lifting eye to facilitate inspection and maintenance.

B. Bearing temperature monitors shall be provided on each main bearing pillow block, with an analog output signal sent to the control panel for display and monitoring. Provide 100 ohm three-wire platinum resistance temperature detectors (RTDs). Bring the RTD leads out to terminal blocks in aluminum junction boxes.

C. Scroll conveyor bearings shall be anti-friction ball or roller type bearings sealed from process contamination. Bearings shall have external grease fitting for lubrication.

D. Bearings shall have an ABMA L-10 life or DIN ISO 281 L-10 life of 100,000 hours minimum.

2.15 MAIN BEARING LUBRICATION SYSTEM

A. Lubrication of centrifuge main bearings shall be provided by means of an automatic feed system. Lubrication feed system shall be one of the following types, and include, at a minimum but not limited to:

1. Forced Oil Type:
    a. Oil reservoir with sight level gauge, inside painted with special paint to prevent condensate corrosion.
    b. Oil reservoir level switch.
    c. Oil filter, 10 micron.
    d. Oil gear pump.
    e. Bypass line with suitable sized valve to regulate the amount of oil, and monitor via flow switch, that is fed to each bearing.
    f. Temperature instrument to monitor oil temperature from each bearing.
    g. Oil to Water Cooler: fixed tube bundle design with oil flow through the shell side. Brass baffles shall be provided for high efficiency and maximum capacity. Oil cooler fulfills its cooling requirements using no more than 10 gpm of cooling water at maximum temperature of 85 degrees F.
    h. Oil solenoid valve.
    i. Oil temperature valve.
2. Oil/Air Mist Type:
    a. Oil reservoir with sight level gauge.
    b. Oil reservoir level switch.
    c. Air/oil feed solenoid valve.
    d. Oil feed adjustment valves.
    e. Air compressor, compressed air supply isolation valve, regulator, and filter.
    f. Low air pressure switches.

B. The entire lubrication system shall be factory assembled and tested as a unit. Power to operate the panel and oil pump shall be 480V, three-phase, obtained from the main motor starter. Provide contacts for a common remote alarm and for centrifuge shutdown. If a compressed air system is required for the lubrication system, the manufacturer shall provide the required compressed air system/equipment per centrifuge. The manufacturer must provide the desiccant style drying system to ensure clean dry air is being delivered. Instrument air shall be field routed to the individual compressed air system if required.

C. The lubrication system shall be interlocked with the centrifuge main drive motor such that low pressure, low flow, and/or low level will de-energize the centrifuge main drive motor. In all cases, the starter for oil gear pump or the air compressor motor controls shall be interlocked with the main drive motor so that bearings are lubricated whenever the centrifuge is running and a delayed trip so that bearings continue to be lubricated while the centrifuge coasts to a stop. The oil gear pump or air compressor shall also be independently operable.

D. All lubrication system signals shall be wired to a common junction box for connection to the external control panel. All wires shall be labeled in accordance with Section 40 99 90, Package Control Systems.

2.16 GUARDS

A. Fabricated guards shall be provided for all gear boxes, pulleys, and belt drives.

1. The guards shall meet OSHA standards and completely enclose the rotating parts of drive system and shall be designed to minimize vibration and noise.
2. Guards, except for the main drive motor, shall have 1-inch diameter holes coincident with the shafts of all equipment to allow the shaft speed to be checked.
3. Fasteners shall be externally accessible.

2.17 FEED TUBE

A. Sludge shall be fed to the centrifuge by means of a removable feed tube suitable to minimize turbulence. The feed connection to the centrifuge shall be a 3-inch minimum 150-pound ASME flanged connection. The maximum inlet pressure required at the centrifuge inlet flange shall be 20 psig at 350 gpm (when based on water with the viscosity of 1 centipoise). The feed tube shall also include a 1-inch NPT connection for polymer.

2.18 FLEXIBLE CONNECTIONS

A. All mechanical and electrical connections to the centrifuge, including, but not necessarily limited to, the feed sludge, polymer, centrate and dewatered sludge cake connections, cooling water supply and return piping, sample line, vents, and electrical raceways shall be equipped with flexible connections. All flexible connections shall isolate centrifuge vibrations from fixed, rigid external connections. No exterior loads shall be transferred to a centrifuge by external connections to the machine. Centrate and dewatered sludge cake flexible connections shall be flanged and fabricated from neoprene, with Type 316 stainless steel bolts with Type 316 stainless steel retainer plates at each end. Piping flexible connectors shall be metal reinforced elastomer with flanged connections. Tubing flexible connectors shall be metal reinforced hose with Type 316 stainless steel hose clamps.

2.19 SOLIDS DISCHARGE CHUTES

A. Type 316 stainless steel solids discharge chutes equipped with flanged and plain end connections for solids and vent piping shall be provided. The solids discharge chute shall be equipped with a sample port.

2.20 CENTRATE CHUTES

A. Type 316 stainless steel centrate chutes equipped with flanged and plain end connections for centrate and vent piping shall be provided. The centrate chute shall be equipped with a sample port.

2.21 SOLIDS DISCHARGE KNIFE GATES

A. Manufacturer recommended knife gate assembly shall be provided for solid discharge chutes to divert sloppy cake to centrate drain piping during startup/shutdown.

2.22 CENTRIFUGE FLUSH VALVE AND SPRAY NOZZLES

A. Centrifuge flush valves shall be provided as required, sized for the flush water piping routed to the centrifuge. Actuator shall be provided and capable of being controlled by the Centrifuge Operator Panel. All necessary fittings and adaptors to be provided as required for installation.

B. The centrifuge cover shall be outfitted with spray nozzles to enable the complete cleaning of the “outside” of the bowl during CIP stage.

1. The nozzles shall be outfitted to clean the entire length of the bowl.
2. In addition, the nozzles shall be outfitted to clean the feed and cake ends of the bowl.

3. The nozzles shall be capable of accepting a chemical compound (base or acid) to further assist the prevention and cleaning of any struvite build up.

2.23 NOISE

A. Centrifuge shall be designed such that when running at the normal operating speed, the average free-field noise level measured at 3 feet around the periphery of the complete centrifuge assembly shall not exceed 87 dBA, when tested at the manufacturing facility, without feed and with inlet and discharge connections sealed.

2.24 VIBRATION MONITORING SYSTEM

A. A vibration monitoring system shall be provided for each centrifuge to perform the following functions:

1. Convert vibration into velocity.
2. Sound a warning and initiate stop of sludge feed if the velocity reaches a certain preset level (HIGH).
3. Sound a warning and shut the centrifuge down if the velocity reaches a separate pre-set level (HIGH HIGH).
4. Provide an adjustable time delay during centrifuge startup to account for initial acceleration and feed induced vibration.
5. Provide an adjustable time delay, not to exceed 5 seconds, during operation to account for momentary excursions due to process changes.

B. Provide vibration sensors installed on each centrifuge and wired to a common terminal junction box. Sensors shall be rigidly attached to each of the two main bearings, positioned to measure displacement.

C. The centrifuge, when running at the normal operating speed, shall not produce vibration velocities greater than 7 mm/sec RMS at the main bearings when tested at the manufacturing facility without feed.

D. All vibration monitoring system signals shall be wired to a junction box for connection to the external control panel. Wires shall be labeled in accordance with Section 40 99 90, Package Control Systems.

2.25 ANCHOR BOLTS

A. Anchor Bolts, Nuts, and Washers: Type 316 stainless steel, minimum 3/4 inch in diameter for all anchor bolts under the centrifuge frame (sized by centrifuge manufacturer and provided by Contractor).

2.26 ELECTRICAL

A. General:

1. Conform with Division 26, Electrical.
2. Provide all necessary electrical components and wiring for a complete, functional system.
3. All motor adjustable frequency drives for the centrifuge system shall be provided in the electrical panel provided as part of this section.
4. Control and electrical panel and interior components shall be rated for continuous operation in 40 degrees C (104 degrees F) ambient conditions.

B. Wiring: Size conductors and conduits for power circuits to the main and backdrive motors. Factory prewire (size, furnish, install, and connect) all skid mounted equipment control conductors and instrumentation cables to skid mounted terminal junction boxes for connection to the control and electrical panel by Division 16, Electrical. All conductors shall be stranded copper, and all wiring shall meet the requirements of NFPA 70, the 2014 National Electrical Code. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in 600-volt twisted shielded pair cable. Analog and power circuits shall not be run in the same conduits. Connections from skid mounted junction boxes to the control and electrical panels will be by others under Division 26, Electrical.

C. Electrical Raceways: All conductors and cables not subject to vibration between prewired devices and skid-mounted terminal junction boxes shall be installed in PVC-coated rigid galvanized steel conduits. Flexible, nonmetallic, liquid-tight conduits shall be provided where flexible conduits are required. Conductors shall be stranded copper.

D. Terminal Junction Boxes: All centrifuge-mounted devices, except for motor leads, shall be prewired to centrifuge-mounted terminal junction boxes (TJBs). Separate TJBs shall be provided for (a) 120V power and (b) 4 mA to 20 mA analog and 24V dc discrete signals. Size, furnish, and install NEMA 4X, Type 316 stainless steel TJBs on the centrifuge skid.

E. Main Drive Motor:

1. Provide squirrel-cage ac induction motor meeting the requirements of Section 26 20 00, Low-Voltage AC Induction Motors, and as specified herein.
2. Motor shall meet the following specific requirements:
    a. Motor Horsepower: 200, maximum.
    b. Synchronous Speed: 1,800 rpm or 3,600 rpm.
    c. Voltage Rating: 460V, three-phase.

d. Enclosure Type: TEFC per Section 26 20 00, Low-Voltage AC Induction Motors.
e. Mounting: Horizontal.
f. Inverter duty rated motor.

3. Provide motor modifications as follows:
   a. With the motor at ambient temperature (COLD), it shall be capable of making two complete starts in succession with coasting to rest between starts within a 1-hour time period. With the motor running (HOT), it shall be capable of at least one restart within 1 hour after any shutdown. The motor insulation temperature classification shall not be exceeded.
   b. The motor shall be of the quiet type design. The noise level shall not exceed 89 dBA sound pressure measured at 3 feet from the motor in all directions.
   c. Provide bi-metallic thermostat for thermal protection.

F. Main Drive AFD: Main drive motor shall be controlled by an adjustable frequency drive provided in the Centrifuge Electrical Panel.

1. The system shall be sized in accordance with manufacturer's design requirements and shall be as specified in Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
2. The motor shall be capable of delivering full load torque across a 10:1 turndown ratio.
3. Drive system shall be capable of flying restart.
4. Drive shall be as specified in Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

G. Backdrive Motor:

1. Provide squirrel-cage ac induction motor meeting the requirements of Section 26 20 00, Low-Voltage AC Induction Motors, and as specified herein.
2. Motor shall meet the following specific requirements:
   a. Motor Horsepower: 60, maximum.
   b. Synchronous Speed: 1,800 rpm.
   c. Voltage Rating: 460V, three-phase.
   d. Enclosure Type: TEFC per Section 26 20 00, Low-Voltage AC Induction Motors.
   e. Mounting: Horizontal.
   f. Inverter duty rated motor.
3. Provide motor modifications as follows:
   a. Provide bi-metallic thermostat for thermal protection.
   b. Attach the motor to the pinion shaft of the differential gearbox.

H. Backdrive AFD: Backdrive motor shall be controlled by an adjustable frequency drive provided in the Centrifuge Electrical Panel.

1. The backdrive system shall provide infinite speed variation between the scroll conveyor and bowl shell of the centrifuge.
2. The system shall be sized in accordance with manufacturer's design requirements and shall be as specified in Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
3. The motor shall be capable of delivering full load torque across a 10:1 turndown ratio.
4. Drive systems shall be capable of flying restart.
5. Drive shall be as specified in Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

I. Centrifuge Emergency Stop: Provide a Mushroom E-stop pushbutton by each centrifuge, and at each Centrifuge Control Panel.

J. Centrifuge Electrical Panels:

1. Provide a drive panel for each centrifuge's main and back drive. The panels will be installed in the Electrical Room by others:

Panel Nos.	Name	NEMA Enclosure	Material
H090-DEW1-MDP01	Dewatering Centrifuge 1 – Starter Panel	12	Painted Steel
H090-DEW1-MDP02	Dewatering Centrifuge 2 – Starter Panel	12	Painted Steel
H090-DEW1-MDP03	Dewatering Centrifuge 3 – Starter Panel	12	Painted Steel

a. Each electrical panel shall contain the following:
   1) A main circuit breaker with a through-the-door lockable handle.
   2) AFD for main drive. Provide a control power transformer in the AFD to supply 120V ac power to the centrifuge control panel. Also provide starter for the lube oil pump, or the air compressor, or the grease pump.
   3) AFD for backdrive.
   4) Provide power transformers as required by the system.

b. Adjustable frequency drives shall be sized in accordance with NEC and Division 16, Electrical.
c. The main circuit breaker shall be a 65,000 symmetrical amp thermal magnetic breaker sized in accordance with centrifuge system requirements.
d. Power Supply: 480-volt, three-phase, three-wire, 60-Hz.

2.27 CONTROLS

A. General:

1. In accordance with the requirements specified in Section 40 90 00, Instrumentation and Control for Process Systems, and related sections.
2. Provide centrifuge controls equipment in a dedicated control panel as specified herein.
3. The controls for all components of each centrifuge shall be provided by a dedicated programmable logic controller (PLC), mounted in the Centrifuge Control Panel. The PLC shall provide all control and monitoring functions required for the operation and monitoring of the centrifuge including, but not limited to, timing, interlocks, startup sequencing, normal and emergency shutdowns, and permissive functions required for safe operation of each centrifuge. Refer to Section 40 99 90, Package Control Systems, for PLC manufacturer and products.
4. The PLC I/O signal types and voltages shall be as specified in Section 40 99 90, Package Control Systems.
5. Each Centrifuge Control Panel shall be equipped with an Operator Interface Terminal (OIT). Refer to Section 40 99 90, Package Control Systems, for OIT manufacturer and products.
6. All indicating lights shall be in accordance with Section 40 99 90, Package Control Systems.
7. Provide uninterruptible power supply (UPS) backup power for all PLC control panels as specified in Section 40 99 90, Package Control Systems.
8. Provide Application software for all digital, programmable components of the centrifuge systems, including submittals, documentation, communication, and testing as specified in Section 40 99 90, Package Control Systems.

B. Centrifuge Control Panels:

1. Provide a control panel for each centrifuge:

Panel Nos.	Name	NEMA Enclosure	Material
H090-DEW1-CPL02	Dewatering Centrifuge 1 Operator Panel	4X	Stainless Steel
H090-DEW1-CPL03	Dewatering Centrifuge 2 Operator Panel	4X	Stainless Steel
H090-DEW1-CPL04	Dewatering Centrifuge 3 Operator Panel	4X	Stainless Steel

2. Each control panel shall be freestanding enclosure, located by the centrifuge, in the centrifuge process area. The location will be nonclassified.
3. Each control panel shall contain the following:
   a. A main circuit breaker with a through the door lockable handle.
   b. Programmable logic controller.
   c. I/O modules.
   d. Panel mount Operator interface terminal (OIT).
   e. Ethernet tap for connecting the package PLC and OIT and for connection to the plant SCADA system.
   f. Mushroom E-stop pushbutton.
4. Power Supply: 120-volt, single-phase, two-wire, 60-Hz.

C. Control Panel Functions:

1. Operator Interface Terminal (OIT):
   a. The OIT for each centrifuge shall provide the primary method for an operator to monitor the status of the centrifuge and to affect its operation by command or directive entry. The OIT shall provide the graphics-based interface between the operator and the centrifuge controller. The graphics and their layout/presentation shall be manufacturer’s standard.
   b. The OIT shall provide all displays and control screens needed to safely and efficiently monitor and control the dewatering centrifuge.
   c. The OIT shall provide for selection of the following:
      1) Centrifuge Control Mode: LOCAL/REMOTE.
      2) Backdrive Control Mode: TORQUE/DIFFERENTIAL.
      3) Centrifuge START.
      4) Centrifuge STOP.
      5) Centrifuge Clean-In-Place (CIP) initiation.

d. Display (at a minimum):
   1) Alarms.
   2) Status and control of each system component.
   3) Bowl speed.
   4) Backdrive speed.
   5) Main drive motor amperage (rms value).
   6) Differential Speed: Scroll versus bowl.
   7) Bearing temperatures.
   8) Backdrive torque.
   9) Vibration.
   10) Centrifuge Control Mode: LOCAL/REMOTE.
   11) Backdrive Control Mode: TORQUE/DIFFERENTIAL.
   12) The specific shutdown condition.
   13) Sludge and polymer flow rates.
   14) All inputs from and outputs to the plant SCADA system.

2. Controller Sequencing: The centrifuge PLC shall contain all programming necessary to safely start and stop the centrifuge, in either the Local or Remote mode. The following minimum sequences and control shall be provided.
   a. Local/Remote: In the Local mode, centrifuge control shall only be available through the centrifuge control. All outputs to the Plant SCADA System shall still be available in Local mode. In the Remote mode, Start, Stop, Backdrive control mode selection, torque set point entry, differential set point entry, and other specified centrifuge controls shall be from the Plant SCADA System.
   b. Start: The start of the centrifuges will be initiated from the plant SCADA system HMI or the local OIT. The start command shall instruct the centrifuge control system to begin its start sequence. The centrifuge shall not be allowed to start more than the stated number of times per hour (two if cold, one if hot). The centrifuge control system shall confirm the successful initiation and/or completion of each step in the startup sequence before continuing with the next step in the sequence.
      1) The start sequence can only begin when the centrifuge feed pump and polymer feed pump are not running (OFF status from plant SCADA system).
      2) Provided all interlocks are in the normal state, the centrifuge control system shall bring the bowl and scroll up to speed and signal when proper conditions have been attained to begin feeding polymer and sludge.

3) OPEN the diverter valve to the centrate drain wet well to convey the slop to the drain system.
4) Once the diverter valve is confirmed open, initiate start of polymer feed pump (request to plant SCADA system).
5) Once the polymer feed pump is confirmed on (ON feedback from plan SCADA system), initiate a preset timer. When the timer has expired, initiate start of centrifuge feed pump (request to plant SCADA system).
6) If the start sequence is interrupted for any reason, including, but not limited to equipment failure, interlock failure, or manual (operator initiated) interrupt, the centrifuge controller shall generate a time delayed FAIL TO START alarm, with an operator adjustable delay from 0 minute to 5 minutes. Stop the centrifuge feed pump and polymer feed pumps (request to plant SCADA system) and allow the machine to coast to a standstill.
7) If the start sequence is successful, continue monitoring interlock status of polymer feed pump, and centrifuge feed pump.

c. Normal Stop Sequence: This command shall instruct the centrifuge control system to begin its normal stop sequence. The centrifuge control system shall confirm the successful initiation and/or completion of each step in the stop sequence. If any step in the sequence fails, the centrifuge controller shall generate an alarm specifying the failed step.
1) Stop the centrifuge feed pump and polymer feed pump (request to plant SCADA system).
2) Once the centrifuge and polymer feed pumps are confirmed off (OFF status from plant SCADA system), start an adjustable timer and maintain a preset differential speed to clear the remaining solids from the bowl.
3) After the timer for the removal of resident solids has expired, or upon reaching an operator entered falling backdrive torque set point, open the flush water valve and start an adjustable timer.
4) After the timer has expired, close the flush water valve. The machine shall then coast to a standstill.

d. Normal Stop Conditions:
1) Centrifuges stop will normally be initiated from the plant SCADA system HMI or the OIT. The normal stop sequence shall also be executed upon occurrence of shutdown interlocks described below:
a) The control system shall cause an automatic “Normal Stop” sequence shutdown of the centrifuge and alert this condition to the Plant SCADA System in the

event that any of the following interlocks are triggered. These automatic shutdown interlocks shall include, but are not limited to:

(1) Backdrive HIGH temperature alarm.
(2) Drive motor over temperature.
(3) Drive motor overload.

2) During normal operation, an excessive solids build-up shall be detected by the centrifuge control system as a higher than normal torque requirement or by sensing excessive vibration. Should the torque or vibration exceed a preset point, the HIGH torque or vibration switch shall close, sending a signal to the centrifuge control system which shall initiate shutdown of the sludge and polymer feeds (request to plant SCADA system). This action will normally result in a reduction of torque and vibration as the buildup is removed from the bowl. When the torque or vibration falls to an acceptable limit, reinitiate start of sludge and polymer feeds (request to plant SCADA system). The high torque control shall be not more than twice the normal operating torque or pressure. The controls shall also allow operation at a set differential speed allowed to vary within the normal operating limits. Controls shall include adjustable timers and or a count of HIGH torque or vibration events in order to initiate an automatic “Normal Stop” in the event of repeated torque or vibration excursions.

e. Controlled Shutdown Conditions:

1) In the event that the above clearing action fails to remedy the high torque or vibration situation and the torque or vibration continues to increase, the centrifuge control system shall respond by issuing a torque or vibration HIGH HIGH alarm at the control panel and similar signal to the Plant SCADA in addition to initiating a “Controlled Shutdown”.

2) The control system shall also cause a “Controlled Shutdown” of the centrifuge and alert this condition to the Plant SCADA System in the event that any of the following interlocks are triggered. These automatic shutdown interlocks shall include, but are not limited to:

a) Drive end/idle end bearing HIGH HIGH temperature alarms.
b) HIGH HIGH torque.
c) HIGH HIGH vibration.

f. Controlled Shutdown Sequence: Controlled Shutdown shall require reset action at the control panel before the unit can be restarted.
   1) This command shall de-energize the centrifuge main drive motor. The centrifuge shall be allowed to coast to a standstill. If available, the backdrive shall remain active until the bowl has coasted to a standstill, controlled to clear as many solids as possible from the bowl.
   2) The sludge and polymer feeds shall be stopped (request to plant SCADA system).
   3) Open the bowl flush water valve for flushing and subsequently close it after an adjustable time period.

g. Emergency Stop: Emergency Stop initiated via E-stop pushbutton at the Centrifuge, at the Centrifuge Control Panel, and from the Plant SCADA System shall stop the centrifuge and all associated equipment instantaneously with no flush water.
   1) This command shall de-energize the centrifuge system.
   2) The sludge and polymer feeds shall be stopped (request to plant SCADA system).

h. CIP Sequence: Provide clean-in-place (CIP) function to clean solids out of the bowl. The CIP will be initiated from the local OIT by pressing a “CIP start” pushbutton. After initiation of CIP, open the flush water valve, energize the backdrive and begin to rotate in the reverse (if required by the manufacturer’s particular design) direction at a low speed for a predetermined time. At the end of the set time, the backdrive shall toggle direction, causing a water “sloshing” effect within the centrifuge bowl and conveyor. The process shall continue until the predetermined overall times ends, a “CIP Stop” key is depressed, or a fault occurs. Any shutdown fault shall terminate the CIP cycle.

3. Provide the following hard-wired interface signals between the centrifuge PLC and the existing PLC-67 in K3:
   a. Discrete Outputs to the Plant SCADA System:
      1) Polymer feed pump START/STOP request.
      2) Centrifuge sludge feed pump START/STOP request.
      3) Quantity of three additional discrete outputs.
   b. Discrete Inputs from the Plant Control System:
      1) Centrifuge sludge feed pump ON status.
      2) Centrifuge polymer feed pump ON status.
      3) Emergency STOP command.
      4) Quantity of two additional discrete inputs.

4. Controller Interface (Data Exchange with the Plant Control System): Provide provisions to make available and receive in contiguous registers the following data to and from the plant control system, through the centrifuge PLC via Ethernet/IP.
   a. Communicated Discrete Outputs to the Plant Control System:
      1) Emergency Stop.
      2) Centrifuge ON status.
      3) Centrifuge READY status.
      4) Centrifuge FAILED TO START status.
      5) Centrifuge FAILED TO STOP status.
      6) Centrifuge control mode REMOTE status.
      7) Backdrive control mode status.
      8) Clean mode status.
      9) Vibration value and vibration warning (HIGH) and shutdown (HIGH HIGH) alarms.
      10) Motor faults.
      11) High torque alarm.
      12) Torque overload (HIGH HIGH) alarm.
      13) Drive end/idle end bearing HIGH temperature alarm.
      14) Drive motor HIGH temperature alarm.
      15) Backdrive HIGH temperature alarm.
      16) Backdrive malfunction alarm.
      17) Backdrive controller (AFD) malfunction alarm.
      18) Main drive controller (AFD) malfunction alarm.
      19) Sludge feed ENABLE signal.
      20) Polymer feed ENABLE signal.
      21) Flush water valve OPEN command.
      22) Belt conveyor FORWARD ENABLE signal.
      23) Belt conveyor REVERSE ENABLE signal.
      24) Quantity of 12 additional communicated discrete outputs.
   b. Communicated Analog Outputs to the Plant Control System:
      1) Bowl speed.
      2) Bowl/scroll differential speed.
      3) Backdrive torque.
      4) Main drive motor amperage (rms value).
      5) Bearing temperature, drive end.
      6) Bearing temperature, idle end.
      7) Bearing vibration value, drive end.
      8) Bearing vibration value, idle end.
      9) Sludge feed pump flow rate setpoint.
      10) Polymer feed pump flow rate setpoint.
      11) Quantity of six additional communicated analog outputs.
   c. Communicated Discrete Inputs from the Plant Control System:
      1) Emergency stop.
      2) Centrifuge START command.

3) Centrifuge STOP command.
4) Centrifuge CIP START command.
5) Backdrive control mode (TORQUE/DIFFERENTIAL).
6) Centrifuge feed pump ON status.
7) Polymer feed pump ON status.
8) Belt conveyor ON status.
9) Quantity of 12 additional communicated discrete inputs.

d. Communicated Analog Inputs from the Plant Control System:
1) Torque set point.
2) Differential speed set point.
3) Bowl speed set point.
4) Quantity of six additional communicated analog inputs.

e. Any other data or status considered by manufacturer as essential to safe operation.

f. Polymer pump START/STOP control and flow control will be from the plant SCADA System. The centrifuge PLC shall initiate START/STOP request for the polymer pump as specified for centrifuge startup and shutdown functions.

g. Sludge feed pump START/STOP and flow control will be from the Plant Control System. The centrifuge PLC shall initiate START/STOP request for the sludge feed pump as specified for centrifuge startup and shutdown functions.

2.28 ACCESSORIES

A. Equipment Identification Plates: Provide a 16-gauge stainless steel identification plate for all equipment, valves, appurtenances, and instruments with equipment/component numbers, securely mounted on the equipment in a readily visible location. The plate shall bear the 1/4-inch die-stamped equipment identification numbers.

B. Lifting Lugs: Equipment and each component thereof weighing over 50 pounds shall be provided with lifting lugs for easy handling.

2.29 PAINTING

A. The paint system shall be a catalyzed epoxy primer with a top coating of aliphatic acrylic urethane in accordance with manufacturer’s typical paint specifications.

B. All carbon steel and cast iron shall be properly prepared and cleaned in accordance with the best standard practices. Minimum surface preparation shall include solvent cleaning, SSPC SP-1 followed by abrasive blasting to near white metal, SSPC SP-10. Or other surface preparation methods will be considered, provided that the method results in the minimum surface profile

required by the paint manufacturer. Apply 3 mils minimum dry film thickness of lead-free catalyzed epoxy polyamide metal primer and one finish coat of aliphatic acrylic polyurethane, 3 mils minimum dry film thickness. Prepare all surfaces and apply all paint in accordance with the paint manufacturer's written directions. The color shall be the manufacturer's standard. Provide 1 gallon of touch-up paint.

2.30 CENTRIFUGE FACTORY TESTS

A. The Owner has the option to inspect the fabrication procedures at any time during the fabrication stage(s) of the centrifuge and associated equipment. Owner's travel expenses will be borne by the Owner.

B. Notify the Owner of the schedule for centrifuge factory testing not less than 45 days in advance and Owner will travel to the factory and witness the centrifuge factory testing.

C. Perform manufacturer's standard functional tests on the centrifuges as follows:

1. Gather and furnish test information necessary to show conformance to specified requirements.
2. Manufacturer's Test Representative shall certify test results.
3. Perform tests on all components actually furnished. Use of factory control panels and factory motors are acceptable.
4. Vibration measurement with bowl filled with water.
5. Operation of machine for minimum of 4 hours with water.
6. Motor starting amperage.
7. Obtain acceptance of test reports from Engineer prior to shipment of equipment.

D. Noise Test: Measure free field sound pressure levels of centrifuge running at the normal operating speed with bowl filled with water and/or with water feed.

E. Motor Tests: See Section 26 20 00, Low-Voltage AC Induction Motors.

F. Scratch Abrasion Test:

1. The sintered tungsten carbide tiles to be used on the wearing face of the conveyor shall be subjected to a dry sand rubber wheel abrasion test. This test shall be conducted in accordance with the current ASTM G65, Procedure A. The test shall be conducted with the following requirements:
   a. Wheel Load: 30 pounds.
   b. Grit: AFS 50/70.

c. Grit Flow Rate: 250 grams per minute to 350 grams per minute.
d. Shape of Sand Curtain: Streamlined.
e. Test Duration: 6,000 revolutions.
f. Rubber Wheel: Chlorobutyl rubber with a Durometer A of 58-62.
g. Wheel Speed: 200 rpm (plus or minus 10 rpm).
h. Wheel Diameter: 8.50 inches to 9 inches.
i. Linear Abrasion Distance: 14,138 feet.
j. Sand Nozzle: Special fabricated design.

2. Test one tile from each lot of tiles used in manufacturing the centrifuges, or four tiles total, whichever requires the greater number of tiles to be tested. The following laboratories are equipped to conduct these tests in accordance with the ASTM Standards and can provide certification of the results:
   a. Colorado School of Mines, Golden, Colorado 80401.
   b. Falex Corp., Aurora, Illinois 60505.
   c. “Or-equal.”
3. The volume loss of the proposed wear resistant material shall not exceed 3 cubic millimeters per tile during the 30-minute test period. Any material that exceeds 3 cubic millimeters loss in 30 minutes will not be allowed.

2.31 PANEL FACTORY TESTS

A. The Owner has the option to inspect the fabrication procedures at any time during the fabrication stage(s) of the centrifuge control and electrical panels and associated equipment. Owner’s travel expenses will be borne by the Owner.

B. Notify the Owner of the schedule for panel factory testing not less than 45 days in advance and Owner will travel to the factory and witness the panel factory testing.

C. Perform manufacturer’s standard functional tests on each centrifuge control and electrical panel as follows:

1. Gather and furnish test information necessary to show conformance to specified requirements.
2. Manufacturer’s Test Representative shall certify test results.
3. Perform tests on centrifuge control and electrical panel actually furnished.
4. Test panel for proper construction, electrical connection, and function.
5. Test all PLC inputs and outputs for proper connection and function.
6. Check all alarms, shutdown conditions, and automatic sequences to verify proper function.

7. Simulate interlocks and signals from other connected equipment in order to demonstrate specified operator interface functions and controls.
8. Obtain acceptance of test reports from Engineer prior to shipment of equipment.

D. AFD Tests: See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

PART 3 EXECUTION

3.01 INSTALLATION

A. General Contractor shall install equipment in conformance with the manufacturer's written instructions, with supervision and inspection performed by manufacturer's representative.

3.02 FIELD TESTS

A. Field Motor Tests: At the time of equipment delivery to the Job Site and after installation prior to startup, the Contractor shall megger test (500-volt megger) each motor phase-to-phase and phase-to-ground in the presence of the Engineer. The 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. The timing and scheduling for testing shall be coordinated with and be dependent upon the Owner's schedule and quantity of sludge available for testing.

B. Contractor shall notify the Owner in writing 60 days prior to when the Pre-Performance Test will occur. Contractor shall include in the notification the type of polymer recommended by the centrifuge manufacturer for the Pre-Performance and Performance testing.

C. Functional Test:

1. Prior to startup, all equipment described herein shall be inspected 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 the Engineer.
2. Functional testing shall be conducted after the installation of the centrifuge and all appurtenances.
3. Perform on each completed centrifuge system without sludge feed prior to startup.

4. Each unit shall be submitted to complete normal start, normal stop, and controlled shutdown cycles. The unit shall then be submitted to a 2-hour running test. At the beginning and end of the test, and at periodic intervals between, all temperature monitoring devices shall be observed and recorded. The belt tension shall be adjusted at the start of the test, checked and readjusted if necessary at the end of the test. All safety devices and the differential speed control for the backdrive unit shall be checked for satisfactory operation. Instrumentation and control systems shall be checked for conformance with these specifications.
5. As part of the test, each centrifuge shall be operated with water feed for a minimum of 30 minutes. At the beginning and end of the 30-minute water test, observe and record all thermometer, pressure gauges, and flow indicator readings.
6. After approximately 1 hour of runtime, the centrifuge shall be measured for proper vibration. Vibration velocities shall not exceed 5 mm per second RMS, with water feed, at the main bearings. If units exhibit vibration in excess of the limits specified, manufacturer shall adjust or modify the unit as necessary. After adjustment and/or modification, unit shall be retested to prove conformance.
7. Proposed test procedures shall be developed by the centrifuge manufacturer and submitted to the Engineer for review, comment, and approval. Testing shall not be begun until the test procedures have been approved by the Engineer.
8. A qualified representative of the manufacturer shall supervise each test, analyze data, and certify the centrifuge's performance during the test.
9. Submit test log to Engineer upon completion of each test.
10. Complete successful functional testing prior to performance testing.

D. Pre-Performance Test:

1. Manufacturer's representative, assisted by the installing contractor and Owner, shall conduct testing to demonstrate continuous, reliable operation, not performance, while dewatering the sludge stream specified.
2. Contractor shall coordinate with centrifuge manufacturer representative, and notify Owner in writing at least 14 days prior to when the Pre-Performance Test will occur. Prior to any testing, the centrifuge manufacturer shall have provided complete Operation and Maintenance Manuals and conducted Pre-Startup classroom training on the dewatering centrifuges. Field training may occur during the Pre-Performance Test. The Functional Test shall be successful before the Pre-Performance Test may be conducted.
3. Pre-Performance Test shall include operation of each dewatering centrifuge for a period of 5 working days (one 5-day, 8-hour work day week) without shutdown due to equipment or system failures.

4. Stoppages due to any failure of provided equipment and instrumentation, such as the centrifuge control and electrical panels, shall not exceed 30 minutes, and such stoppages shall not number more than five over the 5-day test period. A greater number of stoppages or a stoppage longer than 30 minutes shall be deemed a failure of the Pre-Performance Test and the test will stop. Stoppages caused by the Owner may occur without causing failure of the test.
5. Proposed test procedures shall be developed by the centrifuge manufacturer and submitted to the Engineer for review, comment, and approval. Testing shall not begin until the test procedures have been approved by the Engineer.
6. A qualified representative of the manufacturer shall supervise each test, analyze data, and certify the centrifuge's performance during the test.
7. If, in the opinion of the Engineer, the Pre-Performance Test is successful and meets the requirements specified herein, the Engineer will recommend to the Owner, by letter, the acceptance of the Pre-Performance Test and that the dewatering centrifuge may begin the Performance Test, providing other requirements for the Performance Test to begin are satisfied.
8. Should the dewatering centrifuges be unable to achieve the Pre-Performance Test requirements, the centrifuge manufacturer shall perform whatever equipment modifications are deemed necessary such that the equipment can achieve the performance specified. All modifications shall be documented and submitted to the Engineer. Following completion of the equipment modifications, the Pre-Performance Test shall be run again in its entirety.
9. For the initial and any subsequent Pre-Performance Tests, the costs for polymer, power, and feed sludge shall be borne by the Owner. Centrifuge manufacturer shall be responsible for recommending the emulsion polymer to use and centrifuge operational settings.

E. Performance Test:

1. Performance testing shall be done to demonstrate the actual system operating conditions and verify that each dewatering centrifuge meets or exceeds the minimum performance requirements specified in Article Performance Requirements while dewatering the sludge stream specified in Article Service Conditions. Performance testing shall be performed at the solids loading rates specified in Article Performance Requirements.
2. Contractor shall coordinate with centrifuge manufacturer representative, and notify the Owner in writing at least 14 days prior to when the Performance Test will occur. Performance Test shall not proceed until after the Pre-Performance Test is successfully concluded.

3. Manufacturer's representative, assisted by the installing contractor and Owner, shall startup and operate each dewatering centrifuge for a period of 8 hours per day for 2 days, with no interruptions allowed during the 8-hour period. All centrifuge operations and associated manufacturer's field services required to adjust machine settings shall be performed prior to and exclusive of the above specified performance test duration.
4. Proposed test procedures shall be developed by the centrifuge manufacturer and submitted to the Engineer for review, comment and approval. Testing shall not begin until the test procedures have been approved by the Engineer.
5. A qualified representative of the manufacturer shall supervise each test, analyze data, and certify the centrifuge's performance during the test.
6. Steady state operation at the specified sludge feed solids rates shall be maintained throughout the test and all hourly quantities shall be the average during the test period. The centrifuge shall maintain acceptable performance while dewatering feed sludge with percent dry solids concentration 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 in order to make the following determinations:
    a. Sludge Feed Rate: Flow (gpm).
    b. Sludge Feed Concentration: The total dry solids concentration of the feed sludge entering the centrifuge (percent TS).
    c. Dewatering Cake Concentration: The total dry solids concentration of the dewatered sludge cake discharged from the centrifuge (percent TS). Take two duplicate samples per sample interval.
    d. Centrate Concentration: The total suspended solids concentration of the centrate discharged from the centrifuge (percent TSS).
    e. Solids Capture: Percent.
    f. Feed Hydraulic Loading Rate (Exclusive of Polymer): Flow (gpm).
    g. Feed Solids Loading Rate (Exclusive of Polymer): Pounds-per-hour of total dry solids.
    h. Polymer Feed Rate: Flow (gpm).
    i. Polymer Activity and Dose: Pounds active per dry ton of feed solids.
8. Collect samples at approximate 1 hour intervals.
9. Performance will be based upon the arithmetic average of the test results obtained during the test period. The Owner reserves the right to discard obviously high or low erroneous test results. As specified below, laboratory testing will be performed by the Owner. Turnaround time for dewatered cake concentration samples are approximately 24 hours. For more immediate cake results, centrifuge manufacturer may supply their

own instrumentation. Performance results shall be based on the laboratory standard methods results.

10. Prepare a formal test report including all laboratory analysis reports, all measured flows, the mass balance calculations, and the percent capture. Six copies of the final report shall be submitted to the Engineer within 20 days after completion of the test.
11. In the event that the centrifuges do not meet the requirements of these Specifications during the performance test, the representative of the manufacturer shall make such changes in the equipment and methods of operation as deemed necessary and as approved by the Engineer. The necessary adjustments shall be made as soon as practical, but within a period not to exceed 30 days. Following the adjustments, make a second test run similar to the first run. In the event that the centrifuge still does not achieve specified performance during the second test, then the equipment will be subject to rejection. The centrifuge manufacturer shall retain responsibility for the centrifuges until the acceptance test has been successfully completed. However, after initial startup the Owner shall have the right to use the centrifuges as needed to process sludge.
12. If, after a maximum of two test runs, in the opinion of the Engineer, a centrifuge meets the performance requirements specified herein, the Engineer will recommend the final acceptance of the centrifuge. If, in the opinion of the Engineer, the performance test results do not meet the requirements specified herein, the Engineer will notify the centrifuge manufacturer and the Owner of the nonacceptable performance, and Owner shall receive liquidated damages.
13. The cost of all laboratory tests necessary to confirm the sludge characteristics for the initial performance test on a centrifuge will be borne by the Owner. All laboratory tests for performance testing shall be performed by the Owner in conformance with the applicable portions of standard methods. If retesting is required, the centrifuge manufacturer shall pay the Owner or a certified third-party laboratory for all laboratory tests after the initial test.
14. Emulsion polymer used shall be as recommended by the centrifuge manufacturer. Polymer costs for initial testing and for one retest shall be borne by the Owner. Polymer costs for all subsequent testing required shall be the responsibility of the centrifuge manufacturer. Polymer costs for operation of the centrifuges after successful performance testing shall be borne by the Owner.
15. The cost of power, water, feed sludge, centrate disposal, and cake disposal shall be borne by the Owner.

F. Manufacturer's Field Services:

1. Manufacturer's Authorized Representative: Present at Work Site or classroom designated by the Owner, for the minimum person-days listed below, travel time excluded.
2. Minimum services to include:
   a. 4 person-days total for installation assistance, inspection, and certification of installation.
   b. 4 person-days total for functional testing.
   c. 14 person-days total, for prestartup classroom or Job Site training.
   d. 1 year after Project Substantial Completion, 14 person-days total, for prestartup classroom or Job Site training.
   e. 14 person-days, for post-startup training within 1 year of initial startup.
3. 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 the Owner and Engineer. Owner shall pay manufacturer for additional service trips and labor hours, if trips and labor hours exceed the periods specified above due to fault of the Owner.
4. For additional field services regarding the AFDs, see Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

END OF SECTION

SECTION 43 40 01
POLYETHYLENE STORAGE TANK

EQUIPMENT AND COMPONENT NUMBER(S)

H090-DEW1-TNK01: Polymer Bulk Storage Tank.
H090-DEW1-RCP01: Polymer Recirculation Pump No. 1.

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.
3. 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 holddown and support systems. Both plan and elevation views shall be provided. All piping terminal points shall be clearly shown and fully dimensioned.
   c. 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.
   d. Complete design calculations for tanks, supports and appropriate accessories. Diagrams and calculations shall be provided that indicate all static and dynamic loads.
   e. Tank data indicating pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, and details of nozzle designs.
   f. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.
   g. Certified test data on representative samples of standard materials which demonstrate compliance with the physical properties specified herein.

h. Certified copy of all factory test results including gel tests, impact tests, and hydrostatic tests. Provide a list of procedures used in testing.
i. 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.
j. All exceptions and any proposed revisions to the requirements of these Specifications shall be included with the Submittals.
k. Leak detection sensor catalog information and wiring diagrams.

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, drawings, and cut sheets in accordance with 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 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 AND PRODUCTS

A. Assman Corporation; Model No. IMT8850.

B. “Or-equal.”

2.03 SERVICE CONDITIONS

A. Location: Indoors.

B. Ambient Air Temperature Range: 50 degrees F to 90 degrees F.

C. Relative Humidity: Up to 100 percent.

D. Operating Pressure: Atmospheric.

E. Stored Materials:

Stored Materials		
Equipment	**Chemical**	**Specific Gravity**
Polymer Bulk Storage Tank	Emulsion Polymer (40% Active)	1.06
*Wall thickness calculations shall be based on tank contents with a specific gravity of 1.2.		

2.04 TANK DESIGN CRITERIA

A. Minimum Useable Volume: 7,000 gallons.

2.05 CHEMICAL CONTAINMENT

A. Chemical containment of polymer will be achieved by providing double wall storage tanks fabricated from XLHDPE. Polymer piping will also be double wall for containment.

2.06 TANK CONSTRUCTION

A. Tanks specified herein shall be cross linked high-density polyethylene construction with interior anti-oxidant resistant linear HDPE liner and integrally mounted flanged outlet (IMFO) and shall meet or exceed all requirements of ASTM D1998.

B. Tanks shall be vertical, flat bottom, dome top construction with translucent materials to allow observation of liquid level.

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 Useable Volume**	**Maximum Diameter***	**Sidewall Height***	**Overall Height***
Polymer Bulk Storage Tank H090-DEW1-TNK01	7,000 gal	144"	147"	173"
*Tank sizes can be smaller so long as minimum usable volume is met.				

F. Materials shall meet or exceed the following properties:

Parameter	ASTM Test	Requirement
Density (Resin)	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 - 800%
Vicat Softening Point	D1525	240 degrees F
Flexural Modulus	D790	87,000 - 110,000 psi
Brittleness Temperature	D746	-130 degrees F
Heat Distortion Temp	D648	67 degrees C
Polyethylene Notch Test (PENT)	F1473	>1,000 hours

2.07 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.

2.08 FITTINGS

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

Fitting/Opening Schedule		
Service	**Type/Location**	**Diameter**
Tank Fill Inlet	Flanged/Top	2 inch
Vent	Flanged/Top	3 inch
Overflow	Flanged/12" below tank top	4 inch
Recirculation Inlet	Flanged/Tank bottom	2 inch
Recirculation Outlet	Flanged/Top	2 inch
Tank Discharge to Blend Units	Flanged/Tank bottom	2 inch
Level (radar)	MFR Standard/ Top	Coordinate instrument connection and size with instrument provider.
Manway	Flanged/ Top	MFR Standard

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.

2.09 TANK RECIRCULATION PUMP

A. A polymer recirculation pump (H090-DEW1-RCP01) shall be provided with the polymer bulk storage tank (H090-DEW1-TNK01).

B. Pump Design Criteria:

1. Type: Diaphragm.
2. Minimum Flow: 50 gpm.
3. Maximum Pressure: 30 feet head.
4. Motor: 1/2 hp.
5. Electrical: 460V, 3 pH, 60 Hz.

2.10 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. Calibration Tape: Calibration tape shall be self-adhesive, translucent tape calibrated in multiples of 50 gallons or less. Strips shall use black numerals and tick marks to denote gallonage.

C. 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.

D. 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.

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.

2.11 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 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. XLHDPE Tank Schedule.

END OF SECTION

XLHDPE Tank Schedule	
Name of Tank	Polymer Bulk Storage Tank
Equipment Numbers	H090-DEW1-TNK01
Tank Containment	Double-walled (double walled CPVC for piping)
Installation (Vertical/Horizontal)	Vertical
Diameter (inches)	143
Straight Shell Height (inches)*	147
Overall Height (inches)*	173
Support (saddles, flat pad, legs)	Flat concrete pad
Type of Bottom Head	Flat bottom
Type of Top Head	Closed dome top
Ladder Required (Yes/No)	Yes
Tank Location (indoor/outdoor)	Indoor
Ambient Temperature Range (degrees F)	60-80
Exterior Loading (psf):	
Personnel Roof Loads	
Platforms	
Mixers	
Pipe Supports	
Operating Contents:	
Temperature (degrees F, not to exceed 180)	
Chemical Composition	Polymer
Specific Gravity	1.06
Concentration	40% Active
pH Range	
Insulation/Heat Tracing (Yes/No)	No
*Tank can be smaller so long as minimum useable volume is 7,000 gallons or greater.	

SECTION 44 42 19.04
ROTARY POSITIVE DISPLACEMENT BLOWER

PART 1 GENERAL

1.01 REFERENCES

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

1. American Gear Manufacturers Association (AGMA).
2. American National Standards Institute (ANSI).
3. ASTM International (ASTM):
   a. A48/A48M, Standard Specification for Gray Iron Castings.
   b. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
4. National Electrical Manufacturers Association (NEMA).
5. Section 40 99 90, Packaged Control Systems.

1.02 DEFINITIONS

A. Absolute Discharge Pressure: Pressure in pounds per square inch absolute (psia) at the blower discharge flange.

B. Brake Horsepower (BHP): (Shaft) Standard curve horsepower required, corrected for pressure, temperature, and relative humidity at inlet conditions.

C. Discharge Pressure: Pressure in pounds per square inch gauge (psig) at blower discharge flange at rated capacity.

D. Inlet Cubic Feet per Minute (icfm): Volumetric rate of air at the inlet flange of the blower corrected to absolute pressure, temperature, and relative humidity. The pressure takes into account the inlet piping in filter pressure drops.

E. Pressure Rise: Pressure developed within the blower between the inlet and outlet flanges. It is the discharge pressure less the inlet pressure measured at the discharge and inlet flanges, respectively.

F. Standard Cubic Feet per Minute (scfm): Volumetric rate of air measured in standard cubic feet per minute at 68 degrees F, pressure of 14.7 psig, and relative humidity of 36 percent.

1.03 SYSTEM DESCRIPTION

A. Blower system, featuring rotary positive displacement blower(s) to supply air for the Sludge Holding Tank No. 1.

B. Provide blower system, including, but not limited to, blowers, control panel, motors, drives, baseplates, vibration isolators, supports, inlet silencers, discharge silencers, relief valves, flexible connectors, noise enclosures, spare parts, outside air filter, and miscellaneous appurtenances as necessary.

1.04 DESIGN REQUIREMENTS

A. Design equipment with due regard to safety of operation, accessibility, and durability of parts, and complying with applicable OSHA, state, and local safety regulations.

B. Each blower will receive outside air from a dedicated filter and discharge into a main air discharge header.

C. Intermittent and continuous operation in an indoor environment.

D. Blower(s) shall start no more than four times per hour when operating in intermittent service.

E. Blowers shall meet rated performance and sound level when operating at a maximum speed of 6,700 rpm.

F. Maximum Sound Pressure Level: 75 dBA, factory calculated, with inlet and discharge silencers, measured with a sound enclosure.

G. Performance Requirements:

Design Conditions	
Equipment ID	H090-DEW2-BLO01, BLO02, BLO03
Design Capacity, scfm	2,000
Design Capacity, icfm	2,314
Maximum Capacity, icfm	2,545
Altitude, ft	600
Barometric pressure, psia	14.3
Inlet pressure at compressor flange, psia	14.3
Inlet air temperature, degrees F (Guarantee Point)	78

Design Conditions	
Inlet air temperature range, degrees F	20 min to 100 max
Relative humidity, % (Guarantee Point)	36
Discharge pressure at compressor discharge flange, psia	23.3
Blower pressure rise required, psi	9
Pressure relief valve setting, psig	11.9
Shaft brake horsepower, BHP[1,2]	100

[1]Includes main oil pump, if specified, and all gear and bearing frictional losses.

[2]Not to exceed motor nameplate horsepower at 1.0 service factor at the inlet air temperatures design pressure, and altitude listed above.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Complete list of system components to be provided.
   b. Make, model, weight, and horsepower of each equipment assembly.
   c. Complete catalog information, descriptive literature, and specifications.
   d. General arrangement drawings of the factory assembled blower package.
   e. Performance data for each type of equipment that will show compliance with specification requirements stated herein.
   f. Horsepower demand over the operating range of the blower.
   g. Detailed structural, mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work.
   h. Motor: See requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
   i. Monitoring System:
      1) Cut sheet on local blower controller and VFD.
      2) Wiring diagrams, including baseplate-mounted terminal junction box and equipment monitoring panel.
      3) Panel construction and face layout drawings.

j. Sound Enclosure: Complete description of sound enclosure and accessories.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance.
2. Factory calculated sound levels (dBA) of blower unit with silencers and sound enclosure.
3. Identification of outside utility requirements for each component such as air, water, power, etc. Include operating parameters for required utilities.
4. Special shipping, storage and protection, and handling instructions.
5. Manufacturer's written installation instructions.
6. List of 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 the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
8. Routine maintenance requirements prior to plant startup.
9. Test Reports:
   a. Factory test reports for blower and motor.
   b. Field test procedures.
10. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
11. Manufacturer's Certificate of Proper Installation.

1.06 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and materials:

Item	Quantity
Oil, synthetic	Enough for 1 year of continuous operation, per unit
Inlet Filters	Enough for 2 complete changes per unit
Flexible Coupling	One complete set per unit
Control Cabinet Filter Mats	Enough for 2 complete changes per unit
Motor Grease	1 Tube per unit
Special tools required to maintain or dismantle	One complete set for each unit

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. General:

1. Where possible, provide end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, replacement, and manufacturer's service.
2. Manufacture spare parts to United States standard sizes and gauges.

B. Materials, equipment, and accessories specified in this section shall be products of:

1. Kaeser; Screw Type FBS720L.
2. Gardner, Denver; IQHE105/4P-1-100hp.
3. Aerzen, USA.

C. No "or-equal" or substitute products will be considered.

2.02 COMPONENTS

A. Blower:

1. Rotary positive displacement screw type, gear driven by horizontal electric motor.
2. Casing: Two-piece construction with thermally decoupled gearbox section, EN GJL-200 close-grain cast iron strongly ribbed to prevent distortion at the specified operating conditions.
3. Bearings:
    a. Support shaft and impeller assembly by single-row roller bearings sized for a minimum L-10 rating of 100,000 hours at Project conditions.
    b. An extra gear side ball bearing shall be provided for axial forces inherent with a screw blower design.
    c. Bearings and Gears: Lubricated by a splash type lubrication system on both ends of the rotors.
    d. Provide one seal assembly on each end of each rotor, for a total of four assemblies per blower. Each assembly shall consist of two piston ring labyrinth seals and two spiral seals. The drive shaft seal shall be a mechanical sliding ring type seal.
    e. Make further provision to vent area between the two sealing systems to atmosphere to relieve excessive pressure on seals.

4. Impellers:
    a. The primary rotor shall be machined out of a one piece casting made of EN GJL-250 material, with a press fit shaft machined of C45 shaft material. The secondary rotor and shaft shall be machined out of a one-piece casting made of EN GJS-500 material.
    b. Screw blower type, rotating in opposite directions in a common casing without rubbing, liquid seals, or lubrication.
    c. Positioned by timing gears to maintain proper clearances.
    d. Mount impellers and timing gears on shafts supported by antifriction bearings, fixed to control the axial location of impeller/shaft in the casing.
    e. Statically and dynamically balanced by removing metal from impeller body.
    f. Positively timed by a pair of accurately machined and carburized steel spur gears to quality standard 5f 21. Gears mounted on shafts with tapered fit and secured by a locknuts.
5. Gear Drive:
    a. The blower shall be driven by a direct coupled gear driven system.
    b. A robust slip-free gear drive system, which requires no additional oil chambers, oil pumps, or additional bearings shall be utilized.
    c. Drive gears shall be integrated into blower drive side oil chamber.
    d. No additional oil pump, oil reservoir, or heat exchangers shall be used.
    e. Drive motor with flanged direct mount face. Drive motor shall use grease-filled bearings.
    f. Heavy duty mechanical blower/drive shaft seal with drain system towards motor face.
    g. Low radial loads of the motors ball bearing design for long bearing lifetime.

B. Motor:

1. Squirrel-cage ac induction type, meeting requirements of Section 26 20 00, Low-Voltage AC Induction Motors, and as specified herein.
2. Motor Horsepower: 100 hp.
3. Nominal Speed: 3,600 rpm, constant.
4. Rated Voltage: 460 volt, three-phase, 60 Hz.
5. Enclosure Type: TEFC as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
6. Inverter Rated Ready for VFD Operation Drive: Gear driven.
7. Motor Efficiency: Premium efficiency as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
8. Service Factor: 1.0.

C. Blower Support:

1. Baseplate: Cast iron or fabricated steel mounted on concrete equipment pad as shown on the Drawings.
2. Support Stand: Designed by manufacturer and reinforced to withstand anticipated loadings of blower, motor, inlet and discharge silencers, and associated piping.
3. Factory mount blower and motor as a package.
4. Provide vibration isolators to limit transmission of vibration to anchor points at floor.

2.03 ACCESSORIES

A. Air Inlet Filter: Provide as shown on the Drawings.

B. Blower Inlet Filter:

1. Dry-type inlet air filter of configuration shown on the Drawings for each blower.
2. The inlet silencer shall have an integral filter designed to protect the blower from particulates. It shall be located between the absorptive material and the blower inlet.
3. The filter element shall be a washable and reusable polyester element.
4. The filter efficiency shall meet ASHRAE 52.2 MERV7 50 percent to 70 percent at 3 microns to 10 microns corresponding to EN779 G4.
5. Filter element shall be removable without disconnecting the inlet duct.
6. Filters shall be furnished with the blowers and installed within the sound enclosure at the factory.

C. Inlet, Discharge Silencers:

1. Designed to reduce pulsation from rotary screw blowers at blower operating speed.
2. Silencers shall be of the wear-free absorptive type silencer.
3. Silencers shall be factory installed within the sound enclosure.
4. Any pressure loss associated with silencers shall be included in the manufacturer’s performance data.

D. Flexible Connectors:

1. Discharge: Pressure spool, single arch, expansion joint type with 125-pound ANSI flanges.
2. Inlet: Web reinforced silicone rubber sleeve with corrosion resistant clamps.
3. Operating Temperature Rating, Discharge: 300 degrees F.
4. Install as noted above on each blower at inlet and outlet.

E. Check Valve:

1. Single-plate, metal hinged wafer type for each blower; installed in blower discharge piping downstream of silencer and relief valve.
2. Steel body and circular steel plates.
3. Seat: Viton or Silicone for high temperature operation.
4. Elastomeric hinges will not be allowed.

F. Safety Relief Valve:

1. Spring type.
2. Sized to relieve entire discharge flow without overloading blower.
3. Furnish one for each blower.
4. Provide nozzle on discharge silencer to mount relief valve as shown.

G. Temperature Sensor:

1. Provide HIGH discharge air temperature sensor, factory installed within the sound enclosure, for each blower.
2. Locate sensor directly after blower discharge.

H. Noise Enclosure:

1. Total Noise Enclosure: 85 dBA average noise level at 1 meter.

I. Lifting Lugs: Provide lifting lugs on motors and holes to allow for installation of lugs on blower blocks as needed.

2.04 INSTRUMENTATION AND CONTROLS

A. Instrumentation and Controls: In accordance with Section 40 99 90, Package Control Systems. External signal interfaces are required to interface with facility's CCS. Provide items not specifically called out which are required to implement functions required for proper system operation.

B. Control Panel:

1. Panel Power Requirements: Must be powered via transformer and/or power supply within control cabinet. Only one 460V power source should be connected to integrated blower package.
2. IP52 rating.
3. Mounting: Integral and factory installed onboard blower package.
4. Control Capabilities via Local Controller:
   a. LOCAL/OFF/REMOTE.
   b. START/STOP.
   c. RESET for blower fail.

5. Alarms, at a Minimum:
    a. Blower FAIL.
    b. HIGH differential air pressure.
    c. Emergency Stop.
    d. High Discharge Temperature.
    e. Motor overload.
6. Miscellaneous:
    a. RUN time meter.
    b. High inlet vacuum shutdown.
    c. Discharge High Temperature Shutdown: Based on blower performance data, via onboard temperature sensor.
    d. Discharge High Pressure Shutdown: Based on blower performance data, via onboard pressure sensor.
    e. Inlet and Discharge Pressure Readings must be displayed on the local controller.
    f. Inlet and discharge temperature readings must be displayed on the controller.

C. Control Panel External Interfaces:

1. Discrete Outputs to CCS:
    a. Dry contacts shall be pre-wired to a common terminal strip, and suitable for 1 amp at 120V ac.
    b. REMOTE status.
    c. Common FAIL alarm contact that closes on the occurrence of any of (but not limited to) the following conditions (to be used by CCS):
        1) HIGH differential air pressure.
        2) HIGH discharge temperature.
        3) Motor OVERTEMP.
2. Discrete Inputs:
    a. Contact Rating: Wet contact at 24V dc.
    b. START/STOP from CCS.
3. Signals that interface with CCS shall be wired to a terminal block in each panel.

D. System Operation:

1. Functional Requirements:
    a. Provide at each panel:
        1) Acknowledge Alarm pushbutton and associated logic for the common FAIL alarms. When alarm condition occurs, indicate associated condition at panel. Local indication of alarm condition shall remain until condition has been corrected and Acknowledge Alarm pushbutton pressed.

2) Control logic to monitor operation of blower and fully control onboard motor and VFD. Blower shall alarm if a dangerous operating condition such as high discharge pressure or high discharge temperature is measured via onboard sensors.
3) If an alarm is thrown, unit shall not start again until the problematic condition is resolved and the alarm is acknowledged.

2.05 SOURCE QUALITY CONTROL

A. Blower Performance Test:

1. Submit test results for review prior to shipment of package.
2. Perform on the blower actually furnished in accordance with ISO 1217 standards.
3. Test each blower for a minimum of 1 hour in total across five test points after stabilization at design conditions for mechanical integrity and flow performance.
   a. Perform at specified performance pressure rise.
   b. Tolerance on Flow: Plus or minus 4 percent, after correction to rated conditions.
4. Measure power consumption using a calibrated wattmeter.
5. Test Report: Confirm capacity and power, complete with data and calculations used in the test.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer’s written instructions.

B. Verify internal check valve was factory installed on blower package. If absent, install one check valve in the blower discharge piping, downstream of the silencer and safety relief valve.

C. Anchor Bolts: Accurately place using templates furnished by manufacturer and as specified in Section 05 50 00, Metal Fabrications.

D. Install blower package with anchor bolts in strict accordance with manufacturer’s written instructions.

3.02 FIELD QUALITY CONTROL

A. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.

B. Functional Test: Prior to facility startup, conduct on each Blower System for correct rotation, proper connection, quiet operation, and satisfactory specified performance.

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative:

1. Present at Site for minimum person-days listed below, travel time excluded:
   a. 1-person-day for installation assistance and inspection.
   b. 1-person-day for functional testing and completion of Manufacturer's Certificate of Proper Installation.
   c. 1-person-day for post-startup training of Owner's personnel.

END OF SECTION

SECTION 44 42 56.01
SCREW-INDUCED FLOW CENTRIFUGAL 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).
2. American Society of Mechanical Engineers (ASME): B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
3. ASTM International (ASTM):
   a. A48/A48M, Standard Specification for Gray Iron Castings.
   b. A532/A532M, Standard Specification for Abrasion-Resistant Cast Irons.
   c. A536, Standard Specification for Ductile Iron Castings.
4. Hydraulic Institute (HI):
   a. Standard 14.6, Centrifugal Pump Tests.
   b. Standard 9.6.4, Centrifugal and Vertical Pumps for Vibration Measurements and Allowable Values.
5. National Fire Protection Association (NFPA):
   a. 70 National Electric Code, Article 500, Hazardous (Classified) Locations, Classes I, II, and III, Divisions 1 and 2.
   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.

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, 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.

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 requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
7. Adjustable frequency drive data in accordance with requirements of Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
8. L-10 bearing life calculations.
9. Factory finish system.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer's printed installation instructions.
3. Factory Functional and Field Performance Test Reports.
4. 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.
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.

1.04 EXTRA MATERIALS

A. Furnish for this set of pumps:

1. Complete set keys, dowels, pins, etc.
2. Complete mechanical seal.
3. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. Characteristics:

1. Screw induced pump for pumping wastewater; incorporating an impeller that combines action of a positive displacement screw and a single vane centrifugal impeller.

2. Design shall permit low liquid velocities and gradual acceleration and change of flow direction of the pumped media.
3. Impeller/casing design shall result in a single helical passage free of surfaces to which solid or fibrous material can adhere.

B. Suction Liners: Replaceable and field adjustable.

C. Coordinate pump requirements with motor or adjustable speed drive manufacturer and be responsible for pump, drive, and speed controller requirements.

D. Pumps furnished under this section to be provided by a single manufacturer.

E. Flanges to be to ASME B16.1.

2.02 SUPPLEMENTS

A. Specific requirements are attached to this section as supplements.

2.03 ACCESSORIES

A. Base:

1. Horizontal Pump:
   a. Support by minimum 3/8-inch thick fabricated steel or cast iron base with adequate grout holes.
   b. Machined pump and motor mounting surfaces.
   c. Factory coated finish.

B. Coupling:

1. Nonmetallic flexible member type.
2. Flexible Element: Reinforced rubber tire type held in place by twin flanges to cushion shock loads.
3. No lubrication required.
4. Allow for replacement of flexible element without moving either driver or driven equipment.
5. Service Factor: Appropriate for load and operating conditions, but in no case less than 1.5 times the horsepower rating of driving motor.
6. Spacer coupling allows for rear pull out without removing motor.

C. Bearing Housing:

1. The bearing housing shall be of the back pull out design so that the bearing housing and impeller can be removed without disconnecting the casing from the suction and discharge piping.

2. The shaft shall be 1045 steel and provided with suitable bearings capable of taking mechanical and hydraulic loads.
3. The stuffing box shall be isolated from contaminants in the pumped media by a labyrinth fit between the impeller backside and the volute backplate, as well as by pump-out grooves machined into the impeller back shroud and into the volute backplate, to prevent debris from reaching the shaft seal.

D. Shaft Sealing:

1. Tandem mechanical seal arrangement requiring no external flush.
2. The mechanical seal nearest the bearing shall utilize carbon/ceramic faces.
3. The mechanical seal nearest the impeller shall be stainless steel or rubber bellow-type construction firmly attached to the rotating face and clamped to the shaft to prevent contaminants from contacting the spring.
4. The mechanical seal nearest the impeller shall be isolated from contaminants in the pumped media.
5. Back to back mounted mechanical seals are not acceptable unless an approve seal pressurization system is provided.
6. Seals requiring water flush may be furnished in lieu of the non-flushed seal, provided the Contactor, at no extra cost, provides all external auxiliary equipment necessary.

E. Guard: Meeting OSHA requirements.

F. Miscellaneous:

1. Provide tapped drain connection.
2. Provide tapped connections on discharge nozzles.
3. Provide volute clean out and inspection port.

G. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

H. Lifting Lugs: Equipment weighing over 100 pounds.

I. 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. Manufacturer’s premium epoxy and polyurethane coating system “or-equal.”

2.05 SOURCE QUALITY CONTROL

A. Pump:

1. Factory Performance Test:
   a. In accordance with HI Standard 14.6, Grade 1U for centrifugal pump tests.
   b. Include test data sheets curve test results performance test logs.
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. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

C. Hydrostatic Tests: Pump casing 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 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 the 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 poured, nonshrinking grout of 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.

G. Pipe pump drain to hub drain.

3.02 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. Vibration Test:
   a. Test with unit installed and in normal operation, and discharging to the connected piping systems at rates between low discharge head and high discharge head conditions specified, shall not develop vibration exceeding the 80 percent of the limits specified in HI Standard 9.6.4.
   b. If unit exhibits vibration in excess of limits, specified adjust or modify as necessary. Unit that cannot be adjusted or modified to conform as specified shall be replaced.
3. Flow Output: Measured by plant instrumentation and storage volumes.
4. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.
5. Test for continuous 3-hour period.
6. Test Report Requirements: In accordance with HI Standard 1.6 for centrifugal pump tests.

3.03 MANUFACTURER'S SERVICES

A. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.04 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Screw-Induced Flow Centrifugal Pump Data Sheet.

END OF SECTION

SCREW-INDUCED FLOW CENTRIFUGAL PUMP DATA SHEET

Tag Numbers: H040-WAS1-WSP01, H040-WAS1-WSP02, and H040-WAS1-WSP03

Pump Name: WAS Pump No. 1, No. 2, and No. 3

Manufacturer and Model Number: (1) Hidrostal; Model E5K-L
(2) Trillium Flow Technologies; Model SFE5-R
(3) Hayward Gordon XCS

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Waste Activated Sludge (WAS); 10,000 mg/L

Pumping Temperature (Fahrenheit): Normal 70 Max 80 Min 50

Specific Gravity at 60°F: 1 Viscosity Range: _____

pH: 6-8

Abrasive (Y/N) N Possible Scale Buildup (Y/N) N

Total Suspended Solids (mg/L) 5,000 to 17,500

Largest Diameter Solid Pump Can Pass: 4 inches

Min. NPSH Available (Ft. Absolute): _____

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 400 Secondary: 200

Total Dynamic Head (Ft): Rated: 20 Secondary: 24

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): _____

Max. Pump Speed at Rated Capacity (rpm): _____
Constant (Y/N) N Adjustable (Y/N) Y

DESIGN AND MATERIALS

Pump Type: Heavy Duty (Y/N) Y Horizontal (Y/N) Y Frame-mounted (Y/N) Y

Close-Coupled (Y/N) N Belt-Driven (Y/N) N Vertical (Y/N) N

Materials:

Pump Casing: Cast iron ASTM A48CL, Class 30

Suction Liner: HI- Chrome Steel ASTM A532-III-A

Impeller: HI-Chrome Steel ASTM A532-III-A

Shaft: Type 316 stainless steel for mechanical seal

Bearing Housing: Cast iron ASTM A48CL-30, Back Pull Out Design

Long Radius Suction Elbow (Y/N): N

Shaft Seal: Packing (Y/N) No Material: _____

Mechanical (Y/N) Yes Type: Flushless tandem mechanical contained in oil chamber

ABMA L-10 Bearing Life (Hrs): 50,000 Lubrication: _____

Bearings: Outboard End Type: _____ Inboard End Type: _____

Coupling: Falk (Y/N) _____ Fast (Y/N) _____ Spring-Grid (Y/N) _____

Gear Type (Y/N) ____ Spacer (Y/N) _____ Manufacturer Standard (Y/N) ____

Baseplate Material (Horizontal mounted): Carbon Steel.

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 5hp Voltage: 460 Phase: 3 Synchronous Speed (rpm): _____

Service Factor: 1

Adjustable Speed: YES

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _X____ ODP _____ TEFC _____ CISD-TEFC _____ TENV _____ WPI _____ WPII _____ SUBM _____

Adjustable Speed Drive Range: __min to __max, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

REMARKS: EXP classification to be in accordance with NFPA 70 and NFPA 497. All motors are to be sized and selected in accordance with HI 14.6 Grade 2-2B.

SECTION 44 42 56.04
SUBMERSIBLE PUMPS

EQUIPMENT AND COMPONENT NUMBER(S)

H050-FCL1-SCP01: Secondary Scum Pump No. 1.
H050-FCL1-SCP02: Secondary Scum Pump No. 2.

PART 1 GENERAL

2.01 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. UL.

2.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to ratings and nomenclature of Hydraulic Institute Standards.

2.03 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 and Log.
5. Manufacturer’s Certificate of Compliance, in accordance with factory finish system meets requirements specified herein.
6. Suggested spare parts list to maintain equipment in service for period of 1 year and5 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.

2.04 EXTRA MATERIALS

A. Furnish for each pump:

1. One set mechanical seals.
2. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

3.01 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. Pump and Electrical Driver: Meet requirements for class, group, and division location in accordance with NFPA 70.

D. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

E. Pumps furnished under this section to be provided by a single manufacturer.

3.02 SUPPLEMENTS

A. Specific requirements are attached to this section as supplements.

3.03 COMPONENTS

A. Equipment consists of pump complete with motor, control system, guide rail, anchoring brackets, base elbow, power cable, and pump lifting cable and control panel and level sensor.

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 nonclog impellers designed to pass course 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.
4. Type 316 stainless steel intermediate guide rail supports shall be provided for every 6.5-foot span, or as required by the manufacturer.

E. Oil chamber between seals shall be equipped with drain and inspection plug. Plug shall have positive antileak seal and shall be easily accessible from outside.

F. Motor nameplate horsepower not to be exceeded at head-capacity point on pump curve.

G. 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.

H. Motor Protection Module: If required, provide pump with a motor protection module for remote mounting in the vendor provided panel. The 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.

I. Cable Entry System:

1. Junction chamber and motor separated by stator lead sealing gland or terminal board that prevents foreign material entering through pump top.
2. Utilize cable with factory-installed sealing gland with nonshrink epoxy seal system.
3. O-ring compression seal between sealing gland and cable entry point shall also be acceptable.

3.04 CONTROL PANEL

A. NEMA 4X enclosure, for outdoor duty.

B. Refer to Section 40 99 90, Package Control Systems.

C. Free standing, post mounted.

D. Features:

1. Main circuit breaker disconnect interlocked with panel door.
2. Combination circuit breaker type, NEMA rated motor starters.
3. Fused control power transformer, 120V ac.
4. Alternator and pump lead-lag controls.
5. ON/OFF/REMOTE switches.
6. Running lights.
7. High level indication.
8. Low level indication.
9. Pump discharge process indication.
10. Pump recirculation process indication.
11. Normally closed, dry, 5 amps at 120V ac contacts for remote indication of:
    a. High high level alarm.
    b. High level alarm.
    c. Low level alarm.
    d. Low low level alarm.
    e. High pressure alarm.
    f. Moisture alarm.
    g. Motor temperature alarm.
    h. Motor fault alarm.
    i. Seal alarm.
12. Terminal strip for interfacing with external wiring.
13. High temperature indication.
14. Moisture alarm indication.
15. Alarm (high temperature, moisture, motor fault, seal, low level, or high level) beacon located on top of panel.
16. Lightning protection.
17. Intrinsically safe relays as required for UL validation.
18. Alarm silence button.
19. Document pocket located inside panel with pump and panel operation and maintenance manual, and separate laminated pump curve.

20. 110-volt, duplex GFI outlet, weather-protected, and accessible from outside of panel.
21. Run hour meter.
22. 100 watts minimum, condensation heater with thermostat.
23. UL listing mark.

E. Prewired and factory tested.

F. Mount control switches, indicating lights, and switches on hinged front panel.

G. Single Feed: 480 volts, three-phase.

3.05 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 the 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.

3.06 FACTORY FINISHING

A. Manufacturer’s standard epoxy system for continuous submergence in corrosive water.

3.07 SOURCE QUALITY CONTROL

A. Control Panel:

1. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
2. Factory Tests and Adjustments: Test all control panels furnished.

B. Pump:

1. Factory Performance Test:
   a. In accordance with HIS 11.6, Grade 1U for submersible pump tests.
   b. Include test data sheets curve test results performance test logs.

2. Conduct on each pump.
3. Perform under actual or approved simulated operating conditions.

C. Submersible Motor Functional Test: In accordance with HIS 11.6.

PART 3 EXECUTION

4.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Mount the discharge elbow to the floor of the wetwell floor with all stainless steel bolts and fasteners.

C. Connect piping without imposing strain to flanges.

D. No portion of pump shall bear directly on floor of sump.

4.02 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. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.
4. Test for continuous one full wet well pump down cycle.
5. 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.

4.03 MANUFACTURER'S SERVICES

A. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

4.04 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Secondary Scum Pump Data Sheet.

END OF SECTION

SECONDARY SCUM PUMP DATA SHEET

Tag Numbers: H050-FCL1-SCP01 and H050-FCL1-SCP02

Pump Name: Secondary Scum Pump No. 1 and No. 2

Manufacturer and Model Number: (1) Flygt NP-3102 MT 3 465

(2) Or equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent Solids): Secondary Scum. >1% TS

Pumping Temperature (Fahrenheit): Normal: 70 Max 90 Min 40

Specific Gravity at 60 Degrees F: 1 Viscosity Range: 0.71cP – 1.55 cP

Abrasive (Y/N) Y Possible Scale Buildup (Y/N): Y

Minimum diameter solid pump can pass (inches) 0.25

Min. NPSH Available (Ft. Absolute):

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 100

Total Dynamic Head (Ft): Rated: 30

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): >=30%

Max. Pump Speed at Rated Capacity (rpm): Constant (Y/N): Y

DESIGN AND MATERIALS

Pump Type: Heavy-Duty Nonclog (Y/N) Y Other: N/A

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: Cast Iron

Wear Ring Impeller (Y/N): Y Material: Cast Iron

Elastomers: Nitrile Rubber

Fasteners: Stainless Steel

Impeller: Type: Double-Shrouded Non-Clog (Y/N): Y Other: _____
Material: Cast Iron ASTM A48

Shaft Material: Carbon Steel, ASTM A576 with stainless steel sleeve or all stainless steel.

Base Elbow: Cast Iron ASTM A48

Double Mechanical Seal (Y/N): Y Bearing Life (Hrs): 50,000

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 5 Voltage: 460 Phase: 3 Synchronous Speed (rpm): 1,800

Enclosure: EXP

CLASSIFICATION: Class 1, Group D, Division 1

Other Features: _____

Moisture Detection Switches (Y/N): Y

Thermal Protection Embedded in Windings (Y/N): Y

REMARKS: Motors shall be suitable for operating exposed or submerged for extended periods of time. Provide the temperature and leak protection relays loose for installation in the vendor provided control panel.

SECTION 44 42 56.05
HORIZONTAL CHOPPER PUMP AND MIXING ASSEMBLIES

EQUIPMENT AND COMPONENT NUMBER(S)

H090-DEW2-RCP01: Recirculation Pump No. 1.
H090-DEW2-RCP02: Recirculation Pump No. 2.

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. The Work of this section includes providing pump mixing systems as defined herein and all appurtenant Work.

B. Unit Responsibility: The Work requires that the Sludge Holding Tank No. 1 mixing, complete with all accessories and appurtenances (including, but not necessarily limited to, electric motors, safety guards, and spare parts) be supplied by one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment. The supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions indicated without altering or modifying the Contractor's responsibility under the Contract Documents. The Contractor is responsible to the Owner for providing the equipment systems as specified herein.

C. General Requirements: See Division 01, General Requirements, which contains information and requirements that apply to the Work specified herein and are mandatory for this Project.

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 mixing system and recirculation equipment.
e. Motor information as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
f. Factory finish system data sheets.

2. Computational Fluid Dynamics (CFD) analysis that models the flows within each Sludge Holding Tank verifying that nozzle location and orientation provides adequate mixing of the tank contents, under service conditions specified herein. Adequate mixing shall be provided to obtain suspended solids concentrations within 10 percent of the average value regardless of location inside the tank. Model must contain all structural and mechanical elements.

B. Informational Submittals:

1. Factory Functional and Performance Test Reports and Log from actual mixing pumps that will be used in the mixed systems for this Project.
2. Manufacturer’s Certification of Compliance that the 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. Manufacturer’s Certificate of Proper Installation.
6. Suggested spare parts list to maintain the equipment in service for a period of 1 year. 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 Manual.
9. If anchorage and support details, locations, sizes and materials are not identified by the manufacturer, the Contractor shall provide support and anchorage calculations stamped by an engineer registered in the state of the Project. Anchorage and support design criteria shall meet manufacturer’s requirements, design loads provided in the General Structural Notes on the Drawings, and all applicable codes and standards. Provide ICC-ES report and special inspection requirements for any post installed anchors in concrete and masonry. Anchor

calculations shall account for edge distance, concrete thickness and other existing conditions which shall be field verified by the Contractor and identified in the calculations and any related Drawings.

1.04 EXTRA MATERIALS

A. Furnish complete mechanical seal, impeller, and cutter bar.

PART 2 PRODUCTS

2.01 GENERAL

A. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

B. Pumped Mixing System Manufacturer:

1. Rotamix® as manufactured by Vaughan Co., Inc.
2. Or approved equal.

C. Mixing and Recirculation Pump Manufacturer:

1. Vaughan Co., Inc.
2. Trillium Flow Technologies.
3. Or approved equal.

2.02 MIXING SYSTEM DESCRIPTION

A. The Contractor shall furnish one complete mixing system, for Sludge Holding Tank No. 1, consisting of two floor-mounted mixing nozzle assemblies in the tank, and two associated chopper pumps. The dimensions of tank shall be as shown on the Drawings. The nozzles shall be designed to produce a rotational mixing pattern within the tank. The manufacturer shall be responsible for determining mixing assembly quantity, location, appropriate nozzle angles, and hydraulic performance of the pumps and system as a whole. Mixing system shall be designed to adequately mix the tank as specified under Article Field Quality Control, Paragraph Performance Test, with inner structural and mechanical elements including but not limiting to concrete fillets and weirs, as shown on the Drawings.

B. Service Conditions:

1. Design Percentage Total Solids (TS) of Feed Sludge: 3.5 percent maximum. Range 1 percent to 6 percent.
2. Design Temperature of Sludge: 50 degrees F to 90 degrees F.
3. Recirculation Sludge Flows: 300 gpm to 1,000 gpm.

4. Target Tank Turnovers a Day: 6 to 10.
5. The sludge pH is anticipated to be normally 6-8.

C. The Contractor shall submit manufacturer's standard warranties for equipment to be furnished in accordance with this section. The pump warranty shall be manufacturer's standard for 1 year. The nozzle warranty shall be a 10-year nonprorated warranty, commencing on the initial startup date.

D. A performance affidavit shall be supplied certifying that the system as provided will meet or exceed the performance requirements for the specific application if proposed system has less than a minimum of 10 years of proven successful installations of the current design.

E. Nozzle Construction:

1. Nozzles: Shall be glass-lined cast ductile iron, with 1-inch nominal wall thickness to protect against abrasive conditions, and a long straight taper length of at least 10 inches.
2. Assembly Fittings: Shall be glass-lined cast ductile iron, with 150-pound flanged piping connection.
3. Base: Shall be fabricated carbon steel, with 3/4-inch mounting holes for 5/8-inch anchor bolts.
4. Anchor Bolts: Shall be 5/8-inch diameter minimum and sized by the equipment supplier, and of sufficient length to support thrust loads from nozzles. Construction shall be Type 316 stainless steel.

2.03 CHOPPER PUMPS

A. Recirculation Pump No. 1, and No. 2 (H090-DEW2-RCP01 and H090-DEW2-RCP02):

1. Capacity: Determined by mixing system manufacturer. One duty and one standby pump.
2. Head: Determined by mixing system manufacturer for the piping system as shown on the Drawings.
3. rpm: 1,170.
4. Pump shall be direct driven. Pump and motor orientation shall not compromise clearance shown on mechanical drawings for equipment access.

B. Pump Construction:

1. Pumps shall be horizontal chopper type pumps with all appurtenances as specified. The pumps shall be specifically designed to pump waste solids at heavy consistencies. Materials shall be macerated and conditioned by the pump as an integral part of the pumping action. The

pump must have demonstrated the ability to chop through and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood, paper products and stringy materials without plugging, both in tests and field applications.

2. Casing: The pump casing shall be semi-concentric back pullout design, with the first half of the circumference being cylindrical beginning after the pump outlet, and the remaining circumference spiraling outward to the 150-pound flanged centerline discharge.
3. ASTM A536 ductile cast iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics. A 1/4-inch NPT pressure tap shall be included in the discharge flange.
4. Impeller: Shall be semi-open type with pump out vanes to reduce seal area pressure. Chopping/maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a maximum set clearance between the impeller and cutter bar of 0.010-inch to 0.030-inch cold. Impeller shall be cast from ASTM A148 alloy steel, case hardened to minimum Rockwell C 60 and dynamically balanced. The impeller shall have no axial adjustments and no setscrews.
5. Cutter Bar: Shall be recessed into the pump bowl, with a funnel shaped inlet opening, and shall extend diametrically across entire pump suction opening. Cutter bar shall be cast from ASTM A536 ductile iron, or T1 alloy steel, hardened to minimum Rockwell C 50. Replaceable shear bars shall be AISI 8620 or ASTM A148 cast alloy steel, case hardened to minimum Rockwell C 60.
6. Pump Shafting: The pump shaft and impeller shall be supported by AFBMA ball bearings. All shafting shall be AISI 4140 heat treated.
7. Bearings: Shaft thrust in both directions shall be taken up by two back-to-back mounted single-row angular contact ball bearings. Two back-to-back mounted single-row radial bearings shall also be provided. B-10 bearing life shall be minimum 100,000 hours.
8. Bearing Housing: Shall be ASTM A536 ductile cast iron, and machined with piloted bearing fits for concentricity of all components. Bearing housing shall be oil bath lubricated with ISO Grade 46 turbine oil and a side-mounted site glass to provide a permanently lubricated assembly. Viton® double lip seals riding on stainless steel shaft sleeves are to provide sealing at each end of the bearing housing.
9. Seal: Flushless mechanical seal system specifically designed to require no seal flush through the elimination of the stuffing box: The seal shall be made of AISI Type 316 stainless steel and shall be cartridge-type with Viton O-rings and tungsten carbide faces. The cartridge seal shall be preassembled and pretested so that no seal settings or adjustments are required. Any springs used to push the seal faces together must be shielded from the fluid to be pumped. The cartridge shall also include a

17-4PH, heat-treated seal sleeve and an ASTM A536 ductile iron seal gland. The mechanical seal faces shall be lubricated and cooled by a separate oil chamber. The oil chamber shall include a 10 psi pressure relief valve. The area between the seal oil chamber and bearing oil chamber shall be vented and drained to prevent contamination of the bearings.

10. Inlet Manifold: The pump assembly shall be mounted horizontally with 150-pound standard inlet flange, cleanout, 1/4-inch NPT suction pressure tap, drain connection, and mounting feet.
11. Shaft Coupling:
    a. Bearing housing and motor stool design is to provide accurate, self-aligning mounting for a C-flanged electric motor. Pump and motor coupling shall be as manufactured by:
        1) T.B. Woods; Sureflex elastomeric type.
        2) Falk.
        3) "Or-equal."
12. The pump manufacturer shall provide a common pump and motor base constructed of a minimum 3/8-inch thick fabricated steel, suitably reinforced to support the full weight of the pump and motor.

C. Motors: Drive motors shall be inverter duty, horizontal, TEFC, 20 hp minimum, 1.15 service factor, 460 volts, three-phase, 60 Hz. Motor nameplate horsepower shall not be exceeded at any head capacity point on the pump curve. See Section 26 20 00, Low-Voltage AC Induction Motors.

2.04 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 3/8-inch high engraved block type equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

C. Anchor Bolts: Sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

2.05 FACTORY FINISHING

A. Manufacturer's premium epoxy and polyurethane coating system "or-equal."

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:

1. Perform manufacturer's standard motor test on equipment. Include vibration test, as follows:
    a. Dynamically balance rotating parts of each pump and its driving unit before final assembly.
    b. Limits:
        1) Driving Unit Alone: Less than 80 percent of NEMA MG 1 limits.
        2) Complete Rotating Assembly, Including Coupling and Motor: Less than 90 percent of limits established in the Hydraulic Institute Standards.

E. 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:
    a. Record the following:
        1) Total head.
        2) Capacity.
        3) Horsepower requirements.
        4) Flow measured by factory instrumentation and storage volumes.
        5) Average distance from suction well water surface to pump discharge centerline for duration of test.
        6) Pump inlet and outlet pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
        7) 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 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, 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. Type 316 stainless steel, sized by equipment manufacturer in accordance with Section 01 88 15, Anchorage and Bracing.

3.02 FIELD FINISHING

A. Nozzle assemblies manufacturers finish shall be suitable UV exposure. If factory finishes do not meet UV resistant then, field finish nozzle assemblies as specified in Section 09 90 00, Painting and Coating, System No. 2.

3.03 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each pump, system, and subsystem as specified in Section 01 91 14, Equipment Testing and Facility Startup.

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
2. Vibration Test:
   a. Test with units installed and in normal operation, and discharging to the connected piping systems at rates and with the actual building structures and foundations provided shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes in excess of 3 mils.
   b. If units exhibit vibration in excess of the limits specified, adjust or modify as necessary. Units which cannot be adjusted or modified to conform as specified shall be replaced.
3. Flow Output: Measured by plant instrumentation and storage volumes.

B. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

C. Performance Test:

1. In accordance with Hydraulic Institute Standard 1.6, Centrifugal Pump Test.
2. After startup of the sludge holding process, perform a mixing test at each mixing system using each pump to demonstrate adequate mixing.
   a. Perform at conditions stated in Article Mixing System Description.
   b. Select three vertical lines and two depths in each tank.
   c. Take three Samples at each of two depths along each vertical line using Van Doren sampler.
   d. Independent testing laboratory approved by Engineer will perform residue test on each Sample. Mean value of total residue for three Samples at each depth will be used to determine if suspended solids concentrations of all samples are within 10 percent of the average value regardless of location inside the tank.
   e. All testing and sampling shall conform to procedures established in latest edition of Standard Methods for Examination of Water and Wastewater.

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 functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
   c. 1 person-day for post-startup training of Owner's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner.

B. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

SECTION 44 42 56.09
NON-CLOG DRY-PIT CENTRIFUGAL PUMPS

EQUIPMENT AND COMPONENT NUMBER(S)

H090-DEW1-PMP01: Centrate Pump 1.
H090-DEW1-PMP02: Centrate Pump 2.
H090-DEW1-PMP03: Centrate Pump 3.

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): B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.ASTM International (ASTM): A48/A48M, Standard Specification for Gray Iron Castings.
3. Hydraulic Institute (HI) Standards:
   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.
   c. 14.6, Rotodynamic Pump for Hydraulic Performance Acceptance Tests.
4. International Organization for Standardization (ISO): 21940 Series and particularly Mechanical Vibration – Rotor Balancing – Part 11 Procedures and Tolerances for Rotors with Rigid Behavior.
5. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
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. 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. For variable speed motors, provide performance data curves for 50 percent, 60 percent, 70 percent, 80 percent, and 90 percent of nominal speed.
   f. 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.
   g. Lateral and torsional critical speed analysis.
   h. Structural response frequency analysis.
   i. Detail intermediate extension shafting drawings with dimensional information, materials of construction, and complete certified torsional analyses and lateral critical calculations of the complete drive train assembly.
   j. Power and control wiring diagrams, including terminals and numbers.
   k. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.

l. Factory finish system.
m. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic 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, that factory finish system is identical to requirements specified herein.
6. Factory Functional and Performance Test Reports and Log.
7. Field Vibration and Performance Test Reports and Log.
8. Manufacturer's Certificate of Proper Installation.
9. Suggested spare parts list to maintain equipment in service for period of 1 year. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
10. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
11. 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. One complete set packing.
2. One complete set bearings.
3. One complete set gaskets and O-ring seals.
4. One complete set of shaft sleeves.
5. One complete set keys, dowels, and pins.
6. One complete mechanical seal.
7. Set of wear rings.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide a complete, coordinated, and fully functional operating system.

B. Coordinate pump requirements with motor manufacturer and be responsible for pump and motor requirements.

C. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, motor, and adjustable speed controller. See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

D. Pumps supplied under this section to be a standard product of manufacturer and to have proven reliability.

E. Provide a complete lateral and torsional critical speed analysis of each pump-coupling-motor rotating assembly including extension shaft assembly, and structural analysis of complete pump and motor assembly performed by pump manufacturer or qualified third party.

1. Analyst Qualifications: Experienced in performing analyses for pump and motor units of comparable size and complexity.
2. Prepare a written report for each completed analysis documenting analysis and calculation procedures.
3. Submit results of each analysis for review and acceptance prior to pump and motor fabrication.

F. Lateral Analysis:

1. Identify lateral critical speeds for both pump and motor shafts and extension shaft assembly.
2. Include both dry and wet impeller cases.
3. Provide a critical speed map demonstrating that a critical speed does not occur below 1.25 times the maximum rated speed of the pump and motor and does not occur between 0.75 times the blade pass frequency associated with the minimum speed of the pump and 1.25 times the blade pass frequency associated with the maximum specified speed of the pump.
4. Calculate the damped vibration response to unbalance for the shafts and compare to applicable specified requirements to verify acceptable vibration amplitudes.

G. Torsional Analysis:

1. Calculate system torsional natural frequencies, corresponding mode shapes, and steady-state and transient torsional response.
2. Provide an interference diagram demonstrating the following:
   a. No critical speeds occur between 0.80 times the minimum specified operating speed and 1.20 times the maximum rated speed of the pump and motor.
   b. No critical speed associated with the mechanical running speed (one times shaft speed) excitation frequency occurs below 1.20 times the maximum rated operating speed.

3. Forced Response Analysis:
    a. Perform a forced response analysis for all critical speeds determined to occur below 1.20 times the maximum rated operating speed.
    b. Expected excitation frequencies for steady-state operation include as a minimum, but not limited to, electrical line frequency, two times electrical line frequency, current modulating frequencies produced by the variable frequency drive, mechanical running speed (one times shaft speed), two times mechanical running speed (two times shaft speed), and blade pass frequency.
    c. Confirm that calculated steady-state and transient dynamic torsional shaft stresses and coupling torques are below allowable levels, such that the motor shaft, pump shaft, and associated drive train components are capable of an unlimited number of startup and shutdown cycles associated with 0 rpm up to the maximum rated speed.
    d. Include a factor of safety of at least two in the allowable stress levels and demonstrate stresses on a Modified Goodman Diagram.
    e. Confirm that dynamic torque in the couplings is in accordance with coupling manufacturer’s requirements.

H. Structural Response Frequency Analysis:

1. Perform a structural response frequency analysis for the pump and motor assembly.
2. At a minimum, model the motor, pump, and fabricated support, including any other critical components based upon mounting details shown on the Drawings.
3. Confirm that the minimum structural natural frequency of the complete pump and motor assembly is a minimum of 1.25 times the maximum rated pump and motor speed and does not occur between 0.75 times the blade pass frequency associated with the minimum speed of the pump and 1.25 times the blade pass frequency associated with the maximum specified speed of the pump.
4. Verification of calculated natural frequencies of the pump and motor assembly shall be performed by pump manufacturer, or pump manufacturer’s authorized representative, when unit is fully installed at the Project Site.

2.02 SUPPLEMENTS

A. Specific service, performance, and design requirements are attached to this section as supplements.

2.03 EQUIPMENT

A. Pump:

1. Heavy-duty, solids handling, non-clog, dry pit design.
2. Configuration: See Supplements.
3. See the Drawings for pump orientation and rotation.
4. Continuously rising head-capacity curve from runout to shutoff.
5. Designed to operate continuously at any point on specified operating range of performance curve without cavitation, overheating, or excessive vibration.
6. Motor nameplate horsepower rating not to be exceeded by pump brake horsepower required at any point on nominal pump performance curve.

B. Casing:

1. Back pullout design allowing for removal of rotating element without disturbing piping connections.
2. Heavy wall, one-piece volute construction with integral flanged discharge flange and smooth fluid passages. Provide drilled and tapped volute priming and drain connections.
3. Wear ring securely fastened to casing (or suction cover) with recessed stainless-steel screws.
4. Provide handhole for cleanout purposes at volute centerline located to provide access to interior of pump.
5. Flanges:
    a. Conform to ASME B16.1, Class 125-pound, flat face standard.
    b. Provide 1/2-inch gauge connection drilled and tapped in discharge flange.
6. Diffusion vanes or stationary guides are not allowed.

C. Suction Cover (Fronthead):

1. Single-piece construction designed to provide even flow to impeller eye.
2. Flanged connection conforming to ASME B16.1, Class 125-pound, flat face standard.
3. Machine register fitted to casing.

D. Suction Elbow:

1. ASME B16.1, Class 125-pound flat face standard, flanged suction elbow with contoured handhole cleanout and cover.
2. Provide 1/2-inch gauge connection.

E. Stuffing Box Cover (Backhead):

1. Single-piece construction designed with integral stuffing box suitable for use of either conventional packing or mechanical seal. Drilled and tapped 3/4-inch drain connection and large openings to allow easy access to stuffing box.
2. Designed for installation of a minimum of five rings of packing and a split type lantern ring and a split type gland follower. Provide stuffing box with 1/4-inch minimum drilled and tapped connection for injection or venting of the stuffing box.
3. Machine register fitted to casing.

F. 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 L-10 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.

G. Impeller:

1. Single suction, enclosed, non-clogging type design with extremely smooth passageways to prevent clogging.
2. Single-piece construction.
3. Secure to shaft with stainless steel bolt, washer, and key to prevent loosening from either forward or reverse rotation.
4. Dynamically balanced to assure vibration limits for pump are not exceeded.
5. Wear ring securely fastened to impeller with recessed stainless-steel screws. Impeller wear ring to be a minimum of 50 Brinell softer than suction head wear ring.

H. Shaft:

1. Accurately machined over entire length and precision ground at bearing, stuffing box, and bearing housing seal locations such that shaft or sleeves roughness shall not exceed 32 microinches full indicator movement.

2. Designed to transmit full motor horsepower with a liberal safety factor to carry maximum loads imposed and to meet pump vibration requirements.
3. Shaft runout on stuffing box or seal chamber face and at impeller shall exceed 0.002-inch full indicator movement.
4. Provide keyways at both ends.
5. Provide renewable, hooked shaft sleeve positively secured to shaft to prevent leakage.

I. Pump Base: Rugged, heavy duty, with ample strength for support of entire pump and imposed static and operational loads.

J. Coupling:

1. Designed to provide flexible connection between pump and motor.
2. Flexible coupling to be designed to carry maximum horsepower of motor, including service factor, and additional forces imposed by rotating assembly.
3. Flexible coupling selection to take into account torsional analysis of complete pump and motor drive system. There is to be no torsional critical speed within specified speed range. Number of vanes times the rpm is part of this speed range.
4. Provide fabricated coupling guard to comply with OSHA safety standards.

K. High Ring Base:

1. Cast iron or fabricated steel of adequate height to allow access to flexible coupling and designed to carry weight of motor without undue vibration to pump assembly.
2. Provide with shaft guard to comply with OSHA safety standards.

L. Extension Shaft Assembly:

1. Constructed of sufficient diameter and properties to transmit 1.25 times full motor horsepower including service factor.
2. Complete with self-leveling, self-aligning universal joint at pump end, and coupled to meet motor connection requirements at motor end.
3. Pump thrust bearing to be designed to carry weight of lower portion of universal joint assembly and any imposed lateral loads plus loads from pump rotating assembly and hydraulic thrust to meet required L-10 bearing life.
4. Motor thrust bearing to be designed to carry weight of universal joint extended shaft assembly and motor coupling to meet required L-10 bearing life.

5. Designed to allow shaft to be disconnected to swing to the side for removal of rotating assembly.
6. Provide shaft guard to conform to OSHA safety requirements; complete with banded openings to allow access to shaft lubrication fittings.

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 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment

C. Anchor Bolts: Type 316 stainless steel, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

2.05 FACTORY FINISHING

A. Manufacturer to prepare, prime and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Manufacturer’s standard premium coating offering.

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 for Rated Duty Point: 1U.
   b. Pump Test Acceptance Grade for Secondary Duty Point: 2B.
2. Test all pumps furnished. Use manufacturer’s standard test motor for factory tests.
3. Factory tests to include the following:
   a. Hydrostatic testing of pump pressure containing components, to include as a minimum, pump volute, suction cover, and stuffing box cover. Test pressure to be the greater of 150 percent of rated condition or 125 percent of pressure at rated speed with discharge valve closed. Test for 10 minutes.
   b. Performance testing of fully assembled pump, per Hydraulic Institute Standard 14.6. Performance testing to be at rated speed.
   c. Dynamically balance rotating assembly to ISO 21940-11 Grade G6.3 or better prior to final assembly.

d. Vibration testing of fully assembled pump with the Project motor at full rated speed.
   1) Limits of Vibration of Fully Assembled Pump: Less than 90 percent of those established in standards of the Hydraulic Institute.
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.

2.07 FIELD QUALITY ASSURANCE

A. The Contractor shall flush and clean the existing filtrate wet well along with all existing filtrate process drains and associated piping into the existing filtrate wet well (as shown on the Drawings).

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 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 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 space between bottom of baseplate and concrete foundation with a poured, nonshrinking grout of the proper category. 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. Equipment as specified in Section 09 90 00, Painting and Coating.

3.03 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:
   a. Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
   b. Verify alignment of complete extended shaft assembly, including angularity of pump and motor shafts, meets requirements of shafting manufacturer.
3. Flow Output: Measure using plant instrumentation and storage volumes.
4. Operating Temperatures and Vibration: Monitor bearing areas on pump and motor for abnormally high temperatures.
5. Vibration Test:
   a. Test with units installed and in normal operation and discharging to connected piping systems at rate.
      1) Confirm vibration is below limits specified in HIS 9.6.4.
   b. If units exhibit vibration in excess of the limits or modify as necessary to bring units into compliance. Units that cannot be adjusted or modified to conform as specified shall be replaced.
   c. Provide instrumentation in current calibration to measure pump vibration at locations outlined in the Hydraulic Standards.
   d. Prepare test report, including test records for each pump.
6. Performance Test: Conduct on each pump as specified in Section 01 91 14, Equipment Testing and Facility Startup.
7. Test in accordance with Hydraulic Institute Standard 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
8. Test for a continuous 3-hour period without malfunction.
9. Test Records and Report: Prepare and submit a complete test report along with the test records in accordance with Hydraulic Institute Standard 14.6.
10. Use of plant instrumentation is allowed for tests. Provide additional instrumentation required to obtain required test data per the Hydraulic Institute.

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 functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
   c. 1 person-day for prestartup classroom or Site training.
   d. 1 person-day for facility startup.
   e. 1 person-day for post-startup training of Owner's personnel.

3.05 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Centrate Pumps No. 1, 2, and 3 Data Sheet.
2. Centrate Pumps 1, 2, and 3 Induction Motor Data Sheet.

END OF SECTION

CENTRATE PUMPS NO. 1, 2, AND 3 DATA SHEET

Service: Centrate
Pump Name: Centrate Pumps No. 1, 2, and 3
Pump Tag Number(s): H090-DEW1-PMP01, -PMP02, and -PMP03
No. Pumps Required (including spares): 3

Pump A Mfr.: Goulds
Model No.: 3196 MTi
Pump B Mfr.: Xylem
Model No.: 10BF2KD0
Pump C Mfr.:
Model No.:

LIQUID PUMPED AND SERVICE CONDITIONS	PERFORMANCE REQUIREMENTS
Liquid Pumped: CENTRATE	Capacity Rated (U.S. gpm): 250
Pumping Temperature (°F):	Secondary (gpm): 80
Normal: 60 Max: 80 Min: 40	TDH Rated (ft): 44
Specific Gravity @ 60°F: 1	Secondary (ft): 44
Liquid pH: 7	BHP at Rated Point:
TSS (mg/L): 0 – 10,000 mg/L	Secondary (BHP):
Min NPSH Available (ft):	NPSH Required (ft): 4.3
Suction Pressure (ft): Max: Rated:	Max Shutoff Pressure (ft): 49.5
Erosion/Abrasion/Corrosion: No	Efficiency Rated (%): 69.5
Caused by: N/A	Secondary (%):
Scale Buildup: No	Speed Rated Capacity (rpm): 1800
Caused by: N/A	Secondary (rpm):
Ambient Temp (°F): Max: Min:	☐Constant ☒Adjustable
Altitude (ft above MSL): 600	
Location: Indoor	
Area Classification: DWG 01-G-0080	

Remarks:

CENTRATE PUMPS NO. 1, 2, AND 3 DATA SHEET (CONTINUED)

PUMP DESIGN	PUMP MATERIALS
Configuration: Horizontal, Frame Mounted	Casing: ☒ Cast Iron ASTM A48/A48M Cl 30
Nozzle Size (inches):	Impeller: ☒ Hi-Chrome Steel ASTAM A532-3A
Suction: 4 Discharge: 3	Shaft:
Casing: ☐ Single Volute	☐ ANSI 1045 Steel, HR
☒ Centerline Discharge	Wear Ring: ☒ Hi-Chrome Steel ASTAM A532-3A
Impeller: ☒ Open ☐ Single Vane	Mechanical Seal: ☐ Buna N
Wear Ring: ☐ Suction Cover	☐ Tungsten Carbide
Bearing: ABMA L-10 Life (hrs.): 100,000 +	☐ Silicone Carbide
Lubrication: ☐Grease	Extension Shafting: ☐ Steel
Shaft Sleeve: ☐No	Pump Coating System:
Pump Base: ☒ Heavy Duty Fabricated Steel	Protective Exterior Coating: MFR Premium
Suction Elbow: ☐No	Protective Lining: MFR Premium
Type: n/a	Per Section 09 90 00, Painting and Coating
Coupling: ☐ Standard Flexible Type	
Manufacturer:	
Shaft Seal:	
☐Mechanical Type: Flushless	
Tandem	
Manufacturer:	
Seal lubrication:	
Extension: ☐Solid	
Shafting: Number of Segments:	
Max Drive Shaft Seg Length (in):	

Remarks: _____

CENTRATE PUMPS 1, 2, AND 3

INDUCTION MOTOR DATA SHEET

Pump Name: Centrate Pumps 1, 2 and 3

Pump Tag Number(s): H090-DEW1-PMP01, H090-DEW1-PMP02, and H090-DEW1-PMP03

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.

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

Motor Horsepower: 7.5

Voltage: 460

Phase: 3

Frequency: 60

Synchronous Speed (rpm): 1,800

Inverter Duty: ☐ Yes

☐ Thermal Protection: (recommended not)

Guaranteed Minimum Efficiency at Full Load: 85.5 percent

Guaranteed Minimum Power Factor at Full Load: 70 percent

Service Factor (@ rated max. amb. temp.): ☒ 1.15

Enclosure Type: ☒ TEFC

Mounting Type: ☐ Horizontal

☒ Adjustable Speed Drive: See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

Operating Speed Range: _____ min to: _____ max

☐ Variable Torque

Additional Motor Requirements: ☐ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features:

SECTION 44 42 56.13
PROGRESSING CAVITY PUMPS

EQUIPMENT AND COMPONENT NUMBER(S)

H090-DEW1-SFP01: Centrifuge Sludge Feed Pump 1.
H090-DEW1-SFP02: Centrifuge Sludge Feed Pump 2.
H090-DEW1-SFP03: Centrifuge Sludge Feed Pump 3.

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 equipment dimensions, size, and locations of connections and weights of associated equipment.
   e. Power and control wiring diagrams, including terminals and numbers.

f. Motor data in accordance with requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
g. Factory finish system.
h. Manufacturer's Certification of Compliance that factory finish system is identical to the requirements specified herein.
i. L-10 bearing life calculations per ABMA.
j. 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 and Log.
3. Factory Performance Test Reports and Log.
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.
10. Field Performance Test Reports and Log.

1.04 WARRANTY

A. Provide manufacturer's warranty, with Owner named as beneficiary, in writing, to warrant supplied equipment to be free of defects in materials and workmanship for a period of 1 year, with warranty period beginning upon successful completion of Performance Testing.

1.05 EXTRA MATERIALS

A. Furnish special tools, materials, and supplies required to install, commission, and startup equipment.

B. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and materials:

Item	Quantity
Bearings	One complete set per unit
Gaskets and O-ring seals	One complete set per unit
Complete set packing	One complete set per unit
Pump Stator	One per set of pumps
Pump Rotor	One per set of pumps
Connecting rod with pair of universal joint(s), as required by pump type	One complete set per unit
Special tools required to maintain or dismantle	One complete set for each different size unit

C. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Coordinate pump requirements with motor and adjustable speed drive manufacturer and be responsible for pump, motor, and drive requirements.

B. Pumps furnished under this section shall be provided by a single manufacturer.

2.02 ACCESSORIES

A. Stator Thermal Protection:

1. Provide for pumps where indicated in supplements and as specified below:
   a. Stator thermal protection (run dry protection) shall shut pump down before stator damage occurs.
   b. Provide thermowell drilled and tapped into stator and thermocouple for measurement of temperature at pump stator to rotor interface.

c. Provide temperature controller in NEMA 4X enclosure, with dual display for stator temperature and alarm set-point with adjustable hysteresis to prevent on/off cycling of pump when coming off an alarm.
d. Provide thermocouple cable between thermocouple and temperature controller.
e. Provide system operating with external 120-volt power supply.
f. High temperature alarm dry contact rating shall be 5 amps 120V ac. Contact and alarm shall automatically reset when temperature falls below hysteresis value.
g. Provide 4 mA to 20 mA output for stator temperature to be monitored by plant control system.

B. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

C. Lifting Lugs: Equipment weighing over 100 pounds.

D. OSHA-approved guard for direct coupled or belt driven pumps.

E. 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. Coat in accordance with Section 09 90 00, Painting and Coating.

2.03 SPECIAL CONDITIONS

A. Provide progressive cavity pumps with a configuration that has the flexibility of removing stator up and out of pump (instead of removal out of the discharge end).

2.04 FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Manufacturer’s standard premium coating offering.

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 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 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:
   a. Type III test, Acceptance Grade A.
   b. Type IV test, Acceptance Grade A.
3. Perform under simulated operating conditions.
4. Test for a continuous 3-hour period without malfunction. Provide a Test Log.
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 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, 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. Manufacturer's premium epoxy and polyurethane coating system, "or-equal."

3.03 EQUIPMENT TESTING AND FACILITY STARTUP

A. Equipment testing and facility startup shall be in accordance with the requirements of Section 01 91 14, Equipment Testing and Facility Startup.

B. Facility startup specifies order and prerequisites for the following tests of the equipment:

1. ORT 1 testing.
2. Field functional testing.
3. ORT 2 testing.
4. Performance testing.
5. Demonstration testing.

C. Field testing and facility startup shall be performed using a qualified representative provided by the manufacturer as specified in Section 01 91 14, Equipment Testing and Facility Startup, Section 01 43 33, Manufacturer's Field Services, and as specified herein.

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. Test for a continuous 1 hour period without malfunction.
3. Flow Output: Measured by plant instrumentation and storage volumes.
4. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.
5. Verify the following functions of stator thermal protection device:
    a. Stator temperature high setpoint is configured to proper value for pump provided.
    b. Interlock activates when stator temperature reaches high setpoint and inhibits pump form running in all modes.
    c. Interlock resets/releases when stator temperature drops below the hysteresis value.

B. Submit completed Manufacturer's Certificate of Proper Installation.

C. Performance Test:

1. Conduct on each pump as part of Facility Startup.
2. Test for continuous 4-hour period.
3. Operate across specified range of flows, pumping specified media.
4. Record flow rate, suction pressure, discharge pressure, and motor amp draw at approximate 1/2-hour intervals and as needed to record operation over specified range of flows.
5. For sludge pump applications, take sludge samples at approximate 2-hour intervals. Sludge samples to be tested by the Owner for total dry solids content.

3.05 MANUFACTURER'S SERVICES

A. See Section 01 43 33, Manufacturers' Field Services.

B. 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 functional testing and completion of Manufacturer's Certificate of Proper Installation.
   c. 1 person-day for prestartup classroom or Site training. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by the Engineer.
   d. 1 person-day for performance testing and facility startup.

3.06 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Centrifuge Sludge Feed Pumps 1, 2, and 3 Data Sheet.
2. Centrifuge Sludge Feed Pumps 1, 2, and 3 Pump Drive Induction Motor Data Sheet.

END OF SECTION

CENTRIFUGE SLUDGE FEED PUMPS 1, 2, AND 3 DATA SHEET

Service: Centrifuge Feed (Thickened Sludge)
Pump Mfr.: Netzsch
Pump Name: Centrifuge Sludge Feed Pumps 1, 2, and 3
Model No.: NM090BS01LO6B
Pump Tag Number(s): H090-DEW1-SFP01, -SFP02, and -SFP03
No. Pumps Required: 3

Liquid Pumped and Service Conditions

Liquid Pumped: 2.5-5% TS Thickened Sludge
Pumping Temperature (°F):
Normal: 70 Max: 80 Min: 60
Specific Gravity @ 60°F: 1
Viscosity Range (CP) @ 60°F: 0.087-0.538 lbm/s-ft
Vapor Press. @ 60°F: 1.211 psf
Liquid pH:
TSS (mg/L): Normal 25,000-60,000
Max Diameter Solid Pump Can Pass (in):
Min NPSH Available: 42 ft
Suction Pressure (psia): Max: 25 Rated: 19
Erosion/Abrasion/Corrosion: ☐Yes ☒No
Caused by:
Scale Buildup: ☐Yes ☒No
Caused by:
Ambient Temp (°F): Max: 100 Min: 0
Altitude (ft above MSL): 608
Location: ☒Indoor: ☐Heated ☒Unheated ☐Outdoor
Area Classification: DWG 01-G-0080

Performance Requirements

Capacity Rated (U.S. gpm): 250
TDH Rated (PSI): 70
NPSH Required (psig):
Speed Rated Capacity (rpm): 200
☐Constant ☒Adjustable
Speed Range of Rated Speed (%):
Constant Torque: ☐Yes ☐No
Motor per Section 26 20 00, Low-Voltage AC Induction Motors:
Horsepower: 25
Base Speed (rpm):
Voltage: 460 Phase: 3 Hz:
Service Factor:
Inverter Duty: ☒Yes ☐No
Enclosure:
☐DIP ☐EXP ☐ODP ☒TEFC ☐TENV
☐CISD-TEFC ☐WPI ☐WPII ☐SUBM

Remarks: Provide motor with isolated bearings and shaft grounding.

CENTRIFUGE SLUDGE FEED PUMPS 1, 2, AND 3 DATA SHEET (Continued)

Pump Design and Materials (Manufacturer to Supply Missing Data)

Connections:
- Suction size (inches): 6
  - ☒ Flanged Type: _____
  - ☐ Open-Throat
  - ☐ Screwed
  - Orientation: See the Drawings.
- Discharge size (inches): 4
  - ☒ Flanged Type: _____
  - ☐ Screwed

Pump Body:
- Material: _____

Drive Housing:
- Material: _____

Pump Stages: _____

Suction Port:
- Material: _____

Stator:
- Material: _____
- Thermal Protection: ☐ Yes ☐ No

Rotor:
- Material: _____

Connecting Rod:
- Material: _____

Drive Shaft:
- Material: _____

Joint:
- ☐ Gear Type Universal
- ☐ Pin Type Universal
- ☐ Other Type: _____

Shaft Sleeve: ☐ Yes ☐ No:
- Material: _____

Shaft Seal:
- ☐ Packing Material: _____
- ☐ Lantern Ring Material: _____
- ☐ Mechanical Type: _____
  - Material: _____
- Seal Lubrication: _____

Bearing:
- ABMA B-10 Life (hrs): _____
- Lubrication: ☐ Grease ☐ Oil

Coupling: ☐ Mfr Standard
- ☐ Falk
- ☐ Fast
- ☐ Gear Type

Baseplate:
- Design: _____
- Material: _____

Drive Type: ☐ Direct-Coupled
- ☐ Belt
- ☐ Close-Coupled Gear Reducer
- ☐ Bearing-Frame Gear Reducer Drive

Arrangement: ☐ In-Line ☐ Piggy Back
- ☐ Horizontal Offset ☐ Vertical "Z"

Pump Coating System:
- Protective Exterior Coating:
- Protective Lining:
- (Per Section 09 90 00, Painting and Coating)

Remarks: _____

CENTRIFUGE SLUDGE FEED PUMPS 1, 2, AND 3 PUMP DRIVE INDUCTION MOTOR DATA SHEET

Pump Name: Centrifuge Sludge Feed Pumps 1, 2, and 3

Pump Tag Number(s): H090-DEW1-SFP01, -SFP02, and -SFP03

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.

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

Motor Horsepower: 20

Voltage: 230/460

Phase: 3

Frequency: 60

Synchronous Speed (rpm): 1,775

Inverter Duty: ☐ Yes ☐ No

☐ Thermal Protection: _____

☐ Space Heater: _____ volts, single-phase

☐ Moisture Detection Switches

☐ Thermal Protection Embedded in Windings

Guaranteed Minimum Efficiency at Full Load: _____ percent

Guaranteed Minimum Power Factor at Full Load: _____ percent

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☐ 1.15

Enclosure Type: ☐ DIP ☐ EXP ☐ ODP ☐ TEFC

☐ CISD-TEFC ☐ TENV ☐ WPI ☐ WPII ☐ SUBM

☐ Multispeed, Two-Speed: _____/_____ rpm

Winding: ☐ One ☐ Two

Mounting Type: ☐ Horizontal ☐ Vertical

☐ Vertical Shaft: ☐ Solid ☐ Hollow

☐ Vertical Thrust Capacity (lb): Up _____ Down _____

☐ Non-reverse Ratchet

☐ Adjustable Speed Drive: See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

Operating Speed Range: _____ min to: _____ max

☐ Variable Torque

☐ Constant Torque

Additional Motor Requirements: ☐ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features:

Provide motor with isolated bearings and shaft grounding.

SECTION 44 44 63.01
POLYMER FEED SYSTEM, LIQUID

EQUIPMENT AND COMPONENT NUMBER(S)

Polymer Blending Unit No. 1: H090-DEW1-PFP01.
Polymer Blending Unit No. 2: H090-DEW1-PFP02.
Polymer Blending Unit No. 3: H090-DEW1-PFP03.
Polymer Blending Unit No. 1 Control Panel: H090-DEW1-CPL07.
Polymer Blending Unit No. 2 Control Panel: H090-DEW1-CPL08.
Polymer Blending Unit No. 3 Control Panel: H090-DEW1-CPL09.

PART 1 GENERAL

1.01 SUBMITTALS

A. Contractor’s Drawings in accordance with Section 01 33 00, Submittal Procedures.

B. Make, model, and weight of equipment item.

C. Schematic of piping layout showing all equipment, valves, and other accessories.

D. Manufacturer’s catalog information, descriptive literature, specifications, and materials of construction.

E. Information on rotameters and mixer chamber shaft seals indicating pressure rating and service requirements specified herein.

F. Retention time and Gt (mean velocity gradient multiplied by retention time) values for polymer mixing chamber.

G. Dimensions for system components.

H. Electrical control schematic and wiring diagrams that clearly show alarms, shutdowns, and contact closures for central control system.

I. Installation requirements.

J. 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.

K. Factory test report.

L. Manufacturer's installation instructions.

M. 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.

N. Operation and Maintenance Manuals in accordance with Section 01 78 23, Operation and Maintenance Data.

O. 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 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 1-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	3
Flanged bearing	3
Self-aligning bearing	3
Stator (pump)	3
Bearing, idler	3
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 MANUFACTURER

A. Polymer blend unit manufacturer’s production facilities shall be ISO 9001 certified.

B. Modifications to Standard Equipment Model Offerings:

1. Listing of a polymer blend unit manufacturer within this section shall not be justification for acceptance of the manufacturer's standard model offering.
2. Equipment provided by a listed manufacturer shall be furnished, modified as necessary, to conform to the performance, functions, features, and materials of construction as specified herein.

C. The polymer feed system shall be from one of the following listed manufacturers:

1. Velodyne Systems as provided by Clean Water 1.
2. “Or-equal.”

2.03 EQUIPMENT

A. 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 drive for pump to accept 4 mA to 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.

B. 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 cp to 6,000 cp.
2. Polymer and water shall be mixed in a chamber designed to create sufficient mixing energy. Polymer activation efficiency shall be consistent over the entire dilution water range.

C. Polymer Activation and Blending Chamber:

1. These specifications are based on a multi-stage, multi-zone, Hydro-Mechanical polymer activation and blending technology. Alternate technologies will only be considered if proven to provide an equal level of performance, versatility, reliability and quality, otherwise the following technology will be provided without exception.
2. In order to provide control and versatility to optimize the performance of the wide range of polymers available and to optimize system

reliability, a multi-stage Hydro-Mechanical polymer blending technology shall be provided with both a non-mechanical and mechanical mixing stage:

a. Non-Mechanical Stage: To optimize reliability, the device shall be capable of activating and blending polymer based on plant water pressure alone at 30 psid or greater. Polymer shall be injected directly into a water jet by means of an injection quill positioned such that the non-mechanical mixing energy is in no way diminished prior to polymer and water contact. The non-mechanical zone shall be designed such that the velocity of the mixing energy producing water jet is maintained or increases as flow decreases.

b. Hydro-Mechanical mixing Stage: In order to provide optimal polymer performance under all operating conditions and to provide total control over mixing energy, in addition to the non-mechanical mixing stage the device shall be capable of producing its mixing energy independent of plant water pressure through a variable intensity, controllable stainless steel hydro-mechanical mixer. The mixing impeller shall be fully controllable and capable of inducing ultra high, non-damaging mixing energy at all flow rates. This shall be accomplished by controlling mixing intensity and preventing over exposure to, or damaging recirculation through the impeller. The polymer mixing impeller shall be designed to produce both axial and radial flow to optimize mixing effectiveness and to effectively inducing high, non-damaging mixing energy over the systems full flow range.

c. Mixers that rely solely on plant water pressure and or flow for mixing energy will not be acceptable. Mixers where performance is affected by flow rate and therefore retention time resulting in under or over exposure to mixing energy, or which rely on constant speed impellers or that rely on close tolerances for blending shall not be acceptable.

3. In order to prevent polymer build-up, the mixing chamber shall maintain high velocity in the entire chamber - at no time shall there be low velocity within any portion of the mixing chamber.

4. The mixing impeller shall be controlled by an SCR motor controller and driven by a wash-down duty motor. The motor shall be mounted horizontally or above the mixing chamber. Motors mounted under the mixing chamber where seal failure or leaks can damage the motor shall not be acceptable.

5. The mixer drive shaft shall be sealed by a mechanical seal which shall have an integrally mounted and factory plumbed seal flush. A drain hole behind the seal shall be provided in the mixing chamber to drain the polymer solution in case of a seal failure. The seal shall be easily accessible for replacement. Systems without a seal flushing system shall

not be considered. Systems with holes in the mixing impeller to “pull” polymer away from the seal shall not be acceptable or used, as this feature fails to prevent polymer from coating the shaft seal face. All bearings shall be external from the mixing chamber. Internal bearings shall not be acceptable.

6. Both mechanical and non-mechanical mixing zones shall be clear polycarbonate to view the mixing action and blending effectiveness. Acrylic chambers prone to becoming brittle over time and cracking, or opaque pipe shall not be acceptable to meet this requirement. The clear cover shall have a stainless steel reinforced gusseted flange with a stainless steel discharge connection in order to handle maximum operating pressures.
7. The mixing chamber shall have a maximum rated pressure of 100 psi. Provide a pressure relief on the mixing chamber factory set at 75 psi.
8. Provide a neat polymer check valve specifically designed to isolate neat polymer from dilution water. The valve shall be designed with an open, unobstructed path to the valve seat. To minimize check valve plugging due to normally occurring polymer agglomerations, the minimum open area up to and including the valve seat shall be 3/16 inch without exception. The valve body shall be constructed of Teflon with Viton seals. The valve poppet and spring shall be stainless steel. The spring shall be outside of the polymer flow path to prevent build-up and plugging. The locking pin used to hold the valve in place shall be attached to the mixing chamber with a lanyard. The valve shall be readily accessible for cleaning and shall not require tools for removal, cleaning or replacement. Conventional check valves, valves that rely on ball seals, and or check valves that are installed inside the mixing chamber, or which require mixing chamber disassembly for servicing will not be accepted.

D. Supplemental Sludge/Polymer Mixers: 3.

1. Contractor shall provide in-line sludge/polymer mixer and injection at each upstream polymer injection point.
2. Manufacturer shall be SNF Flomix “or-equal.”

E. Pump:

1. Unit shall have a neat polymer metering pump. Pump shall be progressive cavity type.
2. Neat polymer flow shall range from 1 gph to 20 gph.
3. The metering pump shall have an output range of 10 gpm to 105 gpm.

F. 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 from 10 gpm to 100 gpm.
3. Water supply pressure will be approximately 65 psig. All components in the system shall be designed for at least 100 psig working pressure.
4. Polymer feed system shall have a manufacturer's standard dilution water pressure differential type flow element and low flow switch. Flow switch and element assembly shall be installed as per manufacturer's recommendation.

2.04 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, including switching for swing units.

C. Panels:

1. Provide a skid mounted control panel.
2. Material: Anodized aluminum or Type 316 stainless steel.
3. NEMA Rating: 4X.

D. Operator Controls and Indicators:

1. Provide the following panel mounted operator controls and indicators:
   a. ON/OFF/REMOTE hand switch.
   b. Pump Speed Indicator.
   c. Potentiometer (to adjust pump speed in Internal Mode).

E. External Interfaces:

1. Analog Input(s): Pump speed adjust.
2. Discrete Input(s): System RUN command.

3. Discrete Output(s):
   a. Loss of water flow alarm.
   b. System ON status.
   c. In remote status.
4. Analog Output: Polymer pump flow rate.

F. Functional Requirements:

1. When in Remote, unit runs in response to external System RUN command.
2. When in REMOTE, pump speed is adjusted in response to external pump speed adjust 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).

2.05 ELECTRICAL

A. Wiring: Provide wiring between pump controller's termination enclosure, solenoid valves, pressure switches, and the pumps.

1. Provide circuit breakers and controllers for each pump.
2. One 480V ac, 15-amp power feed will be brought to the polymer unit.
3. Wiring shall be in conduit.
4. Provide device fusing/circuit breakers as required.
5. Drives and solenoid valves shall be powered from the polymer blend unit.
6. Fuses and circuit breakers shall be housed in each respective control panel, which shall be NEMA 4X.

2.06 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 the 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.

2.07 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 the Drawings.

3.02 PAINTING

A. All equipment shall be painted with manufacturer's standard painting system for corrosive service.

3.03 MANUFACTURERS' 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. 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.

3.04 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) Stroke length adjustment.
      4) Unit responds to 4 mA to 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 WSSC. During the test, record the following:
            (1) Neat polymer flow rate.
            (2) Dilution water flow rate.

END OF SECTION

SECTION 44 45 16.01
COARSE BUBBLE AIR DIFFUSER SYSTEM

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): 2, Measurement of Oxygen Transfer in Clean Water.
2. American Society of Mechanical Engineers (ASME): B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.
3. 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. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.
   c. A276, Standard Specification for Stainless Steel Bars and Shapes.
   d. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   e. A530, Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
   f. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.

1.02 DEFINITIONS

A. Adequate Mixing: Variation in mixed liquor suspended solids (total residue) of less than 10 percent between the mean value of Samples taken at any two depths along any vertical line extending between the water surface and the elevation of the top of the diffusers.

B. Basin: The structure within which aeration occurs.

C. Distribution Header: Piping between the manifold and the diffuser assembly.

D. Dropleg: Connection from the air source to the manifold.

E. Manifold: A single run of piping that connects the dropleg with the distribution header(s).

F. Standard Cubic Feet per Minute (scfm): Air at 68 degrees F, 14.7 psia, and 36 percent relative humidity.

G. Standard Oxygen Transfer Rate (SOTR): The rate of oxygen transfer to tap water at standard conditions of 20 degrees C, 0.0 mg/L residual dissolved oxygen concentration, and a barometric pressure of 760 mm Hg (dry air).

H. Zone: An area within an aeration basin used to provide a particular type or level of treatment. One or more cells may be included in a zone.

1.03 PERFORMANCE REQUIREMENTS

A. Airflow Rate Output: Not differ by more than 10 percent, at minimum and maximum airflows, for any two system diffusers (based on diffuser with lower flow rate).

B. Air Distribution and Balancing: Control by use of orifices and proper header size selection only.

C. Do not use flow distribution control devices requiring automatic or manual operation.

D. Mixing: Uniform throughout entire sludge holding tank at stated minimum airflow requirements.

E. Achieve adequate mixing in thickened waste activated suspended solids concentrations between 10,000 mg/L and 60,000 mg/L.

F. Air Distribution and Balancing: Sufficient to maintain mixed liquor suspended solids in a state of suspension over entire depth of aeration basin at stated minimum airflow requirements.

G. Material being aerated is thickened waste activated sludge.

H. System Aeration Requirements:

1. Diffuser Airflow (scfm/diffuser):
    a. Minimum: 18.
    b. Average: 20.
    c. Maximum: 22.
2. Available Airflow (scfm per basin):
    a. Peak: 6,000.
    b. Average: 2,000.
    c. Minimum: 800.

3. SOTR (pounds of O_2 per day per basin):
    a. Minimum: 3,300.
    b. Average: 12,000.
    c. Peak: 27,700.

1.04 DESIGN REQUIREMENTS

A. Furnish fixed header, nonclog, coarse bubble diffused air aeration equipment system as a complete package including, but not limited to, dropleg, distribution headers, diffuser connectors, diffusers, supports, header joints, accessories, and miscellaneous appurtenances necessary to place in operation.

B. Furnish complete, engineered systems. Drawings indicate header and diffuser orientations only. Details such as air header sizes and spacing, header supports and spacing, diffuser spacing, etc., shall be defined by and be the responsibility of manufacturer and shall be consistent with requirements in this specification.

C. Design aeration equipment so that upon completion of installation, all diffusers are level to within plus or minus 3/8 inch of a common horizontal plane.

D. Aeration equipment layout shall accommodate the sludge mixing system such that sufficient spacing is provided for workmanship and does not interfere with one another.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
    a. Make, model, and weight of each equipment assembly.
    b. Manufacturer’s catalog information, descriptive literature, specifications, and identification of materials of construction.
    c. Detailed mechanical drawings showing equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work, and weights of associated equipment.
    d. A detailed drawing of proposed aeration equipment layout for each Basin, showing air line sizes and lengths, air distribution headers, and location of diffusers, supports, and expansion joints.
    e. Diffuser, diffuser connector, balancing orifices, and system head loss curves covering range of airflow rates specified.
    f. Calculations showing distribution and balancing of air within each basin for minimum and maximum airflow rates specified.

g. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Factory test results, reports, and certifications. Include oxygen transfer performance test.
3. Special shipping, storage and protection, and handling instructions.
4. Routine maintenance requirements prior to plant startup.
5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
6. Operation and Maintenance Data:
   a. As specified in Section 01 78 23, Operation and Maintenance Data.
   b. Include manufacturer's written preprinted installation instructions with erection drawings indicating, by piece marking, how entire assembly (for each Basin service) is to be shipped and field assembled.
7. Manufacturer's special guarantee.
8. Service records for maintenance performed during construction.

1.06 SPECIAL GUARANTEE

A. Furnish 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 diffusers and diffuser connectors 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 the General Conditions.

1.07 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage following spare parts and special tools:

Item	Quantity
Complete diffuser assemblies	5

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified under this section shall be products of:

1. Tideflex®. Rubber Check Valve Air Diffuser
2. “Or-equal.”

2.02 SERVICE CONDITIONS

A. System:

1. Temperature at Mixed Liquor:
   a. Minimum: 14 degrees C.
   b. Maximum: 30 degrees C.
2. pH of Mixed Liquor: 6 to 8.
3. Mixed Liquor Suspended Solids Concentration:
   a. Minimum: 10,000 gm/L.
   b. Average: 34,000 mg/L.
   c. Maximum: 60,000 mg/L.
4. Basin Sidewater Depth: 3 to 15 feet, excluding conical floor.
5. Allowable Diffuser Mounting Distance Above Basin Floor (floor to diffuser element):
   a. Minimum: 9 inches.
   b. Maximum: 12 inches.
6. Available Pressure at Dropleg (psig): 9.

2.03 AIR PIPING

A. Minimum Schedule 10, Type 304 stainless steel, unless specified otherwise.

2.04 HEADERS

A. Allow for expansion and contraction over a temperature range of 125 degrees F when installed, including support system.

B. Dropleg:

1. Locate elbow from air supply main connection at top of basin. Top connection and dropleg connection to Distribution Header shall be loose follower flanges.
2. Support from its upper connection, with additional support at lower elbow. Connection between dropleg and air manifold shall be a slip joint for ease of installation.

3. Fixed Header System:
   a. Additional ASME B16.5, 150-pound flange located 1 foot above bottom of main air header.
   b. Lifting Eyes: Integrally welded stainless steel, ASTM A240, Type 304L, at minimum 10-foot spacing.

C. Distribution:

1. Fabricate in sections up to 35 feet in length. Bottom elevation of distribution headers shall be same throughout tank. Use eccentric reducers to make changes in diameter in order to maintain diffusers at same elevation. Ends of each header shall have removable end caps.
2. Locate couplings between sections to permit individual header sections to be rotated independently of adjacent header sections. Each distribution header section shall have a positive locking device to prevent rotation. Do not use frictional clamps around header.
3. Piping: Dimensional tolerances conforming to ASTM A554 and ASTM A530.

2.05 DIFFUSER CONNECTORS

A. Factory welded to bottom of distribution headers with maximum diffuser spacing as determined by manufacturers calculations. Diffuser connectors shall be on a common horizontal plane.

B. Single, continuous component; do not use multiple pieces connected by threads or other such means.

C. Connection Between Distribution Header and Diffuser Connector: Capable of withstanding a horizontal or vertical moment of 1,000 inch-pounds, minimum, without permanent deformation.

D. Pipe Connections for Attaching Diffusers:

1. Two 3/4-inch NPT.
2. On opposite sides of air distribution header.
3. Cap or plug for future use pipe connections not provided with diffusers.

E. Stiffening Gussets: Provide, unless Contractor receives written approval from Owner and Engineer. Provide documentation substantiating connectors do not require gussets.

1. Locate on each side of connectors to connect horizontal portion of connector to sidewall of header. Minimum cross-sectional area of each gusset shall be 0.125 square inch.

2.06 DIFFUSERS

A. Coarse bubble, nonclogging type, having no moving parts and providing non-clog aeration. Air shall be released uniformly at each diffuser. Air exit ports shall be below the diffuser connector invert.

B. The diffusers shall be connected to the distribution piping with a threaded connection for installation and maintenance access. The connection material shall be minimum Schedule 40 stainless steel (grade to match piping). Thermoplastic connections and thermoplastic threaded nipples will not be acceptable due to the hydraulic load forces occurring in the process.

C. Provide sufficient quantity of diffusers to meet the requirements of this specification. Locate on both sides of the air distribution headers.

D. Any elastomer components of the diffuser must be clamped to a bushing or pipe nipple using a heavy duty clamp to ensure the diffuser will not separate from the connection during operation. Unrestrained elastomer components using compression fit, snap-on, and friction fit connections will not be accepted due to performance requirements for surge load protection. Provide the proper head loss to ensure uniform air distribution throughout the airflow ranges specified. Use air balancing orifices if necessary.

2.07 SUPPORTS

A. Fabricate of 0.250-inch minimum stainless steel plate, ASTM A240, Type 304.

B. Adjustment:

1. Plus or minus 1/2-inch lateral and plus or minus 2 inches vertical adjustment of the header.
2. Possible without removing the header from the support.

C. Minimum of two supports for each header section. Height sufficient to provide the diffuser elevation shown on the Drawings.

D. Type 1 Header: End support on each header designed to anchor header against longitudinal movement; do not use frictional clamps around headers.

E. Type 2 Header: Supports not at end of header to allow longitudinal movement of supported header section.

F. Bearing Surface: Contoured to fit bottom 120 degrees of header and be a minimum of 2 inches wide.

2.08 HEADER JOINTS

A. Special Flanged or Slip Joints: Locate between sections of air distribution header.

B. Individual Header Sections: Capable of rotating independently of adjacent header sections for alignment purposes.

C. Flanged Joints: Face ring-follower flange type with through bolts, capable of transmitting longitudinal forces caused by expansion and contraction in air distribution header.

D. Slip Joints: Allow for expansion and contraction of air distribution header.

2.09 APPURTENANCES

A. Couplings: Van Stone type flanges, ASTM A182/A182M stainless steel drilled 150-pound ASME B16.5 standard.

B. Face Rings: Stainless steel, ASTM A240/A240M, Type 304L, inside diameter (ID) drilled 1/16 inch larger than pipe outside diameter (OD).

C. Gaskets: Neoprene, 45 durometer to 55 durometer; locate at expansion joints and couplings to form an airtight connection at 20 psig minimum.

D. Miscellaneous: Nuts, bolts, washers, and other nonwelded parts shall be stainless steel, ASTM A240/A240M, Type 304. Threaded assemblies shall be chemically treated or lubricated prior to assembling to prevent galling.

E. Lifting Lugs: Suitably attached for equipment assemblies and components weighing over 100 pounds.

F. Equipment Anchor Bolts: Type 316 stainless steel sized by equipment manufacturer at least 1/2 inch in diameter, or as shown, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

2.10 FABRICATION

A. Shop fabricate welded metal parts and assemblies from stainless steel, ASTM A240/A240M, Type 304L with a 2D finish.

B. Shop fabricate nonwelded parts and pieces from sheets and plates of stainless steel, ASTM A240/A240M, Type 304 or from bars of stainless steel ASTM A276, Type 304, unless specified otherwise.

C. After fabrication, pickle and passivate stainless steel assemblies and parts in accordance with ASTM A380.

D. Welds and Welding Procedure:

1. Shop weld with filler wire using MIG, TIG or shield-arc, or plasma-arc welding inert gas processes. Provide a cross-section equal to or greater than parent metal.
2. Provide full penetration butt welds to interior surface with gas shielding to interior and exterior of joint.
3. Provide smooth, even distribution interior weld beads with an interior projection not exceeding 1/16 inch beyond inner diameter of air header or fittings.
4. Field welding is not permitted.

2.11 FACTORY TESTING

A. Perform tests on all aeration systems furnished.

B. Oxygen Transfer Performance Testing Procedure:

1. In accordance with ASCE 2. Use a Theta value of 1.024. Specific details of test procedure and any deviation from requirements stated below must be reviewed and approved by Engineer.
2. Nonsteady-state reaeration test shall consist of three reaeration test runs. SOTR shall be average of SOTRs obtained for each reaeration test run. Sodium sulfite catalyzed with cobalt chloride shall be used to strip residual dissolved oxygen between reaeration test runs.
3. Test Facilities: Provided by manufacturer and subject to Engineer’s approval, and capable of providing sidewater depths and diffuser submergences specified under Article Service Conditions. Test aeration tank shall be a minimum of 200 square feet.
4. Diffuser density for each test shall be equal to or less than diffuser density proposed by manufacturer for aeration system being tested. Diffuser density is defined as number of diffusers per square foot of tank area.
5. For each system being tested, test airflow rate per diffuser (scfm per diffuser) shall not be greater than airflow rate per diffuser proposed for manufacturer’s system.

C. Obtain approval of test reports from Engineer prior to shipment of any equipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's written instructions.

B. Anchor Bolts: Accurately place anchor bolts using templates furnished by manufacturer and in accordance with Section 05 50 00, Metal Fabrications.

3.02 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each unit.

B. Performance Test:

1. Conduct on each unit.
2. Perform under actual or approved simulated operating conditions. Airflow shall be as measured by plant instrumentation. Calibrate airflow instrumentation as part of testing procedure.
3. Test for a continuous 12-hour period without malfunction.
4. Adjust, realign, or modify units and retest, if necessary.
5. Conduct tests for each aeration Basin system as follows:
    a. Pressure Test: Measure air pressure immediately upstream of elbow located at top of each dropleg, and at maximum airflows and submergences stated under Article Performance Requirements.
    b. Mixing Test:
        1) Perform at minimum airflows stated in Article Performance Requirements.
        2) Select three vertical lines and two depths in each basin.
        3) Take three Samples at each of two depths along each vertical line using Van Doren sampler.
        4) Independent testing laboratory approved by Engineer will perform residue test on each Sample. Mean value of total residue for three Samples at each depth will be used to determine conformance with requirements.
        5) All testing and sampling shall conform to procedures established in latest edition of Standard Methods for Examination of Water and Wastewater.

3.03 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. 2 person-days 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.

END OF SECTION

SECTION 44 46 13.01
BELT CONVEYOR SYSTEM

EQUIPMENT AND COMPONENT NUMBER(S)

Sludge Conveyor: H090-DEW1-CNV01.
Sludge Conveyor Operator Panel: H090-DEW1-CPL05.

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. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   c. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength Standard.
5. Conveyor Equipment Manufacturers Association (CEMA): Belt Conveyors for Bulk Material.
6. National Electric Manufacturers Association (NEMA): MG 1, Motors and Generators.
7. UL: 674, Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.02 RELATED SECTIONS

A. Section 40 99 90, Packaged Control Systems.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements: Design conveyor system to meet service at less than 60 percent of the conveyor's rated capacity or 25 percent through filling. Each conveyor drive unit shall be designed for 100 percent of rated capacity.

B. Dewatered sludge is received from centrifuges in the Dewatering Building and is required to be conveyed to the discharge location as shown on the Drawings (Dewatered sludge Storage Bay). Dewatered sludge cake will consist of thickened, undigested biological sludge from the treatment of municipal wastewater. Dewatered sludge cake solids content will range from 18 percent to 22 percent total solids, with a typical cake solids content of 20 percent total solids.

1.04 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. Performance specifications of equipment.
   c. Process schematics associated with equipment.
   d. Calculations, including:
      1) Effective conveyor belt tension, Te, pound.
      2) Conveyor belt horsepower.
      3) Maximum conveyor belt unit stress, PIW, pound per inch width.
      4) Shaft slope at pulley hub location, radians.
      5) L-10 bearing life for head, tail, and snub pulleys.
   e. Fabricated items, equipment structural supports, platforms, handrails, and associated items.
   f. Design loadings, for load combinations, to be transmitted to foundations or supports.
   g. Size, length, and spacing of anchor bolts or attachments to the foundations or supports.
   h. Specific details of attachment of bracing members to concrete or steel structures.
   i. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

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. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Installation instructions.
4. Manufacturer’s test reports.
5. Manufacturer’s list of proposed spares, and expendables.

6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
7. Provide complete O&M manual.
    a. Manual shall be in a white three-ring binder, and shall include at a minimum tabbed sections defining scope, mechanical and structural calculations, catalog cuts, and drawings.
    b. Manual shall include: Equipment Data Pages, Equipment Introduction and Operation, Warranty, Long Term Storage, Troubleshooting, Maintenance and Lubrication, Spare Parts List, Equipment Listing, Catalog Cuts, and Drawings.
8. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.05 QUALITY ASSURANCE

A. Qualifications: Shop Drawings for conveyor support structures shall be stamped by a registered engineer of the state in which conveyor will be installed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: After testing and before dismantling for shipment, matchmark and tag wiring and mechanical connections to ensure proper field assembly.

1.07 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and materials:

Item	Quantity
Belt Pans with Hardware	5
Guide Blocks	10
Chain Attachments	5
Rubber Scraper Blade Insert	12

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Belt conveyors shall be designed to convey dewatered sludge with a bulk density ranging from 45 pounds to 60 pounds per cubic feet.

B. Belt conveyors, and all related components supplied under this section shall be designed and rated for continuous duty service (24 hours per day, 7 days per week, 365 days per year) operation.

C. All parts furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, transportation, erection and continuous operation. All materials for the conveyors and belt cleaning systems shall be new and shall be of the very best quality, entirely suitable for the service to which the units are to be subjected and shall conform to all applicable sections of these specifications.

D. The belt conveyor equipment shall be factory pre-assembled, factory pre-wired, and factory tested to the greatest extent practical.

2.02 SERVICE CONDITIONS – DEWATERED SLUDGE

A. Material Conveyed: Dewatered, thickened biological sludge from a municipal wastewater treatment plant.

B. Bulk Density: Dewatered Sludge: 45 pounds to 60 pounds per cubic foot.

C. Moisture, Percent/Weight: 18 percent to 22 percent.

D. Capacity: 400 cubic feet per minute.

E. Intermittent Use: 5 days/week.

F. Running Hours/Day: 8.

G. Belt Size: 26 inches.

H. Belt Speed: 30 feet per minute.

I. Location: Partial Outside/Inside, as shown on the Drawings.

2.03 MANUFACTURERS

A. Dewatered Sludge Conveyor:

1. Serpentix Conveyor LLC.
2. No “or-equal” or substitute products will be considered.

2.04 COMPONENTS

A. Frame:

1. Material: Conveyor frame and conveyor support shall be constructed of structural steel conforming to ASTM A36 and factory finished hot dipped galvanized to ASTM A123-892 Specifications.
2. The frame shall include adequate supports for drive and tensioning sections.
3. Frame must be designed and sealed by a licensed structural engineer in the State of Oklahoma.
4. Conveyor support locations are only shown when the adjoining structure requires that the conveyor support points be limited to specific locations. The absence of defined conveyor support locations or support details on the Drawings shall not relieve the Contractor of the responsibility of providing required conveyor supports.
5. Supports shall not restrict access to other process systems.
6. Design conveyor structures in conformance with the AISC Manual of Steel Construction, AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.
7. Limit maximum total deflection to less than 1/300 of span. Brace supports adequately to carry horizontal loads.
8. The flange, webs, legs, or wall thickness of conveyor support framing shall not be less than 11-gauge. Use C-channel tubular steel, pipe, flat bar, or other members that provide a clean design that shall minimize dust ledges and pockets.

B. Drive Unit Station:

1. Fully assembled drive station shall consist of a TEFC energy efficient motor, a durable corrosion resistant UHMW polyethylene sprocket, gear reducer, V-belt, sheaves, and steel sprockets.
2. Single chain drive between reducer and steel sprocket shaft is to be provided for further power and speed reduction.
3. Belt drive sheaves shall be interchangeable in order to provide different speed by means of other size sheaves.
4. Directly coupled drive motor-gear reducer combinations shall not be acceptable.

5. A mechanical ratcheting clutch shall be incorporated into the drive design to prevent or mitigate damage to any of the drive components/ drive structure.
6. Any type of over-torque condition created by product overloading or jamming conditions will cause the ratcheting clutch to release, isolating the power from the electric motor to the gearbox and other power transmission components.
7. Torque setting is adjustable and shall be properly set at the factory for each conveyor application.
8. Furnish OSHA coupling, belt, and chain guards as required.

C. Chain Tensioning Station: Fully assembled tension station shall consist of a durable corrosion resistant UHMW polyethylene chain sprocket, a constant pressure spring-loaded chain tensioner adjustable by a single ratchet, and track all fabricated and assembled in a structural frame ready for installation.

D. Conveyor Belt and Chain (Minimum Criteria):

1. Conveyor belt as supplied by manufacturer shall consist of conveyor belt pans, tracks and supports, take up and drive stations.
2. Conveyor belt pans shall be 26-inch wide and shall travel at 30 fpm.
3. Loading onto the conveyor(s) shall be distributed evenly and shall not exceed a design capacity rated at 20 wet tons per hour.
4. Conveyor shall have a watertight modular conveying surface with a 20-degree troughed cross-section at the outside of the belt width.
5. Each modular conveying section shall have a convolution that permits the assembled belt to make continuous vertical, horizontal and helical turns that shall flatten out as it goes over the drive station, and allows for continuous belt cleaning with a pre-tensioned scraper bar.
6. Modular belt pan section shall be reinforced with nonmetallic stiffeners molded into each modular belt section to achieve troughing.
7. Conveyor(s) shall be designed in such a way that all moving parts of the system, except for the drive and tension station components shall pass a single designated point along the conveying path which may be used for maintenance and/or service of the conveyor.
8. Conveying surface shall consist of individually replaceable modular belt pan sections molded of moldable plastic rubber (MPR).
9. Belt pans shall be fastened every 8 inches and supported by a nylon attachment and two durable enhanced, plastic guide (and wear) blocks bolted to a case hardened alloy steel chain.
10. Chain shall have a minimum breaking strength of 35,000 pounds.
11. Each modular belt pan section shall have a cleat like convolution at least 1-1/2 inches high, permanently molded into the rubber.
12. Closed link alloy steel chain, with alternating horizontal and vertical links shall allow for movement in two or more directions.

13. The 4-inch pitch chain shall be guided by the guide blocks bolted bilaterally to each vertical chain link.
14. Belt pan attachments and guide blocks shall be shipped assembled on the chain.
15. Chain and guide blocks shall operate in a UHMWPE track consisting of a base, two sides and two top containment angles.

E. Conveyor Tracks and Supports:

1. Fabricated I beam shall be the structural frame of the conveyor system.
2. Top and bottom flanges of the I-beam shall have the UHMWPE track, with bilaterally positioned angles to contain the guide blocks as they are pulled through the track system by the steel chain.
3. Structural I beam shall be fabricated from 1/8-inch thick, Type 304 stainless steel.
4. Containment angles shall be UHMWPE.
5. Guide blocks shall stabilize the belt pan surface in the event of unbalanced material loading.
6. Track sections of required length shall be factory fabricated and ready for Job Site assembly by splice bolting where indicated.
7. Conveyor supports shall be structural steel conforming to ASTM A36.
8. All shop welding shall conform to the latest standards of the American Welding Society.

F. Skirtboards:

1. Conveyor skirt boards shall be provided at each loading area per dimensions shown on the Drawings.
2. Skirts shall be 3/8-inch thick HDPE and shall be supported by brackets from the conveyor frame.
3. Brackets shall be Type 304 stainless steel.

G. Drip Pans: 16-gauge, galvanized steel sheet drip pans, with Type 304 stainless steel hanger brackets shall be provided below the conveyor. Drip pan shall have a high spot just before the conveyor belt exits the building. Drip pan shall extend the entire length of the conveyor (indoor and outdoor).

H. Wall Weather Seal: A 10-gauge Type 304 stainless steel weather seal with vinyl finger extensions is to be installed where the conveyor passes through the wall.

I. Safety Stop Switch:

1. Flag arm safety pull cord switches on each side of the conveyor with orange protective coated cable running the entire length of the conveyor.
2. NEMA 7 (Explosion Proof), 20 amps, 125V ac, 250V ac, or 480V ac, single-pole, double-throw circuit.

J. Zero Motion Speed Switch:

1. Located on the tension station, the zero speed switch is to be hardwired to the conveyor control circuit.
2. NEMA 7 (Explosion Proof), 120V ac, 5 amps, isolated contact, 10-second start delay.
3. Electro Sensors SCP 1000 presettable speed switch in an explosion proof housing with a PVC split collar magnet pulsar wrap, “or-equal.”

K. Belt Scraper: Pretensioned scraping mechanism with a replaceable rubber, dual blade and UHMWPE backing plate to continuously remove material from the conveying surface shall be provided at the conveyor discharge.

L. Hardware: All nuts, bolts and washers shall be Type 304 stainless steel.

M. Belt Spray Wash:

1. Located on underside of conveyor belt near the tension station, at mid-point of sloped belt, and adjacent to the drive station.
2. 3/4-inch diameter Type 304 stainless steel spray header with four spray nozzles.
3. Bronze manual ball valve.

N. Drip Pan Spray Wash:

1. Two drip pan spray wash systems, located along drip pan as indicated on the Drawings.
2. Each spray system consists of minimum 3/4-inch diameter Type 304 stainless steel spray header with at least four spray nozzles.
3. Drip pan spray wash system shall be capable of providing 5 gallons per minute at a minimum of 50 psi.
4. Each spray system includes bronze manual ball valve.
5. Contractor to coordinate with manufacturer to fabricate a drip pan sump and drain to capture washwater from belt and drip pan spray wash systems and conveyor to centrate drain.

O. Bearings:

1. Self-aligning, antifriction type, mounted in malleable iron housings.
2. Meet ABMA Standards with an L-10 life rating of 100,000 hours.
3. Bearing seals shall prevent the ingress of water and dust.

P. Half-Moon Covers:

1. Furnish 18-gauge Type 304 stainless steel half-moon covers with 10-gauge Type 304 stainless steel cover bands, with Type 304 stainless steel brackets located as shown on the Drawings.
2. Provide half-moon covers across the entirety of the conveyor.
3. Provide hinged or easily removable sections between centrifuges.
4. Comply with OSHA Standards.

2.05 CONTROL SYSTEM

A. General Instrumentation and Control Requirements: See Section 40 99 90, Package Control Systems. All instrumentation, control, and electrical components provided under this section, including panel fabrication and color coding of lights and switches, shall comply with the requirements of Section 40 99 90, Package Control Systems.

B. Provide all items not specifically identified which are required to implement a complete and functional system.

C. Equipment remote control and alarm monitoring provided by plant control system, furnished by others.

D. Control Panel:

1. Tag: H090-DEW1-CPL10.
2. Location: As shown on the Drawings.
3. Mounting: Wall mounted.
4. Power: 480-volt, three-phase, 60-Hz.
5. Type: NEMA 4X, Type 304 stainless steel.
    a. Certification: UL 508A label.
6. Incoming Power and Distribution:
    a. Provide main circuit breaker with external operator mechanism.
    b. Provide a 480V/120V ac control power transformer sized appropriately for the control circuit loads.

7. Motor Starters:
    a. Solid state reduced voltage soft starter with integral bypass and the following integral functions:
        1) Phase reversal, phase loss, phase imbalance, SCR overtempt, SCR short and overload protection.
    b. Provide starter properly sized for each motor.
8. Operator Controls and Status Indicators:
    a. EMERGENCY STOP pushbutton.
    b. Conveyor HAND/OFF/REMOTE selector switch.
    c. Conveyor running indicator light.
    d. EMERGENCY STOP ACTIVATED indicator light.
    e. CONVEYOR ZERO SPEED FAULT indicator light.
    f. CONVEYOR OVERLOAD indicator light.
    g. FAULT RESET pushbutton.
    h. Elapsed run time meter.
9. External Interfaces:
    a. Discrete Inputs:
        1) Enable interlock from Plant SCADA system.
        2) RUN command interlock from Plant SCADA system.
    b. Discrete Outputs:
        1) Conveyor REMOTE mode signal to Plant SCADA.
        2) EMERGENCY STOP signal to Plant SCADA.
        3) COMMON FAULT signal to Plant SCADA.
10. Functional Requirements:
    a. HAND/OFF/REMOTE Operation:
        1) HAND: Run conveyor, regardless of interlock conditions.
        2) REMOTE: System run command shall activate a timer, which shall allow conveyor to run for a preset duration after system RUN command has cleared, allowing all material to clear prior to shutting down conveyor.
        3) EMERGENCY STOP: All system faults shall shut down conveyor regardless of selected system mode.
    b. Manual reset shall be required prior to restarting the system in the event of any system fault. Control circuit shall latch on the indicator light associated with any system fault upon detection of fault condition.

2.06 ACCESSORIES

A. Anchor Bolts: Contractor to supply Type 304 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.

B. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

C. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted conveyor drive station and shall have the job name and serial number.

2.07 FABRICATION

A. Shop fabricate conveyor structural member and supports from structural carbon steel conforming to ASTM A36/A36M. Steel plate shall conform to ASTM A36/A36M or ASTM A283. Bolts shall conform to ASTM A325.

B. Fabrication shall adhere to the Area Classification and Materials Selection Table on Sheet 01-G-0085.

C. Galvanize in accordance with ASTM A123/A123M.

2.08 SOURCE QUALITY CONTROL

A. Inspect conveyor components for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Assemble and perform no-load running tests of the conveyor drive system at manufacturer’s plant before shipment.

C. Control Panel:

1. Inspect for required assembly criteria, component locations, labeling and ratings.
2. Inspect panel assembly for neatly arranged wiring and exceptional workmanship.
3. Test point to point continuity check per assembly drawings prior to energizing panel.
4. Test control circuit functionality.

2.09 WARRANTY

A. Manufacturer shall guarantee the equipment to be free of mechanical defects due to labor or materials for a period of 24 months from equipment startup.

B. In the event the equipment does not meet the performance specified, the Seller shall make whatever modifications or additions required to bring the equipment into compliance at no additional cost to the Owner.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with the manufacturer's installation instructions.

B. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture.

3.02 FIELD FINISHING

A. Conveyor and Supports: As specified in Section 09 90 00, Painting and Coating.

B. Following installation, touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, and consistency, and type of surface of the original shop/factory finish.

3.03 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each conveyor.

1. Alignment: Prior to facility startup, test complete assemblies for correct rotation, proper alignment and connection, quiet operation, and satisfactory specified performance.

B. Performance Test:

1. Conduct on each conveyor.
2. Perform under actual or approved simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction at full volumetric flow rate.

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, functional and performance testing and completion of Manufacturer's Certificate of Proper Installation, prestartup classroom or Site training, and facility startup.
2. Manufacturer's Pre-startup Training.

B. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Dewatered Cake Conveyor Data Sheet.

END OF SECTION

DEWATERED CAKE CONVEYOR DATA SHEET

Project: Haikey Creek WWTP Biosolids Improvements

Owner: City of Tulsa, Oklahoma

Equipment Name: Sludge Conveyor

Equipment Tag Number(s): H090-DEW1-CNV01

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: 5 hp

Voltage: 460

Phase: 3

Frequency: 60-Hz

Synchronous Speed: 1,800 rpm

☐ Thermal Protection: _____

☐ Space Heater: _____ volts, single-phase

Guaranteed Minimum Efficiency at Full Load: _____ percent

Guaranteed Minimum Power Factor at Full Load: _____ percent

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☐ 1.15

Enclosure Type: _____

☐ Multispeed, Two-Speed: _____ / _____ rpm

Winding: ☐ One ☐ Two

Mounting 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 Torque

Additional Motor Requirements: ☒ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features:

_____

_____

_____

SECTION 44 46 13.05
COMPOST MIXER SYSTEM

EQUIPMENT AND COMPONENT NUMBER(S)

Compost Mixer 1: H095-COM2-MXR01.
Compost Mixer 2: H095-COM2-MXR02.
Compost Conveyor 1: H095-COM2-CNV01.
Compost Conveyor 2: H095-COM2-CNV02.
Compost Conveyor Panel 1: H095-COM2-CPL01.
Compost Conveyor Panel 2: H095-COM2-CPL02.
Compost Conveyor Panel 3: H095-COM2-CPL03.

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. A36, Standard Specification for Structural Steel.
   b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   c. A325, Standard Specification for High-Strength Bolts for Structural Steel Joints.
5. Conveyor Equipment Manufacturers Association (CEMA):
   a. Standard No. 502.
   b. Publication, "Belt Conveyors for Bulk Material."
6. National Electric Manufacturers Association (NEMA): MG1, Motors and Generators.

1.02 RELATED SECTIONS

A. Section 40 99 90, Package Control Systems.

B. Section 44 46 13.01, Belt Conveyor System. (Note: Both mixer and belt conveyor systems to be supplied and warranted by one vendor.)

1.03 SYSTEM DESCRIPTION

A. Performance Requirements: Design conveyor system to meet service at less than 60 percent of the conveyor's rated capacity or 25 percent through filling. Each conveyor drive unit shall be designed for 100 percent of rated capacity.

B. Material received from the Compost Mixers is required to be conveyed to the discharge location as shown on the Drawings. The mixed compost feedstock material will consist of a mixture of woodchips and dewatered sludge discharged from the mixers onto the conveyor.

1.04 SUBMITTALS

A. Submittal requirements for the compost conveyors shall adhere to the same requirements outlined in Section 44 46 13.01, Belt Conveyor System, Article Submittals.

B. Action Submittals:

1. Shop Drawings:
    a. Detail drawings and specifications for components of equipment showing all dimensions, parts, construction details, and materials.
    b. Performance specifications of equipment.
    c. Process schematics associated with equipment.
    d. Standard operating procedures.
    e. Jamb removal and troubleshooting guidance.
    f. Standard lubrication requirements.
    g. Calculations, including:
        1) Effective torque, foot–pounds on each particle.
        2) Working horsepower.
        3) Maximum shear unit stress, pound force per inch of width.
        4) Discharge conveyor speed, depth, discharge height from anchor bolt elevation.
        5) Height of top of hopper gunwale from anchor bolt elevation (datum).
        6) L-10 bearing life for head, tail, and snub pulleys.
        7) Equipment sizing.
        8) Anchorage details.
    h. Fabricated items, equipment structural supports, platforms, handrails, and associated items.
    i. Design calculations for items covered by these Shop Drawings. Calculations shall show design stresses in structural members and connections for loading combinations. Seal the calculation of the structural member calculations by a professional engineer.

j. Design loadings, for load combinations, to be transmitted to foundations or supports.
k. Size, length, and spacing of anchor bolts or attachments to the foundations or supports.
l. Specific details of attachment of bracing members to concrete or steel structures.
m. Seal the structural shop drawings by a professional engineer.
n. Wiring and control schematics, details of the control panels including panel layout, bill of materials terminals and numbers.

C. Informational Submittals:

1. Manufacturer's test reports.
2. Manufacturer's Certificate of Proper Installation.
3. Installation Instructions.
4. Operation and Maintenance Data.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: After testing and before dismantling for shipment, matchmark and tag wiring and mechanical connections to ensure proper field assembly.

B. Delivery: In accordance with the General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. Mixer equipment and conveyors shall be designed to work in tandem with each other. All components supplied under this section shall be designed and rated for continuous duty (24 hours per day, 7 days per week, 365 days per year) operation.

2.02 SERVICE CONDITIONS – COMPOST FEEDSTOCK

A. Material Conveyed: Dewatered sludge and shredded wood chip amendment mixture.

B. Bulk Density:

1. Compost Feed Stock: Approximately 800 pounds per cubic yard or 20 pounds per cubic foot.
2. Dewatered Sludge: See Section 44 46 13.01, Belt Conveyor System.
3. Bulking agent: 60 percent to 80 percent total solids, 250 pounds to 450 pounds per cubic yard.

C. Capacity: 250 tons per hour.

D. Intermittent Use: 5 days/week.

E. Running Hours/Day: 8.

F. Belt Size: 48 inches.

G. Belt Speed: 350 feet per minute.

H. Location: Outside underneath canopy, as shown on the Drawings.

2.03 MANUFACTURER

A. Compost Feedstock Conveyor: Kuhn; Roto-Mix Conveyor.

2.04 MIXERS

A. General: Mixer specification is based on manufacturer and model listed first in Paragraph Manufacturer and Product in this article. If other manufacturer's products are used, modification to dimensions and power supply etc., may be required to suit. Feed rate, volumetric capacity, and transfer efficiency must be equal for any alternative design.

B. The stationary mixer shall consist of one large diameter "reel" and two blending augers. The reel must turn slowly, lifting materials up and into the blending augers. The lower auger moves the material toward the front during the mixing process and charges the door opening during the unloading process. The upper auger turns at high speed, breaking up clumps and moving material toward the rear of the unit.

C. Design Requirements:

1. Capable of conveying mixture at a rate of 72 cubic yards (four batch loads) per hour.
2. Capable of eliminating all sludge balls over 1 inch in diameter.
3. Density of mixed material is approximately 1,000 pounds per cubic yard.
4. Mix components consist of sludge at 14 percent to 24 percent total solids, 1,350 pounds to 1,600 pounds per cubic yard; bulking agent at 50 percent to 70 percent total solids, 350 pounds to 6,000 pounds per cubic yard.
5. Material Conveyed: Dewatered sludge and shredded yard waste/wood chip amendment.
6. Size Distribution: 1/2-inch to 6-inch particles including splintered chips up to 6 inches long and 2 inches in diameter.

7. Continuous use.
8. Running Hours/Day: 4.
9. Mixer Volume: 22 cubic yards.
10. Number of Mixers: Two.

D. Mixing Box:

1. Mixer shell to be constructed of A-36 carbon steel lined with 12-gauge, Type 304 stainless steel. Support members, shields, undercarriage, etc., are to be made of A-36 carbon steel. The reel and augers are to be powered by a high torque, low speed chain and sprocket drive, completely housed in an oil bath enclosure. All bearings are to be high quality triple lip seal, self-aligning, and greaseable. Bearings that are not readily accessible are to be connected to lubrication points with flexible grease tubes. The mixer shall be equipped with a side discharge opening that is to be 22 inches high by 42 inches wide and equipped with a hydraulically controlled door.
2. Unloading time is to be approximately 3 minutes.

E. Electric Drive: Mixer shall be powered by a 75 hp, 480-volt, three-phase electric motor using a 2:1 reduction gearbox. A control package, consisting of a TEFC motor, a NEMA 4 steel enclosure, fusible main disconnects, magnetic starter with overloads, control transformer with fused primary and secondary, power supply for scale, remote control panel with dust-tight buttons, and complete mounting on the unit shall be included. The electric door control shall include a 480V ac hydraulic power pack, 2 hp starter, control panel, and hoses.

F. Slide Tray Discharge: Slide tray discharge will be used to direct material onto 60-inch wide stacking conveyor. Transfer to load conveyor uniformly in center of conveyor trough with minimal (less than 1 percent) spillage. Slide tray discharge shall facilitate the transfer of mixed solids onto a perpendicular 60-inch wide conveyor belt without spillage at all feed rates. Mixer slide tray shall have raising and lowering capabilities as needed to facilitate fee conveyance of mixed material downstream.

G. Finish: The base coat shall be a two-part epoxy primer. The finish coat shall be a two-part urethane. Standard color is gray.

H. Controls and Accessories:

1. Electronic Scale: A digital scale with four-point weigh bar mounts shall be supplied which offers capacities to 40,000 pounds and accuracies of one half of 1 percent. Display is to be 4 inches high and audio/visual alarm is available at preset weights. Radio controller is to be provided to

zero the scale from a remote location. Radio controller can be used to open and close the mixer gate and transfer contents to the belt conveyor.

2. Provide an 18-inch by 1/4-inch steel extension spill or splash boards designed by manufacturer to prevent spillage when materials are loaded by front end loader into the mixer.
3. Provide exterior ladder for inspection of mixer interior.

I. Control Panels (H095-COM2-CPL01):

1. NEMA 4 painted steel enclosure, 480 volts, three-phase, for outdoor duty, for additional panel requirements.
2. Free standing, mounted on 9-inch concrete pad.
3. Control panel shall include:
   a. 150A main circuit breaker disconnect interlocked with panel door.
   b. Combination circuit breaker type, NEMA rated motor starters.
   c. Fused control power transformer, 120V ac. Sized to accommodate all control devices plus 1,500 watts for receptacle.
   d. HAND/OFF/AUTO selector switch for mixer unloading system.
   e. START/STOP/AUTO switch for each component.
   f. Running lights (red).
   g. Motor failure alarm lights (amber).
   h. Hydraulic system failure alarm light (amber)
   i. Terminal strip for interfacing with external wiring.
   j. Alarm (high temperature, moisture, or high level) beacon located on top of panel.
   k. System EMERGENCY shut down push button.
   l. EMERGENCY alarm with (system shut down due to EMERGENCY button) light (amber)
   m. Lightning protection.
   n. Intrinsically safe relays as required for UL validation.
   o. Alarm silence button.
   p. 110-volt, duplex GFI outlet, weather-protected, and accessible from outside of panel.
   q. UL labeled panel.
   r. See Section 40 99 90, Package Control Systems, for component and wiring requirements.

J. Electrical:

1. General:
   a. Provide all necessary electrical components and wiring for a complete, functional system. Electrical components shall be provided in accordance with the requirements of Division 26, Electrical.

b. Instruments supplied in this section shall be wired by the system supplier to a common terminal junction box. Each conductor shall be terminated on a separate terminal point. Provide separation between analog signals and 120-volt power connections.

2. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make the necessary modifications to the electrical wiring and documentation as part of the lump sum price. All wiring shall meet the requirements of Section 26 05 05, Conductors, and NFPA 70. All insulation shall be rated 600 volts, minimum. All low-voltage (24V) signals shall be run in twisted, shielded pair cable.
3. Electrical Raceways: All electrical wiring shall be installed in conduit meeting the requirements of Section 26 05 33, Raceway and Boxes, and NFPA 70.

K. Operation Description:

1. Normal operation shall require the mixer/conveyor control panel to be set in AUTO mode. The mixer and conveyor system shall be controlled locally using a vendor-supplied control panel.
   a. In AUTO mode, mixer shall start via a wireless hand-held remote from the front end loader (FEL) cab once materials have been successfully loaded into the mixer. Once the targeted mixer has finished mixing after a predetermined length of time (as recommended by mixer manufacturer, set by operator), an audible alarm shall be activated and the mixed mixer shall stop. The conveyor shall then start automatically. The discharge gate for mixed mixer shall then open, material shall be directed onto the conveyor for loading mixed material up and over the wall for storage of mix in the three-sided mix bunker.
   b. In HAND mode, typically used for maintenance only, operator shall be able to manually control the mixer start and stop, mixer gate start and stop, and conveyor start and stop.
2. Each mixer shall have a large letter display visible by the FEL operator during loading process and shall indicate weight of the material inside the mixer.
3. AUTO MODE ONLY Interlocks. Mixers shall only be able to discharge contents one at a time and only if mixer’s discharge door downstream (if applicable) is not interfering with travel of mixed materials from discharge mixer. Mixers shall only be able to discharge if discharge conveyor is operating.

4. When either the conveyor is failed or stopped, mixer motor is overloaded, or hydraulic pump for discharge door is overloaded, or E-STOP button is activated, the FAIL signal shall be delivered to the appropriate control panels and the mixer(s) and /or conveyor shall be stopped automatically.

L. Manufacturer and Product:

1. Kuhn Knight; Model RC 260 Stationary Mixer.
2. Or Engineer-approved equal.

2.05 CONVEYOR COMPONENTS

A. Frame:

1. Material: Type 316 stainless steel.
2. Type: 20-inch deep truss with angle or channel top and bottom chords, angle lattice, and cross bracing.

B. Head Section:

1. Furnish a 16-inch diameter, 63-inch wide welded steel drum type head pulley, complete with lagging.
2. Support pulley shaft in pillow block bearings spaced at minimal distance to clear the running belt.
3. Furnish a belt cleaner at the underside of the head pulley to remove adhering material.
4. Furnish spring or counterweighted neoprene rubber blade belt cleaner on a channel or truss frame, for connection to the intermediate section of conveyor.

C. Tail Section:

1. Furnish a 14-inch diameter, 48-inch wide welded steel wing type tail pulley.
2. Support pulley shaft in pillow block bearings spaced at minimal distance to clear the running belt.
3. Furnish a belt cleaner-plow at the return belt prior to the tail pulley to prevent objects passing between the pulley and belt.
4. Furnish two feed-point troughing transition idlers, assembled and mounted on a channel or truss frame, for connection to the intermediate section of conveyor.

D. Idlers:

1. Carrying Idlers: 60-inch, 20-degree, equal length, CEMA C roll diameter, 4-inch steel rolls, with factory-sealed bearings.
2. Return Idlers: 60-inch flat conventional CEMA C roll diameter, 4-inch rolls, with factory-sealed bearings.
3. Idlers for Belt Scales: Scale quality, turned and balanced to 0.015 T.I.R (Total Indicated Runout).

E. Belt (Minimum Criteria):

1. Oil-resistant material.
2. 48-inch wide, multiple ply, rated at 330 piw (pounds per inch width).
3. Top Cover: 3/16 inch.
4. Bottom Cover: 1/16 inch.
5. Service: Conventional.
6. Splice: Mechanical fastener.

F. Skirtboards:

1. Fabricate from 10-gauge minimal thickness Type 304 stainless steel plate.
2. Seal lower edge with a 60-durometer rubber, rectangular strip, clamped to the exterior of the skirtboard, with provision to adjust for wear.
3. The spacing shall not exceed 2/3 belt width.
4. Set skirtboard length at 2 feet per 100 fpm belt speed, but not less than three times the belt width.
5. Attach to the conveyor support frame and terminate over an idler.

G. Drive Assembly:

1. Single drive, located at the head end.
2. Furnish OSHA coupling, belt, and chain guards.

H. Gear Reducer:

1. Shaft mounted, with a V-belt drive.
2. Gear housing shall provide complete protection under service conditions.
3. Gears: Manufactured to meet the requirements of AGMA Standards and rated Class II operation.
4. Lubrication: By splash as a minimum. Furnish with oil heater.
5. Furnish internally located and lubricated backstops.

I. Controlled Acceleration: Accelerate the conveyor belt from rest by reduced voltage.

1. Applied Torque: Adequate to start a fully loaded belt.

J. Creep Drive:

1. Furnish an independent motor and drive machinery capable of driving the empty conveyor through a clutch arrangement.
2. Install as part of drive assembly.

K. Shafts: Size shafts to ensure a bending deflection at the pulley end disc of no greater than 5 minutes.

1. Drive and Tail Shafts:
   a. AISI Steel Grade Designation: 1040.
   b. Select the heat treatment process (such as, normalize, anneal, 400-degree quench and temper, or 800-degree quench and temper) that will result in a minimum yield tensile strength as required for the calculated shaft loads.
   c. Accurately grind and fit with key seats, as required.
   d. Stepdown diameters will not be acceptable without prior approval.
2. Other Shafts: 65,000 psi minimum yield tensile strength, heat-treated, alloy steel.

L. Bearings:

1. Self-aligning, antifriction type, mounted in malleable iron housings, and fitted with taper-locking hubs.
2. Meet ABMA Standards with an L-10 life rating of 100,000 hours.
3. One bearing on each shaft shall float to compensate for shaft expansion.
4. Bearing seals shall prevent the ingress of water, dust, and material handled.

M. Takeup: Tail pulley, manually adjusted screw type operated.

1. Minimum Takeup Length: 3 percent of the total belt length.

N. Emergency Stop Switch: Furnish belt conveyors with an emergency stop system consisting of pull cord switches actuated by a cable system running the full length of both sides of the conveyor.

1. Cables and Supports:
   a. Orange-colored, plastic-covered steel aircraft cable.
   b. All cable end fittings and intermediate cable support eyes.
   c. Cable support eyes every 10 feet.

2. Switches:
    a. Limit the required actuating force to OSHA guidelines.
    b. Manually reset after actuation.
    c. Visual indication of operation.
    d. NEMA 250, Type 4, enclosure, with a single-pole, double-throw output contact, rated for switching an inductive load of 5 amps at 120V ac.
3. Manufacturers and Products:
    a. Conveyor Control Components; Model RS.
    b. Crouse-Hinds; Model AFU.

O. Structural Supports:

1. Design conveyor supports.
2. Connect to building structure.
3. Conveyor support locations are only shown when the adjoining structure requires that the conveyor support points be limited to specific locations. The absence of defined conveyor support locations or support details on the Drawings shall not relieve the Contractor of the responsibility of providing required conveyor supports.
4. Supports shall not restrict access to other process systems.
5. Design conveyor structures in conformance with the AISC Manual of Steel Construction, AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.
6. Limit maximum total deflection to less than 1/300 of span. Brace supports adequately to carry horizontal loads.
7. The flange, webs, legs, or wall thickness of conveyor support framing shall not be less than 1/4 inch. Use tubular steel, pipe, flat bar, or other members that provide a clean design that will minimize dust ledges and pockets.

2.06 CONTROL SYSTEM

A. General Instrumentation and Control Requirements: See Section 40 99 90, Package Control Systems. All instrumentation, control, and electrical components provided under this section, including panel fabrication and color coding of lights and switches, shall comply with the requirements of Section 40 99 90, Package Control Systems.

B. Provide all items not specifically identified which are required to implement a complete and functional system.

C. Equipment remote control and alarm monitoring provided by plant control system, furnished by others.

D. Control Panel:

1. Tag: H095-COM2-CPL01.
2. Location: As shown on the Drawings.
3. Mounting: Wall mounted.
4. Power: 480-volt, three-phase, 60 Hz.
5. Type: NEMA 4X, Type 304 stainless steel.
   a. Certification: UL 508A label.
6. Incoming Power and Distribution:
   a. Provide main circuit breaker with external operator mechanism.
   b. Provide a 480V/120V ac control power transformer sized appropriately for the control circuit loads.
7. Motor Starters:
   a. Solid state reduced voltage soft starter with integral bypass and the following integral functions:
      1) Phase reversal, phase loss, phase imbalance, SCR overtempt, SCR short and overload protection.
   b. Provide starter properly sized for each motor.
8. Operator Controls and Status Indicators:
   a. EMERGENCY STOP pushbutton.
   b. Conveyor HAND/OFF/REMOTE selector switch.
   c. Conveyor running indicator light.
   d. EMERGENCY STOP ACTIVATED indicator light.
   e. CONVEYOR ZERO SPEED FAULT indicator light.
   f. CONVEYOR OVERLOAD indicator light.
   g. FAULT RESET pushbutton.
   h. Elapsed run time meter.
9. External Interfaces:
   a. Discrete Inputs:
      1) Enable interlock from Plant SCADA system.
      2) RUN command interlock from Plant SCADA system.
   b. Discrete Outputs:
      1) Conveyor REMOTE mode signal to Plant SCADA.
      2) EMERGENCY STOP signal to Plant SCADA.
      3) COMMON FAULT signal to Plant SCADA.
10. Functional Requirements:
    a. HAND/OFF/REMOTE Operation:
       1) HAND: Run conveyor, regardless of interlock conditions.
       2) REMOTE: System run command shall activate a timer, which shall allow conveyor to run for a preset duration after system RUN command has cleared, allowing all material to clear prior to shutting down conveyor.
       3) EMERGENCY STOP: All system faults shall shut down conveyor regardless of selected system mode.

b. Manual reset shall be required prior to restarting the system in the event of any system fault. Control circuit shall latch on the indicator light associated with any system fault upon detection of fault condition.

2.07 ACCESSORIES

A. Anchor Bolts: Contractor to supply Type 304 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.

B. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

C. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted conveyor drive station and shall have the job name and serial number.

2.08 SOURCE QUALITY CONTROL

A. Inspect for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Assemble and perform no-load running tests of the conveyor drive system at manufacturer’s plant before shipment.

C. Control Panel:

1. Inspect for required assembly criteria, component locations, labeling and ratings.
2. Inspect panel assembly for neatly arranged wiring and exceptional workmanship.
3. Test point to point continuity check per assembly drawings prior to energizing panel.
4. Test control circuit functionality.

2.09 WARRANTY

A. Manufacturer shall guarantee the equipment to be free of mechanical defects due to labor or materials for a period of 24 months from equipment startup.

B. In the event the equipment does not meet the performance specified, the Seller shall make whatever modifications or additions required to bring the equipment into compliance at no additional cost to the Owner.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with the manufacturer's installation instructions.

B. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture.

3.02 FIELD FINISHING

A. Following installation, touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, and consistency, and type of surface of the original shop/factory finish.

3.03 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each conveyor.

1. Alignment: Prior to facility startup, test complete assemblies for correct rotation, proper alignment and connection, quiet operation, and satisfactory specified performance.

B. Performance Test:

1. Conduct on each mixer, related equipment, and conveyor system.
2. Perform under actual or Engineer-approved simulated operating conditions.
3. Test for a continuous 4-hour period without malfunction.
4. Coordinate test with conveyor system, using Engineer-approved design conditions, and demonstrate proper mixing of material as specified.
5. Coordinate text with mixer system to deliver designed operating conditions without spill or impact with downstream mixer tray on the compost feed stock system.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner for installation assistance, inspection, field test, startup and Site training.

1. 3 person-days, for both mixer and attached mix discharge conveyor system. Representative for installation assistance and inspection, functional and performance testing and completion of Manufacturer's

Certificate of Proper Installation, prestartup classroom or Site training, and facility startup.

2. Manufacturer’s Pre-startup Training.

B. See Section 01 43 33, Manufacturers’ Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this specification:

1. Compost Conveyor 1 and 2 Data Sheet.

END OF SECTION

COMPOST CONVEYOR 1 AND 2 DATA SHEET

Project: Haikey Creek WWTP Biosolids Improvements

Owner: City of Tulsa, Oklahoma

Equipment Name(s): Compost Conveyor 1 and Compost Conveyor 2

Equipment Tag Number(s): H095-COM2-CNV01 and H095-COM2-CNV02

Type:

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: 20 hp and 20 hp

Voltage: 460

Phase: 3

Frequency: 60-Hz

Synchronous Speed: 1,800 rpm

☐ Thermal Protection: _____

☐ Space Heater: _____ volts, single-phase

Guaranteed Minimum Efficiency at Full Load: _____ percent

Guaranteed Minimum Power Factor at Full Load: _____ percent

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15

Enclosure Type: TEFC

☐ Multispeed, Two-Speed: _____ / _____ rpm

Winding: ☐ One ☐ Two

Mounting 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 Torque

Additional Motor Requirements: ☐ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features:

Conveyor capacity shall handle 250 tons/hour based on 20 lbs/CF of material. Material is mixed woodchips and dewatered cake.

SECTION 46 24 25
IN-LINE SLUDGE GRINDERS

EQUIPMENT AND COMPONENT NUMBER(S)

Grinder 1: H090-DEW1-GRD01.
Grinder 1 Local Control Panel: H090-DEW1-CPL01.

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. This section includes the supply, delivery, Site storage, installation, testing and placement into operation of one in-line sludge grinders for the dewatering feed to the centrifuges, including the drive motor, control panels, and all appurtenances as specified herein and shown on the Drawings.

B. Electric motors shall be provided as part of the work of this section and comply with Division 26, Electrical.

C. Control System Requirements: Conform to the requirements of Section 40 99 90, Package Control Systems.

D. All O&M data, O&M manuals, training requirements, special tools, spare parts, and warranties shall be provided in accordance with Division 01, General Requirements.

1.02 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).
5. National Electric Code (NEC).
6. National Electrical Manufacturers Association (NEMA).
7. UL.
8. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Substantiation of motor horsepower selection.
   d. Detailed mechanical and electrical drawings showing the equipment dimensions, size, 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. Complete data on motors as specified in Division 26, Electrical.
   h. Complete drawings of the control panels showing all components, both door mounted and internal and complete wiring schematics, to completely illustrate the equipment to be supplied. Instrumentation and control submittals to be in accordance with Section 40 90 00, Instrumentation and Control for Process Systems.
   i. Factory finish system in accordance with Section 09 90 00, Painting and Coating.
      1) Where system proposed is different from that specified, or where, in the manufacturer's opinion, the coating system(s) proposed exceed(s) the requirements specified, submit the complete technical literature of the proposed system(s) for review.
      2) Where equipment is to be factory-prepared and primed, and field finished, and if manufacturer of finish coating differs from that of shop primer, Contractor shall provide both manufacturers' written confirmation that the prime coat and finish coat are compatible.

B. Informational Submittals:

1. Anchorage and bracing calculations, drawings and cut sheets in accordance with Section 01 88 15, Anchorage and Bracing.
2. A statement indicating and supporting bearing life.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Suggested spare parts list to maintain the equipment in service for a period of 5 years.

6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance (with current price information).
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.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage, and handling shall be in accordance with in accordance with Section 01 61 00, Common Product Requirements.

B. The containers shall provide adequate protection for the equipment in a dry indoor environment between 40 degrees F and 100 degrees F until time for installation.

1.05 QUALITY ASSURANCE

A. Qualified suppliers shall have a minimum 5 years' experience at manufacturing, two-shafted grinding equipment and controlling equipment with a minimum of 10 installations at equivalents applications. Supplier shall provide a list of names and dates of installations for verification by the Engineer.

B. The manufacturer must certify that the unit can be returned for maintenance to the factory or a local repair facility.

1.06 WARRANTY

A. Manufacturer's warranties shall be per Division 01, General Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURER AND PRODUCT

A. The sludge grinders and motor controls shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods. The grinders shall be:

1. JWC Environmental; 30004T-1206.
2. "Or-equal."

B. Basis of Design: Muffin Monster Model No. 30004T-1206-DI as manufactured and supplied by JWC Environmental, Inc.

1. 6-inch ANSI 125-pound flat face flanged pipe connection.
2. Maximum Design Flow Capacity: 700 gpm (1.00 mgd).
3. Nominal Cutter Stack Height: 12 inches.
4. Pipe Connection: 6-inch ANSI 125-pound flat face.
5. Cutter Stack Configuration: Single Zone-Helical.

2.02 SERVICE CONDITIONS

A. Each grinder, under continuous operation, shall be capable of chopping and shredding rags, wood, plastics, and similar materials found in anaerobically digested wastewater sludge originating from municipal wastewater. The small chopped and shredded pieces shall produce a completely homogenized sludge mixture. Grinder feed characteristics:

1. Solids Content: 1 percent to 10 percent.
2. Temperature: 40 degrees F to 100 degrees F.
3. Abrasive.
4. Specific Gravity: 1.0.

B. Grinders shall be installed on the suction line of the dewatering centrifuge feed pumps as shown on the Drawings. Flange connections on the suction and discharge shall be as shown on the Drawings.

2.03 SPARE EQUIPMENT

A. To provide system redundancy, an additional spare grinder of the same make and model shall be provided for maintenance purpose, and the spare shall be stored nearby for quick installation. Package unit for long-term storage.

2.04 PERFORMANCE REQUIREMENTS

A. The grinders shall have a minimum flow through capacity of 600 gpm.

B. The grinders shall be heavy-duty units capable of operating continuously, processing wet or dry and designed for grinding anaerobically digested sludge into uniform, homogenized slurry. Grinders shall be rated for 150 psig (seals 60 psig) working pressure. Headloss through the unit shall not exceed 0.5 psi at all specified flow rates and solids content.

C. Maximum Discharge Solids Size: 0.4 inch by 0.4 inch by 0.5 inch.

2.05 MATERIALS AND EQUIPMENT

A. Pipe flange adaptors for inline applications shall be 125-pound ANSI B16.1, and have gasketed clean out covers for access to the cutting chamber.

B. The main housing shall be a solid cast structure made of ASTM A3950 or ASTM A536 ductile iron. The one-piece flanged body shall be capable of remaining in-line if removal of the cutter cartridge and drive assembly is required for service. The main housing shall maintain a clearance not to exceed 5/16 inch between the major diameter of the cutter and the housing. The main housing shall be provided with a covered access port for equipment inspection. Access port covers shall be of the same material as the main housing.

A. The grinder shall be of the two-shaft design with a 261-pound-foot full load torque with reducer, and a 1,330-pound-force full load force at the cutter tip. The shafts shall counter rotate and one shaft shall rotate at approximately two thirds the speed of the other shaft. The shaft shall be equipped with a minimum of individual 13-tooth cutters and spacers.

B. The grinder shall be constructed of corrosion resistant material to resist corrosion due to cavitation or galvanic action. Shafts shall be constructed from AISI 4140 heat treated steel hexagon stock. Each hexagon shaft shall be a minimum of 2 inches. Round shaft shall not be provided. Cutters and spacers shall be cast from AISI 4130 or AISI 4140 heat treated alloy steel, surface ground for uniformity and through hardened to 45–52 Rc on the cutters and 34–52 Rc for the spacers.

C. Each grinder shall be self-cleaning without the use of an external flushing system. Each grinder shall be a straight-through design to minimize clogging.

D. Mechanical shaft seals shall be provided and shall operate on the reverse pressure principle. The radial and axial loads of the shafts shall be borne by oversized Conrad-type (deep-groove) ball bearings. The bearings shall be protected by a combination of replaceable seals and end face mechanical seals. Face materials shall be tungsten carbide, not requiring an external flush or any type of lubrication. The bearings and seals shall be housed in a replaceable cartridge that supports and aligns the bearings and seals, as well as protects the shaft and end housings. O-rings shall be made of Buna-N or EPDM elastomers. Products requiring lubrication or flushing are not acceptable.

E. There shall be a motor speed reducer for each motor. The speed reducer shall be greased for life. Gearing shall be classified for continuous duty, AGMA Class III, 24-hour, heavy shock duty with 2.0 service factor based on motor nameplate rating. The output shaft of the gear reducer shall be directly coupled to the grinder input shaft using a two-piece coupling.

F. Each grinder shall be capable of continuous operation at low or no flow conditions.

G. Fabrication shall adhere to the Area Classification and Materials Selection Table as shown on the Drawings.

2.06 ELECTRICAL EQUIPMENT

A. General:

1. Electrical equipment shall be in accordance with NEMA standards and NEC requirements.
2. Auxiliary control devices shall be rated 10 amps, 120V ac (pilot duty) and shall provide isolated contacts of the control of each associated motor. Furnish complete electrical schematics, wire diagrams, one-line diagram and dimensional drawings of all electrical equipment specified hereinafter.

B. Each drive motor shall be a minimum of 3 hp, 1,800 rpm, 460V, three-phase, 60-Hz and shall meet the requirements of Division 26 20 00, Low-Voltage AC Induction Motors. Motor shall be vertical, totally enclosed fan cooled (TEFC) and premium efficiency.

C. NFPA electrical classification for the grinder environment shall be unclassified.

2.07 CONTROLS

A. Each grinder motor controller shall also include programmable logic controller to sense a jam and activate a reversing and alarm sequence, under voltage protection, over voltage protection, fuse protection, over current and motor stall protection, motor starter and contacts for remote signal operation.

B. Each grinder shall be provided with its own control panel with a wall mounted NEMA 4X FRP enclosure. Each panel shall be preassembled and prewired for connection to a 480V, three-phase, 60-Hz source. Each control panel shall be provided with a main circuit breaker disconnect with a flange mounted operating handle, a transformer to supply 120V control power and a full voltage reversing combination magnetic motor starter. Each control panel shall have UL listing for “industrial control panels”. Circuit breakers and

motor starters shall be fully rated for an available fault current of 65,000 amps RMS symmetrical.

C. All wiring shall be identified with a number code and all external connections brought to a numbered terminal strip. Wiring shall comply with the applicable requirements of the latest edition of the NEC. Interconnecting wiring between this panel and the grinders and other equipment shall be included under Division 26, Electrical.

D. The system controls shall provide the following operation:

1. Operate in HAND, OFF, or REMOTE mode. In the REMOTE mode, the grinder will automatically start and stop when the respective dewatering centrifuge feed pump starts and stops.
2. Sense an overload (jam) condition, momentarily reverse to clear the condition and return to a forward direction. If the overload has cleared, return to normal operation.
3. If the overload has not cleared, the same procedure shall be repeated (as specified above).
4. If the overload (jam) has still not cleared (within 30 seconds) unit shall reverse, shut down and energize a light and alarm circuit.
5. Resetting an overload condition shall only be permitted at the local control panel.
6. Thermal motor overload protection and single-phase protection shall be included in the control panel.

E. Operator Controls:

1. Field panel shall have the following door mounted operator controls and indicators:
    a. HAND/OFF/REMOTE selector switch.
    b. FORWARD-REVERSE selector switch.
    c. Indicator: White POWER ON pilot light.
    d. Red RUN pilot light.
    e. Amber OVERLOAD pilot light.
    f. RESET pushbutton.

F. Local control panel for each grinder shall be provided with three Form “C” dry output contacts, rated at 120V ac with tagged terminals for a remote common alarm signal, motor run status, and for position status of the L-O-R selector switch. Output contacts shall be wired to tagged terminals.

G. Motor shall automatically stop when low voltage condition occurs.

2.08 ANCHORAGE

A. Design the anchorage system to secure and support equipment. The anchorage system shall be designed in accordance with Section 01 88 15, Anchorage and Bracing.

B. All anchor bolts, washers, nuts, bolts and other hardware necessary to secure the system shall be Type 316 stainless steel.

C. Structural computations signed by a professional engineer registered in the State of Oklahoma shall be submitted for the record.

D. Contractor shall furnish and install anchorage system in accordance with the manufacturer’s drawings and written instructions.

2.09 SURFACE PREPARATION AND SHOP PAINTING

A. Provide manufacturer's premium grade coating. Chips, coating defects, or damage to coating system will not be accepted. Package unit for transport and installation to mitigate coating damage.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with the manufacturer’s instructions and recommendations in the locations shown on the Drawings. Grinders shall be rigidly supported on U-shaped pipe supports. Installation shall include furnishing the required grease and/or oil for initial operation. The grades of grease and/or oil lubricants shall be in accordance with the manufacturer’s recommendations.

3.02 INSPECTION AND TESTING

A. Furnish the services of a factory representative, who has complete knowledge of proper operation and maintenance to inspect and adjust the installed equipment prior to operation of the units and to final inspect the final installation and supervise a test run of the equipment.

B. After the grinders and their associated pumps are installed and their piping completed and ready for operation, conduct in the presence of the Engineer and under the supervision of the manufacturer’s factory representative, test runs using water to demonstrate the unit’s ability to operate as specified, without noise, vibration or overheating. Any deficiencies noted during the testing shall be corrected at no additional cost to the Owner.

C. When digested sludge becomes available, another test shall be made in the presence of the Engineer under regular operating conditions, to further demonstrate that the grinder performance conforms to this section. It shall also be demonstrated that each grinder control system performs as specified.

D. The grinder will not be accepted until the grinder passes a 1-month performance test under normal operating conditions with sludge. If the grinder shuts down due to a jam condition four times during the 1-month performance test, the grinder will be considered unacceptable. The manufacturer shall be permitted to modify the equipment completely at the manufacturer's expense and the tests repeated as described above.

3.03 MANUFACTURER'S SERVICES

A. Provide Manufacturer's Representative in accordance with Section 01 91 14, Equipment Testing and Facility Startup. 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. 2 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for pre-startup classroom or Site training.
4. 1 person-day for post-startup training of Owner's personnel.

B. Training shall not commence until accepted detailed lesson plan, including but not limited to, the basic operation and troubleshooting of the grinder, has been reviewed by Engineer. The training shall include power point presentation and handouts for all participants. All material, including PowerPoint presentation, shall be turned over to the Owner for future training of operating personnel.

C. See Section 01 43 33, Manufacturers' Field Services.

3.04 MANUFACTURER'S CERTIFICATION OF PROPER INSTALLATION

A. The Contractor shall provide manufacturer's Certification of Proper Installation in accordance with Section 01 33 00, Submittal Procedures.

3.05 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Grinder 1 Data Sheet.

END OF SECTION

GRINDER 1 DATA SHEET

Project: Haikey Creek WWTP Biosolids Improvements

Owner: City of Tulsa, Oklahoma

Equipment Name: Grinder 1

Equipment Tag Number(s): H090-DEW1-GRD01

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: 3 hp

Voltage: 460

Phase: 3

Frequency: 60-Hz

Synchronous Speed: _____ rpm

☒ Thermal Protection: _____

☐ Space Heater: _____ volts, single-phase

Guaranteed Minimum Efficiency at Full Load: _____ percent

Guaranteed Minimum Power Factor at Full Load: _____ percent

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☐ 1.15

Enclosure Type: TEFC

☐ Multispeed, Two-Speed: _____ / _____ rpm

Winding: ☐ One ☐ Two

Mounting 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 Torque

Additional Motor Requirements: ☒ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features:

Provide one spare grinder unit.